TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL AND DIRECT SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)

TRUCK, FIRE FIGHTING, 4x4,

MODEL 1350 PKP/200 AFFF

NSN 4210-00-4845729

ANSUL FIRE PROTECTION

REPORTING ERRORS AND RECOMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistake or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, U.S. Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. A reply will be furnished directly to you.

REPORTING EQUIPMENT IMPROVEMENTS (EIR'S)

If the Fire Fighting Truck needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you do not like about your equipment. Let us know why you do not like the design or performance. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at: U.S. Army Troop Support Command, ATTN: AMSTR-QX, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. We will send you a reply.

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AXLE-FRONT

AXLE-FRONT FRONT AXLE ALIGNMENT SPECIFICATIONS 1978-1979--1980

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Introduction

Outlined herein are Front Alignment Specifications pertaining to "Caster" "Camber" "Toe-In" and "King Pin Inclination".

Check alignment at regular intervals and particularly after front suspension has been subjected to extremely heavy service or severe impact loads. Before checking and adjusting alignment, components such as wheel bearings, tie rods, steering gear, shock absorbers and tire inflation should be inspected and corrected where necessary.

The caster, camber and toe-in settings are for unladen (no payload) vehicles.

King pin inclination is not required for any of the front end alignment checking machines as a means of obtaining caster or camber. A check of king pin inclination can be used as an indicator of damaged king pins, knuckles or spindles.

Caster Measurement and Correction

Caster specifications are based on unladen (no payload) vehicles. If the frame is not level when alignment checks are made., this must be considered in determining whether the caster setting is correct.

With the vehicle on a smooth, level surface, frame angle should be measured with a bubble protractor placed on the frame rail. The degree of tilt from the level frame position is the angle that must be used in determining a correct caster setting. Positive frame angle is defined as forward tilt (front end down) and negative angle as tilt to rear (front end high).

The measured frame angle should be added or subtracted, as required from the specified caster setting, to obtain the caster that should actually be measured on vehicle.

- 1. Positive frame angle should be subtracted from specified setting.
- 2. Negative frame angle should be added to specified setting.

As an example, if the specified, caster setting is a positive 1 deg. and it is found that the vehicle has a positive one degree frame angle, then the measured caster should be 0 deg. \pm 1/2 deg. caster angle when the chassis is operating under load.

Possible causes of incorrect caster are sagging springs, bent or twisted axle, or unequally tightened spring U-bolts. In most cases a twisted axle would be the cause if caster varies more than the specified 1/2 deg. between left and right side.

If caster must be corrected, taper shims can be used as required between the springs and axle. Spring U-bolts should be tightened evenly and to specified torque after the addition or removal of shims. Be sure spring center bolt drops into I-beam pilot. Also, when tightening U-bolt nuts, be sure at least one full thread of U-bolt is visible when nut is tightened to specified torque. If not visible, use longer U-bolt.

IMPORTANT

When U-Bolts are replaced, the new must be grade 5 minimum incorporating rolled threads.

U-bolt nuts are to be flanged head type or those having a nylon insert locking feature.

Checking and Correcting Front Wheel Toe-In

No change should be made in toe-in until the other factors of front wheel alignment are known to be within specifications. Incorrect toe-in results in excessive tire wear caused by side slippage. When attempting to determine the cause of excessive wear, first check camber, caster and king pin inclination in the order named. (King pin inclination is a reference and not adjustable in the field.)

Turn the front wheels to the exact straight-ahead position. When setting toe-in adjustment, the front suspension must be neutralized; that is, all component parts must be in the same relative position when making the adjustment as they will be in a normal static unladen position. To neutralize the suspension, the vehicle must be rolled forward 12 to 15 feet. By rolling the vehicle forward, all tolerances in the front suspension are taken up and the suspension is then in normal static unladen position. Neutralizing the front suspension is extremely important, as after the vehicle has been jacked up in order to scribe the tires, the front wheels will not return to the normal static unladen position due to the tires gripping the floor surface when the vehicle is lowered.

IMPORTANT

The toe-in specifications listed are designed to yield a "0" degree toe-in condition in normal operations with payload.

SPECIAL INSTRUCTIONS

Before attempting front alignment procedures observe the following:

- A. Caster angles are for an unladen (no payload) vehicle. If frame is not level, the frame angle must be added to front high or subtracted from front low the caster angle to obtain true caster reading.
- B. Caster angle difference between left and right wheel not to exceed 0 deg. 30 minutes.
- C. Toe-In dimension may be measured from center of tread, or from inside of tire.
- D. Tolerance unless otherwise noted:
 - 1. Caster plus or minus 0 deg. 30 minutes except Scout II & Cargostar which is plus or minus 1 deg. 0 min.
 - 2. Toe-In plus or minus 1/16 inch.
 - Camber plus or minus 0 deg. 30 minutes.
- E. After the axle model "P/S" = Power Steering "M/S" = Manual Steering

CHASSIS MODEL	AXLE MODEL	CASTER		TOE - IN		CAMBER		KING PIN INCLINATION (DEGREE)	
		DEGREE	MINUTES	INCH	MM	DEGREE	MINUTES	LT.	RT.
SCOUT II	FA-3	0	0	3/32 to 5/16	1.59 to 7.94	1	0	8 1/2	8 1/2
	FA-44	0	0	3/32 to 5/16	1.59 to 7.94	1	0	8 1/2	8 1/2
LOADSTAR	FA-54	0	0	1/16	1.59	1	0	8	8
	FA-64	2	0	1/16	1.59	0	±30	0	0
	FA-71	2	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-73	2	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-78	2	0	0 to 3/8	0 to 9.53	0	±30	0	0
	FA-79	2	0	0 to 3/8	0 to 9.53	0	±30	0	0
	FA-101	2	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-109	1	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-139	1	0	1/16	1.59	LT.0	30	4 1/4	4 1/2
						RT.0	15		
	FA-309	1	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-329	1	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-339	2	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-342	1	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
CARGOSTAR	FA-74	3	30	1/8	3.15	LT. 0	30	4 1/4	4 1/2
		_				RT. 0	15		
	FA-103	3	30	1/8	3.15	LT. 0	30	4 1/4	4 1/2
	E4 400			1/0	0.45	RT. 0	15	4.4/4	1.1/0
	FA-109	3	30	1/8	3.15	LT. 0	30	4 1/4	4 1/2
	E4 400			1/0	0.45	RT. 0	15	4.4/4	4.4/0
	FA-139	3	30	1/8	3.15	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		

CHASSIS MODEL	AXLE MODEL	CAS	STER	ТО	TOE - IN		CAMBER		KING PIN INCLINATION (DEGREE)	
		DEGREE	MINUTES	INCH	MM	DEGREE	MINUTES	LT.	RT.	
CARGOSTAR (Cont.)	FA-231	3	30	1/8	3.15	LT. 0	30	5 3/4	6 1/4	
						RT. 0	0			
	FA-309	3	30	1/8	3.15	LT. 0	30	4 1/4	4 1/2	
						RT. 0	15			
	FA-329	3	30	1/8	3.15	LT. 0	30	4 1/4	4 1/2	
						RT. 0	15			
	FA-339	3	30	1/8	3.15	LT. 0	30	4 1/4	4 1/2	
						RT. 0	15			
S-SERIES	FA-71	2	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2	
						RT. 0	15			
	FA-73	2	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2	
						RT. 0	15			
	FA-101	1	45	1/16	1.59	LT. 0	30	4 1/4	4 1/2	
						RT. 0	15			
	FA-109 P/S	3	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2	
						RT. 0	15			
	FA-109 M/S	2	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2	
						RT. 0	15			
	FA-118 P/S	3	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2	
						RT. 0	15			
	FA-118 M/S	2	30	1/16	1.59	LT. 0	30	4 1/4	41/2	
						RT. 0	15			
	FA-127 P/S	3	30	1/16	1.59	LT. 0	30	41/4	41/2	
						RT. 0	15			
	FA-127 M/S	2	30	1/16	1.59	LT. 0	30	41/4	41/2	
						RT. 0	15			
	FA-139 P/S	3	45	1/16	1.59	LT. 0	30	4 1/4	41/2	
						RT. 0	15			
	FA-139 M/S	2	45	1/16	1.59	LT. 0	30	4 1/4	4 1/2	
						RT. 0	15			
	FA-231	3	15	1/16	1.59	LT. 0	30	5 3/4	6 1/4	
						RT. 0	0			
	FA-232	3	15	1/16	1.59	LT. 0	30	5 3/4	6 1/4	
						RT. 0	0			



CHASSIS MODEL	AXLE MODEL	CAS	STER	TOE - IN		CAMBER		KING PIN INCLINATION (DEGREE)	
		DEGREE	MINUTES	INCH	MM	DEGREE	MINUTES	LT.	RT.
S-SERIES (Cont)	FA-309 P/S	3	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
, ,						RT. 0	15		
	FA-309 MI/S	2	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-329 P/S	3	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-329 M/S	2	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-339 P/S	3	45	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-339 M/S	2	45	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-341 P/S	3	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
	FA-341 M/S	2	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
FLEETSTAR (4x2) FA-101	2	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
(6x4) FA-101	4	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
(4x2) FA-109	1	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
(6x4) FA-109	3	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
(4x2) FA-139	1	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
(6x4) FA-139	3	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
(4x2) FA-231	2	0	1/16	1.59	LT. 0	30	S 3/4	6 1/4
						RT. 0	0		
(6x4) FA-231	4	0	1/16	1.59	LT. 0	30	5 3/4	6 1/4
						RT. 0	0		
(6x4) FA-232	4	0	1/16	1.59	LT. 0	30	5 3/4	6 1/4
						RT. 0	0		



CHASSIS MODEL	AXLE MODEL	CAS	STER	TOE - IN		CAMBER		KING PIN INCLINATION (DEGREE)	
		DEGREE	MINUTES	INCH	MM	DEGREE	MINUTES	LT.	RT.
FLEETSTAR (Cont.)									
(4x2)	FA-309	1	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
(6x4)	FA-309	3	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
(4xZ)	FA-329	1	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
(0.4)	E4 000	-	^	4/40	4.50	RT. 0	15	4.44	4.4/0
(6x4)	FA-329	3	0	1/16	1.59	LT. 0 RT. 0	30	4 14	4 1/2
(4×2)	FA-339	1	20	1/16	1.59	LT. 0	15 30	4 1/4	4 1/2
(4x2)	FA-339	'	30	1/16	1.59	RT. 0	30 15	4 1/4	4 1/2
(6x4)	FA-339	3	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
(0,4)	1 A-333		U	1/10	1.55	RT. 0	15	4 1/4	4 1/2
(4x2)	FA-340	1	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
()				.,		RT. 0	15	, .	,_
(6x4)	FA-340	3	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
(3.1.)			•			RT. 0	15		
PAYSTAR	FA-191	3	30	1/16	1.59	0	-15	0	0
	FA-192	3	30	1/16	1.59	0	-15	0	0
	FA-193	3	30	1/16	1.59	0	-15	0	0
	FA-194	3	30	1/16	1.59	0	45	5 1/2	5 1/2
	FA-195	3	30	1/16	1.59	0	45	5 1/2	5 1/2
	FA-231	3	30	1/16	1.59	LT. 0	30	5 3/4	6 1/4
						RT. 0	0		
	FA-232	3	30	1/16	1.59	LT. 0	30	5 3/4	6 1/4
						RT. 0	0		
	FA-233	3	30	1/16	1.59	LT. 0	30	5 3/4	6 1/4
						RT. 0	0		
	FA-237	3	30	1/16	1.59	LT. 0	30	5 3/4	6 1/4
	FA 000	 	22	1/10	4.50	RT. 0	0	10/4	0.4/4
	FA-238	3	30	1/16	1.59	LT. 0	30	J 3/4	6 1/4
	FA 000	1	20	1/10	4.50	RT. 0	0	5.0/4	0.4/4
	FA-239	3	30	1/16	1.59	LT. 0	30	5 3/4	6 1/4
						RT. 0	0		



CHASSIS MODEL	AXLE MODEL	CASTER		TOE - IN		CAMBER		KING PIN INCLINATION (DEGREE)	
		DEGREE	MINUTES	INCH	MM	DEGREE	MINUTES	LT.	RT.
PAYSTAR (Cont.)	FA-339	3	30	1/i6	1.59	LT. 0	30	4 1/4	4 1/2
						RT. 0	15		
COF-5370	FA-231	3	30	1/16	1.59	LT. 0	30	5 3/4	6 1/4
						RT. 0	0		
	FA-232	3	30	1/16	1.59	LT. 0	30	5 3/4	6 1/4
						RT. 0	0		
	FA-233	3	30	1/16	1.59	LT. 0	30	5 3/4	6 1/4
						RT. 0			
CONVENTIONAL								/ /	
TRANSTAR	FA-231	0	45	1/16	1.59	LT. 0	30	5 3/4	6 1/4
						RT. 0	0		
	FA-329	1	0	1/16	1.59	LT. 0	30	4 1/4	4 1/2
		_				RT. 0	15		
	FA-339	0	45	1/16	1.59	LT. 0	30	4 1/4	4 1/2
	54.040		45	4/40	4.50	RT. 0	15	4.4/4	4.4/0
	FA-340	0	45	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	EA 244	1	0	4/40	4.50			4.4/4	4.4/0
	FA-341	1	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
CO-TRANSTAR	FA-231	1	15	1/16	1.59	LT. 0	30	5 3/4	6 1/4
CO-TRANSTAR	FA-231	1	13	1/16	1.59	RT. 0	0	5 3/4	0 1/4
	FA-329	1	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
	1 A-329	'	30	1/10	1.59	RT. 0	15	4 1/4	4 1/2
	FA-339	1	15	1/16	1.59	LT. 0	30	4 1/4	4 1/2
	177.000	'	10	1,710	1.00	RT. 0	15	7 1/7	7 I/Z
	FA-340	1	15	1/16	1.59	LT. 0	30	4 1/4	4 1/2
		'	.0	., 10		RT. 0	15	'''	
	FA-341	1	30	1/16	1.59	LT. 0	30	4 1/4	4 1/2
		· ·	30		1.00	RT. 0	15	'''	,_

FRONT ALIGNMENT SPECIFICATIONS 1979-1910

FRONT ALIGNMENT SPECIFICATIONS (LEFT HAVE DRIVE)

PS=Power Steering MS=Manual Steering

CHASSIS MODEL	AXLE MO	DEL	CAS	STER	ТО	E IN	CAN	IBER
			Degree	Minutes	Inch	MM	Degree	Minutes
	FA-3 - FA-44	1979	Ö	0	3/32-5/16	1.59-7.94	1	0
Scout	FA-3 - FA-44	1980	2	30	0020	00-5.08	0	30
Cargostar	FA-74-FA-103 - FA	-109 - FA-139	ALL	AXLES	ALL	AXLES	ALL	AXLES
_	FA-309 - FA-329	- FA-339	3	30	1/8	3.175	LT 0	30
							RT 0	15
	FA-231 - FA-232		3	30	1/8	3.175	LT 0	30
							RT 0	0
S-Series	FA-64 - FA-78		2	30	0019	00-5.08	0	45
	FA-71 - FA-73		2	0	1/16	1.59	LT 0	30
							RT 0	15
	FA-81		3	0	0019	00-5.08	0	45
	FA-82 - FA-83		2	30	0030	00-7.62	0	15
	FA-101		2	30	1/16	1.59	LT 0	30
							RT 0	15
	FA-109		(PS) 3	30	1/16	1.59	LT 0	30
			(MS) 2	30			RT 0	15
	FA-118 - FA-127		(PS) 3	30	1/16	1.59	LT 0	30
			(MS) 2	30			RT 0	15
	FA-139		(PS) 3	45	1/16	1.59	LT 0	30
			(MS) 2	45			RT 0	15
	FA-226		(PS) 3	0	1/16	1.59	LT 0	30
			(MS) 2	0			RT 0	0
	FA-231 - FA-232	- FA-233	3	15	1/16	1.59	LT 0	30
							RT 0	0
	FA-309 - FA-329		(PS) 3	30	1/16	1.59	LT 0	30
			(MS) 2	30			RT 0	15
	FA-339 - FA-340		(PS) 3	45	1/16	1.59	LT 0	30
			(MS) 2	45			RT 0	15
	FA-341		(PS) 3	30	1/16	1.59	LT 0	30
			(MS) 2	30			RT 0	15

FRONT ALIGNMENT SPECIFICATIONS 1979-1910

FRONT ALIGNMENT SPECIFICATIONS (LEFT HAVE DRIVE) (Cont'd)

PS=Power Steering MS=Manual Steering

CHASSIS MODEL	AXLE MODEL	CAS	STER	TC	E IN	CAN	IBER
		Degree	Minutes	Inch	MM	Degree	Minutes
1853 FC	FA-139 - FA-339	(PS) 3	45	1/16	1.59	LT 0	30
		(MS) 2	45			RT 0	15
	FA-342	2	43	1/16	1.59	LT 0	30
						RT 0	15
Paystar	FA-191 - FA-192 - FA-193	3	30	1/16	1.59		15
	FA-194 - FA-195 - FA-196	3	30	1/16	1.59	0	45
	FA-231 - FA-232 - FA-233	ALL	AXLES	ALL	AXLES	ALL	AXLES
	FA-237 - FA-238 - FA-239	3	30	1/16	1.59	LT 0	30
						RT 0	0
	FA-339	3	30	1/16	1.59	LT 0	30
						RT 0	15
Conventional	FA-231	0	45	1/16	1.59	LT 0	30
Transtar						RT 0	0
	FA-234	1	0	1/16	1.59	LT 0	30
						RT 0	0
	FA-329	1	0	1/16	1.59	LT 0	30
						RT 0	15
	FA-339 - FA-340	0	45	1/16	1.59	LT 0	30
						RT 0	15
	FA-341	1	0	1/16	1.59	LT 0	30
						RT 0	15
COF-5370	FA-231 - FA-232 - FA-233	3	30	1/16	1.59	LT 0	30
						RT 0	0
CO-Transtar II	FA-226 - FA-231	1	15	1/16	1.59	LT 0	30
						RT 0	0
	FA-234	1	20	1/16	1.59	LT 0	30
						RT 0	0
	FA-329	1	30	1/16	1.59	LT 0	30
						RT 0	15
	FA-339 - FA-340	1	15	1/16	1.59	LT 0	30
						RT 0	15
	FA-341	1	30	1/16	1.59	LT O	30
						RT 0	15

FRONT ALIGNMENT SPECIFICATIONI (Cont'd.) 1979-1980

SERIAL NOS.

RIGHT HAND DRIVE
1980 PRODUCTION ONLY
KH 10001 AND UP = SPRINGFIELD
KG 10001 AND UP= FORT WAYNE
KC 10001 AND UP = CHATHAM

IMPORTANT

THE CAMBER SETTING FOR RIGHT HAND DRIVE VEHICLES IS THE SAME AS LEFT HAND DRIVE EXCEPT THOSE LISTED BELOW. ALL OTHER SPECIFICATIONS ARE THE SAME WHETHER RIGHT OR LEFT HAND DRIVE.

CHASSIS MODEL	AXLE MODEL	CA	CAMBER		
		<u>Degree</u>	<u>Minutes</u>		
Cargostar	FA-109 - FA-139 - FA-309 FA-329 - FA-339	LT 0 RT 0	15 30		
S-Series	FA-73 - FA-101 - FA-109 FA-309 - FA-339	LT 0 RT 0	15 30		
Conventional Transtar	FA-339	LT 0 RT 0	15 30		
Paystar	FA-339	LT 0 RT 0	15 30		

FRONT ALIGNMENT SPECIFICATIONS (Cont'd.) 1979-1980

KING PIN INCLINATION

KING PIN INCLINATION ON ALL AXLES IS 4 1/4 DEGREES LEFT AND 4 1/2 DEGREES RIGHT EXCEPT ON THE FOLLOWING:

AXLE MODEL	KING PIN INCLINATION (DEGREE)				
	LEFT	RIGHT			
FA-3 (1980)	9	9			
FA-3 (1979)	8 1/2	8 1/2			
FA-44 (1980)	9	9			
FA-44 (1979)	8 1/2	8 1/2			
FA-64	0	0			
FA-78	0	0			
FA-81	0	0			
FA-82	8	8			
FA-83	8	8			
FA-191	0	0			
FA-192	0	0			
FA-193	0	0			
FA-194	5 1/2	5 1/2			
FA-195	5 1/2	5 1/2			
FA-196	5 1/2	5 1/2			
FA-226	5 3/4	6 1/4			
FA-231	5 3/4	6 1/4			
FA-232	5 3/4	6 1/4			
FA-233	5 3/4	6 1/4			
FA-237	5 3/4	6 1/4			
FA-238	5 3/4	6 1/4			
FA-239	5 3/4	6 1/4			
FA-234*	0° 45'	0° 15'			

^{*}Top of King Pin Hole tilted outboard ir. I-Beam.

AXLE-FRONT

<u>IH MODEL</u>	<u>IH CODE</u>
FA-64	02064
FA-78	02078
FA-81	02081

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DESCRIPTION

The axle covered in this manual is a front driving unit incorporating hypoid gears and spherical steering knuckles. Driving torque from the axle shaft to the wheels is transmitted by a drive flange bolted to the axle shaft.

Complete Overhaul

- 1. Jack up truck until load is removed from the springs and place floor jack under frame to safely secure truck weight off axle.
 - 2. Drain lubricant from housing.
 - 3. Disconnect brakes.
 - 4. Disconnect drag link from ball stud bracket.
- 5. Disconnect propeller shaft from pinion shaft yoke.
- 6. Support axle on portable floorack and remove spring bolts.
- 7. Roll axle out from truck and position on stationary floor jacks.
- 8. Remove tires and rims or disc wheels as appropriate.

DISASSEMBLY

Differential

- 1. To remove differential carrier from axle housing remove mounting nuts from carrier to axle housing flange.
- 2. Use puller screws provided in carrier mounting flange to start carrier from housing.
- 3. Support weight of carrier safely on roller type floor jack or portable floor lift and roll jack and carrier out from under truck.
 - 4. Mount differential carrier in rebuild stand.
- 5. Remove cotter pins from bearing adjuster locks and remove locks from bearing caps.
- 6. Match mark one differential bearing cap and leg of carrier with punch or chisel to identify each for correct reassembly.
- 7. Remove bearing cap bolts and take off the bearing caps and bearing adjusters (Fig. 1).

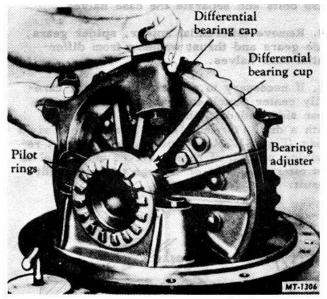


Fig. 1. Removing Differential Bearing Caps

Attach chain sling from overhead hoist and lift differential and drive gear assembly from the differential carrier (Fig. 2). Tilt either the carrier or differential assembly to allow drive gear to pass pinion radial bearing. Place differential assembly on bench.

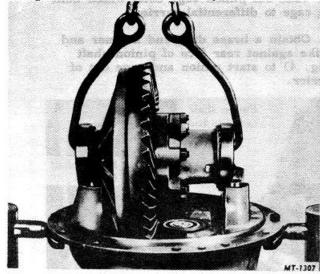


Fig. 2. Lifting Differential from Carrier

8. Match mark differential case halves with a punch or chisel to assure correct alignment on reassembling.

- 9. Remove self-locking nuts from differential case bolts and separate the case halves.
- 10. Remove differential spider, spider gears, side gears and thrust washers from differential case halves.
- 11. If necessary to remove drive gear, carefully center punch each rivet head on drive gear side and drill through the rivet head with a drill .79 mm (1/32") smaller than rivet body (Fig. 3). Use a punch to press out remaining portion of rivet. Never use chisel to cut off rivet heads or damage to dase might result.

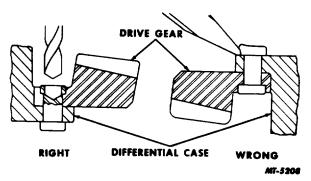


Fig. 3. Drive Gear Rivet Removal

- 12. Take out pinion cage bolts which hold the cage to differential carrier.
- 13. Obtain a brass drift and hammer and strike against rear face of pinion shaft (Fig. 4) to start pinion and cage out of carrier.

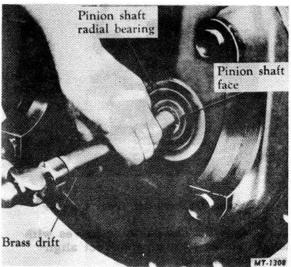


Fig. 4. Loosening Pinion and Cage from Carrier

14. Remove the pinion and cage assembly from the carrier (Fig. 5). Because of the weight of the pinion and cage assembly make sure that parts are secured safely while removing. Pinion and cage might be damaged if allowed to fall.

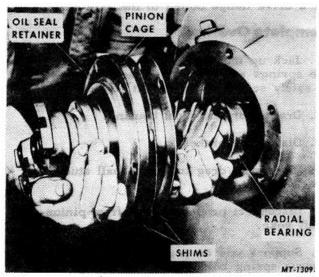


Fig. 5. Removing Pinion and Cage Assembly

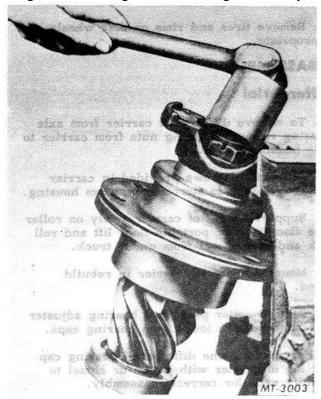


Fig. 6. Removing Pinion End Nut

15. Mount the pinion and cage assembly in a heavy duty vise and remove the pinion end nut as shown in Fig. 6.

- 16. Drive the pinion assembly from the companion flange with a soft hammer. Do not allow pinion assembly to fall.
 - 17. Remove pinion cage "O" ring type seal (Fig. 7).
- 18. Tap pinion from cage and remove forward thrust bearing.
- 19. Remove the thrust bearing spacer from the pinion shaft.
- 20. If it is necessary to remove the rear thrust bearing or the radial bearing from the pinion shaft, remove these bearings with a suitable puller.

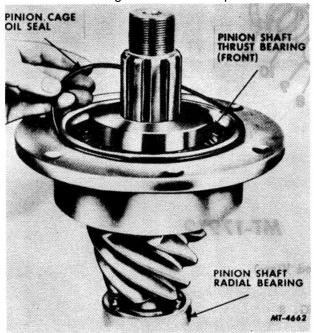


Fig. 7. Removing Pinion Cage Oil Seal CLEANING, INSPECTION AND REPAIR

Remove all dirt, old lubricant and gasket material from components of the front axle. Immerse in cleaning solvent and use a stiff brush if necessary. Bearings should be cleaned separately in clean solvent and special efforts taken to protect their finely machined surfaces. If compressed air is used for drying, do not spin bearings while drying.

Never use anything but brake fluid to clean hydraulic brake cylinders.

Examine all bearings for roughness, damage to wear by rotating each bearing slowly in the hand. If in doubt as to bearing condition, replace. Ring gear, drive pinion, differential pinions and any other gears should be checked for damaged teeth, worn spots, or distortion. Inspect differential case assembly for cracks, damage or distortion. Make sure splined ends of axle shafts are neither twisted or cracked. Shim packs should be of uniform thickness. Discard thrust washers and obtain new even when only slight wear is indicated. Always use new gaskets. Hex nuts and capscrews with rounded corners, all lockwashers, seals, pins and bushings should be replaced.

REASSEMBLY

Differential

The principal adjustments made on the differential carrier assembly are devised for establishing the proper gear tooth contact and thereby obtaining a long wearing, quiet running front axle. Fundamentally, there are five adjustments to be covered and these are accomplished as the differential carrier assembly is assembled. To emphasize their importance these five steps or adjustments are listed here as well as in the actual assembly procedure. These adjustments are:

- 1. Preload the pinion bearings.
- 2. Establish the pinion nominal dimension.
- 3. Set gear lash.
- 4. Preload the differential bearings.
- 5. Check the gear tooth contact.

Refer to the exploded view (Fig. 8) and reassembly differential carrier as follows.

- 1. Press rear thrust bearings (6) firmly against shoulder of pinion shaft (12).
- 2. Press radial bearing (13) on stub end of pinion shaft (12) and against pinion. Stake face of pinion evenly in six places to secure radial bearing in place (Fig. 9).

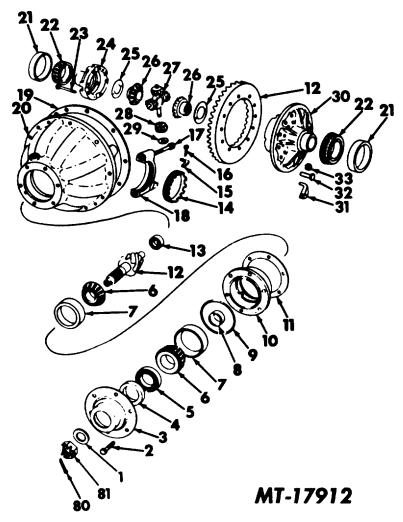


Fig. 8. Differential (Exploded View)
LEGEND FOR FIG. 8

1	WASHER
2	BOLT, hex-hd.
3	RETAINER, pinion oil seal
4	SEAL, pinion oil (felt)
5	SEAL, pinion oil
6	BEARING, pinion cone

Key Description

- 7 BEARING, pinion cup8 SPACER, pinion bearing
- 9 SEAL, pinion bearing cage (cork)
- 10 CAGE, pinion bearing C
- 11 SHIM, pinion bearing cage12 GEAR SET, ring and pinion
- 13 BEARING, pinion pilot
- 14 ADJUSTER, differential bearing
- 15 LOCK, differential bearing adjuster
- 16 PIN, cotter
- 17 BOLT, bearing cap
- 18 CAP, bearing

Key Description

- 19 GASKET, differential carrier
- 20 CARRIER, differential
- 21 BEARING, Differential cup
- 22 BEARING, differential cone
- 23 BOLT, differential case
- 24 CASE, differential
- 24 CASE, unite
- 25 WASHER
- 26 GEAR, differential side
- 27 SPIDER, differential
- 28 PINION, differential
- 29 WASHER, differential pinion
- 30 CASE, differential
- 31 SCOOP, oil
- 32 RIVET, ring gear
- 33 NUT, hex.

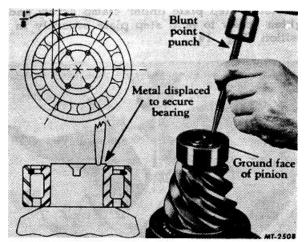


Fig. 9 Staking Pinion Straddle Bearing

It is suggested that for locating punch positions for staking, the end of the pinion be painted with Prussian Blue and a circle be scribed on end of pinion about 3.17 mm (1/8") in from the pinion circumference. When staking the bearings be careful to make the depth of the indentations or stake points uniform, otherwise bearing may be damaged. Deep punch or stake marks are not necessary. Apply the staking operation at opposite sides of the pinion end until all stake points are obtained. Where special staking tools are available, they can be used, otherwise the use of a blunt or round nosed punch is satisfactory.

- 3. If bearing cups (7) have been replaced, press new cups firmly against shoulders of pinion cage (10).
- 4. Prelubricate the bearings with gear lubricant.
- 5. Position spacer (8) on pinion shaft and against rear thrust bearing.
- 6. Insert pinion and rear thrust bearing (6) in pinion cage.
- 7. Mount pinion and cage in arbor press and place prelubricated front thrust bearing (6) on pinion shaft. Press bearing firmly and squarely against spacer.

Pinion Bearing Preload

Pinion bearing preload is established by selecting the correct size spacer (8) located between the two pinion thrust bearings and tightening pinion end nut to the specified torque (see "TORQUE CHART").

8. Temporarily assembly the pinion, cage and

flange assembly, less oil seal and retainer. Clamp the assembly in a vise to hold the companion flange. Tighten end nut to specified torque.

9. The pinion cage should be rotated while tightening the pinion to seat and align the bearings. Rotation of the pinion is important. Otherwise a false condition of bearing load could exist. The bearing rollers must be seated against the face of the bearing cone (Fig. 10).

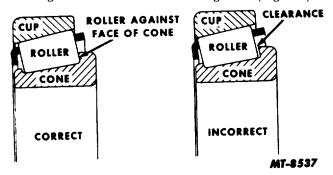


Fig. 10 Pinion Bearing Roller Position

10. To measure bearing preload, wrap a strong cord or soft wire about the pinion cage and attach end to spring scale (Fig. 11). Read scale only while cage is rotating. Compare this scale reading with the figure shown in "SPECIFICATIONS".

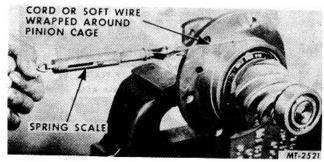


Fig. 11 Measuring Pinion Bearing Preload

11. When preload does not agree with "SPECIFICATIONS", bearing load may be increased by installing a thinner spacer or decreased by using a thicker spacer. Determine spacer thickness using a micrometer (Fig. 12) and make a new selection accordingly. Closer adjustment may be obtained by working spacer to desired thickness, using emery cloth on a flat surface.

12. Wash spacer clean of emery cuttings before installing on pinion.

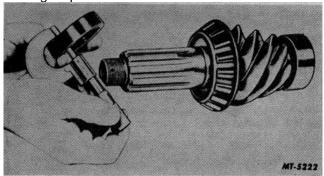


Fig. 12 Measuring Spacer Thickness

13. After pinion bearing preload is established good practice would be to check bearing roller ends to see whether they are in contact with bearing cone face. Use a feeler gauge ribbon. There must be no clearance at ends of rollers (Fig. 11).

Check pinion end nut for correct torque and install cotter pin.

Pinion Nominal Dimension

To establish pinion nominal dimension which is the distance from the face or finished end of the installed pinion to the centerline of the ring gear or cross shaft, proceed as follows.

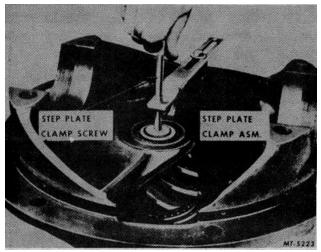


Fig. 13 Locating Step Plate Clamp

14. Install pinion, cage and bearing assembly in differential carrier. Obtain step plate clamp assembly from SE-1065 Pinion Setting Gauge set and attach it to differential carrier flange, locating step plate clamp screw over center of pinion (Fig. 13).

15. Install step plate under clamp screw and tighten screw to hold step plate securely in position (Fig. 14).

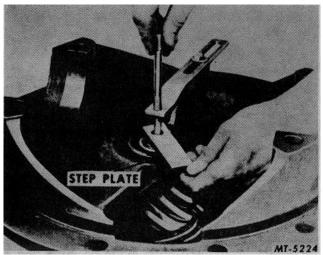


Fig. 14 Installing Step Plate

16. The step plate is necessary to project the face of the pinion where it can be measured by the gauge which is on the centerline of the drive gear.

Be certain lugs on step plate straddle the bearing staking indentations on end of pinion.

17. Mount assembled SE-1065 gauge in bearing bores of carrier (Fig. 15). See "SPECIFICATIONS" for correct disc size.

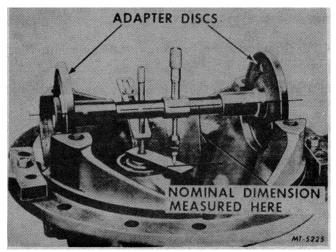


Fig. 15 Assembled Gauge in Position

18. Make certain that bearing bores are clean and free of nicks and burrs. Adjust micrometer so it is directly over end at a 90 degree angle to step plate.

- H
- 19. Run micrometer thimble down to measure distance between center of ring gear and step plate. Make a note of this reading along with the nominal dimension given in "SPECIFICATIONS". Locate on pinion the etched marking which indicates variation from zero cone setting. If it is a minus figure, subtract it from specified dimension, and if a plus figure, add it to specified Results of calculation will provide the corrected pinion nominal dimension to which pinion Comparison of corrected nominal must be set. dimension with the actual or measured dimension indicates amount of change necessary for correct pinion position. It may be necessary to add or remove shims between cage and differential carrier to provide correct pinion nominal dimension.
- 20. Remove gauge and prepare to install ring gear and differential carrier in differential housing.
- 21. If drive gear was removed from case, rivet gear to case flanged half.

When reinstalling ring gear, it is suggested that Riveting Jig SE-1575 be used. This special tool is designed for use with either hydraulic or mechanical press equipment. Rivet pressures for ring gear installation should be in accordance with those given in "SPECIFICATIONS".

- 22. Apply axle lubricant to differential case inner walls and all other component parts.
- 23. Place thrust washer (25) and side gear (26) in flanged half of case together with spider (27), pinion gears (28) and thrust washers (29).
- 24. Install opposite side gear and thrust washer in differential case plain half (24).
- 25. Align the match marks and join the two differential case halves. Draw assembly together with four equally spaced bolts (23) and nuts (33).
- 26. Check assembly for free rotation of side gears and pinions and if satisfactory, install remaining differential case bolts. Tighten to torque specified in "TORQUE CHART".
- 27. Differential bearings (22) are installed by pressing them squarely onto differential case halves.
- 28. Prelubricate differential bearings with axle lube and place bearing cups (21) over bearings. Attach chain sling to differential assembly and install in carrier.

- 29. Place bearing adjusters (14) in carrier and turn hand tight against bearing cups (21).
- 30. Observe match marks on bearing caps and install caps onto legs of differential carrier (20).
- 31. Install bearing cap bolts(17) and washers. Tighten to specified torque. (See "TORQUE CHART").
- 32. Tighten bearing adjusters (14) alternately until all end play is eliminated. Rotate differential while tightening.

Gear Lash

33. A special effort should be made to set the backlash between pinion and ring gear to the same amount as was originally built into them .15-.30 mm (.006" to .012"). Generally the amount of backlash is stamped or etched on the ring gear. When installing new gears, backlash is measured with a dial indicator mounted on differential housing (Fig. 16). To adjust the backlash move the ring gear toward or away from the pinion. This is done by backing off one adjusting ring and advancing the opposite ring the same amount.

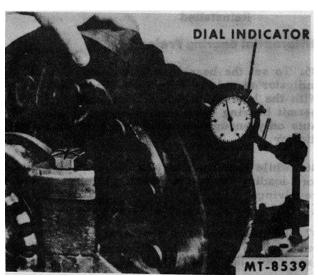
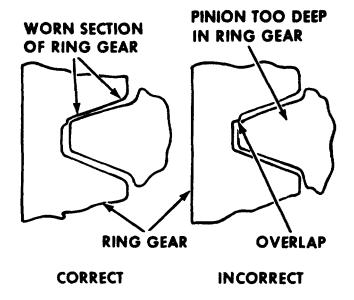


Fig. 16 Setting Correct Backlash

34. When original gear and pinion sets are being reinstalled, the wear pattern of the gear teeth must be considered in, the backlash adjustment. Gears that have been in service for long periods form running contacts which should not be greatly changed. If, in

checking backlash, the amount measured is in excess of the amount shown on the ring gear, the lash may be reduced only in the amount that will avoid overlap of the worn tooth section (Fig. 17). A slight overlap at the worn section will cause gear operation to be noisy and rough.



MT-8540

Fig. 17 Correct and Incorrect Lash Adjustment where worn Gears are Reinstalled

Differential Bearing Preload

- 35. To set the bearing preload, mount dial indicator at side of ring gear (Fig. 18). With the bearing capscrews loosened to permit bearing movement, loosen adjusting nuts only enough to notice end play on indicator.
- 36. While gear is held in .000" end play and before loading bearings, check gear for runout by revolving ring gear. If runout exceeds 20 mm (.008"), remove differential and check for cause.
- 37. Tighten both adjusting nuts from .000" end play to preload the differential bearings (see "SPECIFICATIONS").
- 38. Tighten bearing cap, capscrews or stud nuts to specified torque (see "TORQUE CHART").
- 39. Recheck gear lash to make certain that the lash setting has not been changed.

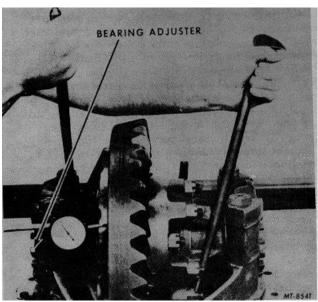


Fig. 18 Adjusting Bearing Preload

40. Install adjusting rings locks and cotter pins.

Gear Tooth Contact

41. Apply oiled red lead lightly to the hypoid gear teeth (Fig. 19).

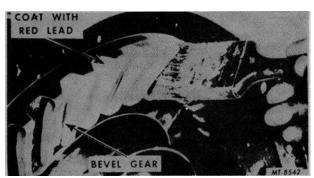


Fig. 19 Painting Gear Teeth for Obtaining Tooth Contact Impressions

- 42. When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts (Fig. 20).
- 43. Sharper impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the gear teeth. Coast side should be correct when drive side is correct. Generally, coating approximately

twelve teeth is sufficient for checking purposes

- 44. With adjustments properly made, a correct tooth contact similar to that shown in Fig. 20, will be secured. The area of contact starts near the toe of the gear and extends about 62 1/2 per cent of the tooth length. This adjustment results in a quiet running gear and pinion set which, because the load is distributed over the teeth within the proper area, will deliver all the long service built into it.
- 45. When checking paint impressions on gear teeth of an axle under heavy load, the impressions usually spread out somewhat longer than the patterns obtained from a bench test. This can be considered as normal. Ring gears when mounted should show a bearing toward the toe or small end of the tooth, but never at the heel or large end. The reason being that it is practically impossible to make gears and gear mounting so rigid that no deflection will occur when full torque is applied. This deflection causes the bearing to approach the heel of the tooth. When gears are adjusted so that the bearing is toward the heel of the tooth, it results in a concentration of load on the top corner of the heel and breakage will follow.

INSTALLATION

Differential Carrier

- Using chain sling and overhead hoist, move differential carrier assembly from rebuild stand to roller type floor jack.
- 47. Place a new carrier to housing gasket C19) on differential carrier (20) and roll carrier into position on the axle housing. Install the housing bolts and lockwashers and tighten to specified torque (See "TORQUE CHART").

rf



Fig. 20 Tooth Contact Impressions

AXLE END DISASSEMBLY

(Wheel, Hub, Drum and Brake Group Removed)

Trunnion Housing Disassembly

1. Slide spindle off Trunnion Housing Studs, (retaining nuts removed when disassembling brake group). See Fig. 1.

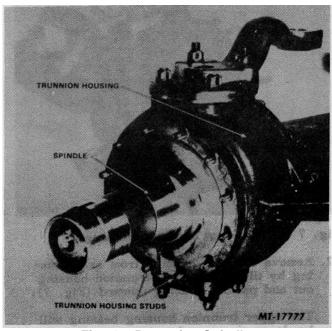


Fig. 1 Removing Spindle

2. Remove axle shaft and universal joint assembly from axle housing (Fig. 2).

Care should be taken not to damage axle shaft oil seal in end of axle housing when removing axle shaft.

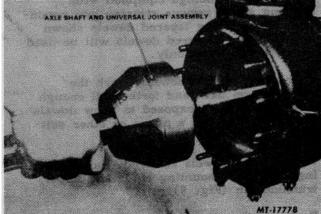


Fig. 2 Removing Axle Shaft and Universal Joint Assembly

3. Remove retaining ring half (halves) mounting bolts and lockwashers from back side of trunnion housing (Fig. 3).

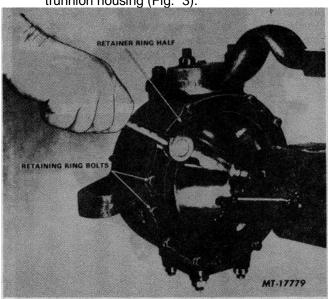


Fig. 3 Removing Retaining Ring Half (Halves) Mounting Bolts

4. Remove retaining ring halves, split ring retainer, seal with spring, steering ball felt, flange and gasket from back side of trunnion housing (Fig. 4).

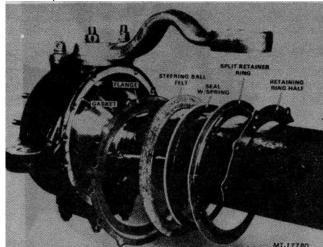


Fig. 4 Trunnion Housing Seals and Retainers

5. Loosen both upper and lower trunnion cap retaining nuts. Remove bottom cap mounting nuts and lockwashers only at this time.

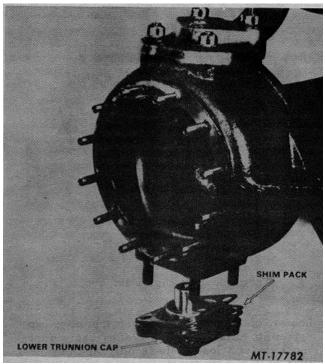


Fig. 5 Trunnion Cap Retaining Nuts

6. Remove lower trunnion cap and shim pack (fig.6). Retain and mark shim pack for reassembly.

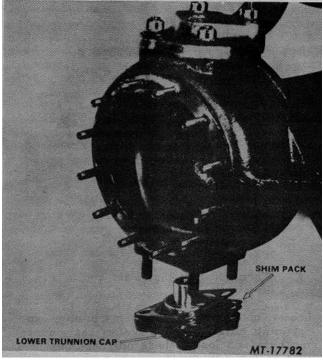


Fig. 6 Trunnion Cap and Shim Pack

The lower trunnion bearing will lay loose on bottom of trunnion housing when lower trunnion cap is removed. Remove lower trunnion bearing by pulling trunnion housing away from axle housing to provide access to bearing as shown in Figure 7.

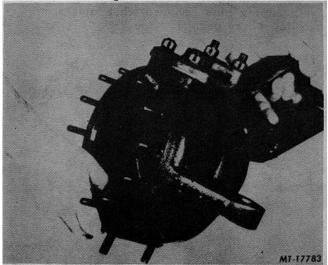


Fig. 7 Removing Trunnion Housing

- 7. Remove trunnion housing from axle housing by tilting bottom of trunnion housing out and pulling housing upward (Fig. 7).
 - The upper trunnion housing bearing will lay loose on upper bearing race of axle housing end when trunnion housing is removed. Remove upper trunnion bearing.
- 8. Place trunnion housing on workbench and remove upper trunnion cap retaining nuts (previously loosened), lockwashers, trunnion cap and shim pack.
 - On trunnion housings equipped with steering arms, remove steering arm retaining nuts exposing tapered dowels shown in Figure 8. Tapered dowels will be used with steering arms only.
- To remove tapered dowels, work the steering arm back and forth until enough of the dowels are exposed to allow dowels to be gripped with a pliers or other suitable tool.
- 10. With tapered dowels removed, pull steering arm off of mounting studs and upper trunnion pin (Fig. 9).
 - Remove upper trunnion cap shim pack. Retain and mark shim pack for reassembly.

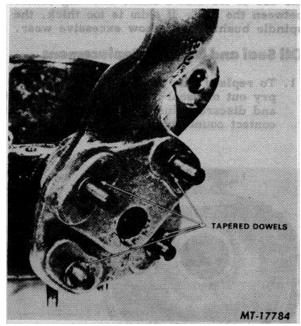


Fig. 8 Tapered Dowels

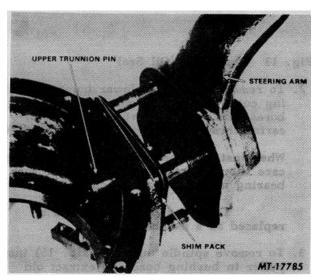


Fig. 9 Steering Arm Removal

It is not necessary to remove the upper trunnion pin upon trunnion housing disassembly. However, if so desired the upper trunnion pin may be tapped from its bore by working through the trunnion housing rear opening.

Axle Shaft and Universal Joint Disassembly

1. Place axle shaft in a vise equipped with soft jaws. Grasp shaft end of universal

joint and pull while rapping back side of joint with a soft faced hammer (see Fig. 10).

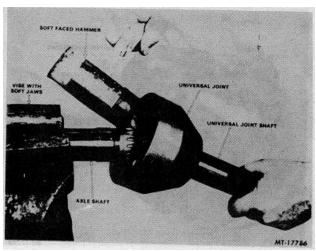


Fig. 10 Axle Shaft and Universal Joint Disassembly

Remove lock ring from axle shaft end and discard. A new lock ring should always be used on reassembly.

2. Place universal joint in a vise equipped with soft jaws with outer race bell upward.

Tilt inner race in outer race until one ball can be removed, continue this procedure until all balls are removed. A soft faced hammer may be used to aid inner race movement. See Fig. 11.

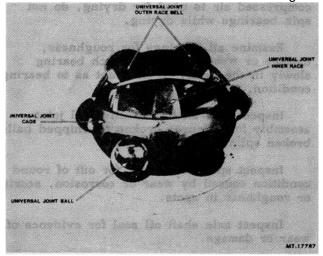


Fig. 11 Removing Universal Joint Balls

3. Roll universal joint cage at a right angle to universal joint outer race bell with

the two elongated openings in cage aligned with opposite teeth of outer race bell (Fig. 12). Lift cage and inner race from outer race bell.

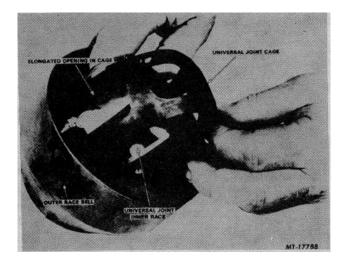


Fig. 12 Removing Cage and Inner Race

4. To separate inner race from cage turn inner race at right angle to cage, align notched tooth of inner race with elongated opening in cage, and roll inner race out of cage.

Cleaning and Inspection

Remove all dirt, old lubricant and gasket material from all components. Immerse in cleaning solvent and use a stiff brush if necessary. Bearings should be cleaned separately in clean solvent and special efforts taken to protect their finely machined surfaces. If compressed air is used for drying, do not spin bearings while drying.

Examine all <u>bearings</u> for roughness, damage or wear by rotating each bearing slowly in the hand. If in doubt as to bearing condition, replace.

Inspect axle shaft and universal joint assembly for seizure, broken or chipped balls, broken splines or other damage Inspect spindle bushing for out of round condition caused by wear or corrosion, scoring or roughness in spots.

Inspect axle shaft oil seal for evidence of wear or damage.

Inspect for evidence of wear due to improper drive flange shim size. Wear on the interior surface of ball end of axle housing and on edge of ball joint bell housing indicates

the use of too thin a shim, allowing contact between the two. If shim is too thick, the spindle bushing will show excessive wear.

Oil Seal and Bearing Replacement

 To replace axle shaft oil seal (Fig. 13) pry out old seal from bore of axle housing and discard. Install new seal. Seal must contact counterbore.

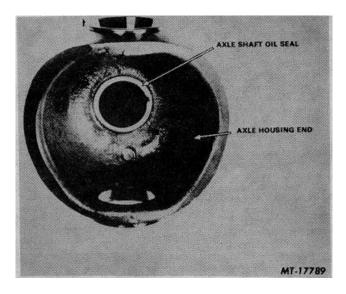


Fig. 13 Axle Shaft Oil Seal

2. To remove upper and lower trunnion bearing cups, drive cups out of axle housing bores with a driver and brass drift inserted through the opposite bore (Fig. 14).

When installing new trunnion bearing cups care should be taken not to nick or scar bearing mating surface of cup.

Cups and bearings should be replaced as a matched set.

 To remove spindle bushing (Fig. 15) insert puller in bushing bore and extract old bushing and discard.

Install new bushing in bore. Bushing must contact counter bore.



Fig. 14 Removing Trunnion Bearing Cup

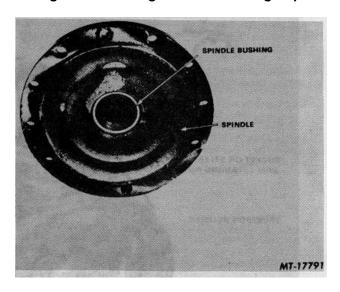


Fig. 15 Spindle Bushing

Axle Shaft and Universal Joint Assembly

1. Assemble inner race and cage by indexing notched tooth of inner race with elongated opening in cage and rolling inner race into cage. See Fig. 16.

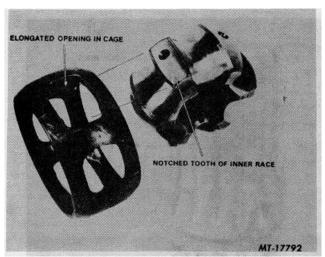


Fig. 16 Assembling Inner Race and Cage

2. Align elongated openings of cage with opposite teeth of outer race bell and lower inner race and cage assembly into outer race bell (Fig. 17).

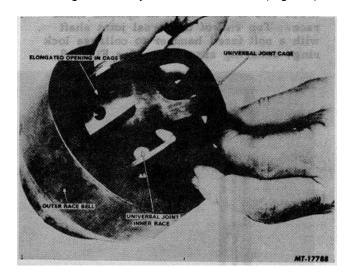


Fig. 17 Assembling Inner Race, Cage and Outer Race Bell

- Tilt inner race in outer race until one ball can be inserted, continue this procedure until all balls are inserted. Prelubrication of components and a soft faced hammer may be used to aid inner race movement.
- 4. Install new lock ring on axle shaft end and place axle shaft in a vise equipped with soft jaws. See Fig. 18.

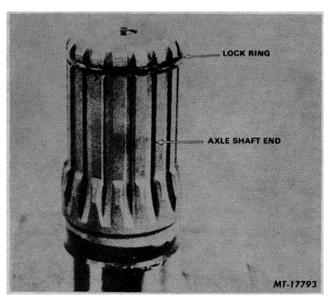


Fig. 18 Axle Shaft Lock Ring

 Place universal joint on top of axle shaft index end of axle shaft in splined inner race. Tap end of universal joint shaft with a soft faced hammer to collapse lock ring, securing assembly. See Fig. 19.

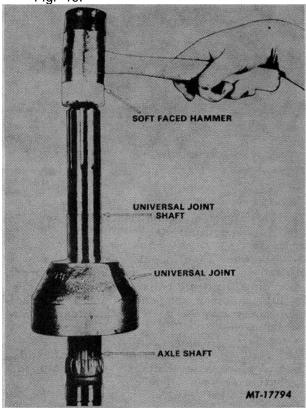


Fig. 19 Assembling Axle Shaft and Universal Joint

6. Pack universal joint bell with lubricant.

Trunnion Housing Assembly

- Using original shim pack install upper trunnion cap. Torque retaining nuts to 81 to 95 Newton Meters (60 to 70 ft.lbs). On trunnion housings equipped with steering arms, install tapered dowels before installing lockwashers and retaining nuts. Torque retaining nuts to 81 to 95 Newton Meters (60 to 70 ft.lbs.).
 Refer to Fig. 8.
- Lubricate trunnion bearings thoroughly.
 of axle housing end. Lower trunnion housing
 into place on axle housing end indexing upper
 trunnion pin with upper trunnion bearing.
- 3. Place lower trunnion bearing in bottom of trunnion housing and align with lower bearing cup. Using original shim pack install lower trunnion cap. Torque retaining nuts to 81 to 95 Newton Meters (60 to 70 ft.lbs.).

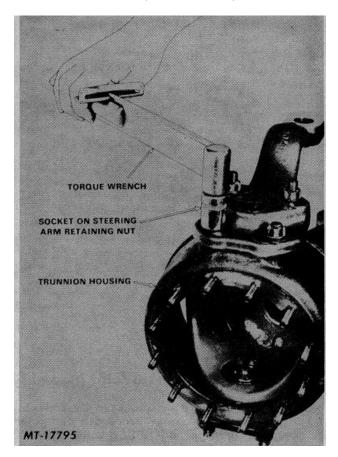


Fig. 20 Checking Bearing Adjustment

- 4. Check trunnion bearing adjustment by placing a torque wrench on trunnion cap or steering arm retaining nut and swinging trunnion housing. Torque should be 11 to 20 Newton Meters (8 to 15 ft. lbs.). To increase torque, remove shims, to decrease torque, add shims. See Fig. 20.
- Install gasket, flange, steering ball felt, seal with spring, split retainer ring and retaining ring halves on rear of trunnion housing. See Fig. 21 for correct order or component installation.

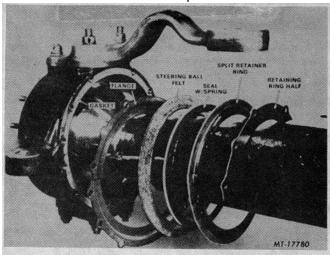


Fig. 21. Trunnion Housing Seals and Retainers
Install retaining half (halves) lockwashers and
mounting bolts. Torque mounting bolts to 14 to
20 Newton Meters (10 to 15 ft lbs.).

6. Install axle shaft and universal joint assembly in axle housing indexing splined end of axle shaft

- with side gear of center unit (Fig. 22). When installing axle shaft and universal joint assembly care should be taken not to damage axle shaft oil seal.
- 7. Slide spindle over universal joint shaft and on to trunnion housing studs.
- 8. Fill axle housing end with lubricant through grease zerk located behind trunnion housing on top center of exposed portion of steering ball.
- 9. Axle end assembly is now complete. Spindle is retained to trunnion housing by brake group retaining nuts upon brake group reassembly.

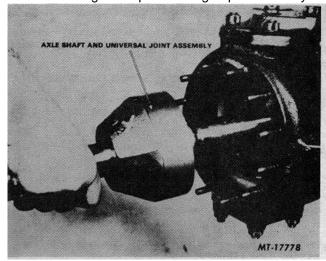


Fig. 22. Axle Shaft and Universal Joint Assembly

SPECIFICATIONS

IH Model FA-64

FA-78

IH Cod 02064

02078

Pinion:

Drive Hypoid

Nominal Dimension 82.6 mm (3.2530")

SE-1065-9 Disc D (2)

Cage Rotating Torque (lbs.) 2.7-7.7 Kg (6-17 lbs.)

Differential

Bearing Preload 1 Notch Each Side

Housing:

Lubricant Capacity 8.2 Liters (17.8 Pints)

Serial Number Location On Bolt Circle of Differential

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TORQUE CHART

(Torque figures based on bolts and nuts that are cleaned and oiled.)

Pinion Shaft End Nut	Newton Meters	(Ft. Lbs.)
Pinion Cage to Carrier Bolt	441 N-m	(325 ft.lbs.)
Carrier to Housing Bolt	136 to 163 N-m	(100 to 120 ft.lbs.)
Differential Case Bolts	47 to 61 N-m	(35 to 45 ft.lbs.)
Bearing Cap to Carrier	109 to 122 N-m	(80 to 90 ft.lbs.)
Trunnion Cap and Steering Arm to Trunnion Housing Stud	203 to 217 N-m	(150 to 160 ft.lbs.)
Trunnion Cap and Steering Arm to Trunnion Housing Stud Nut	95 to 109 N-m	(70 to 80 ft.lbs.)
Seal Retainer Half to Trunnion Housing Bolt	81 to 95 N-m	(60 to 70 ft.lbs.)
Spindle to Trunnion Housing Stud	14 to 20 N-m	(10 to 15 ft.lbs.)
Spindle to Trunnion Housing Stud Nut	41 to 54 N-m	(30 to 40 ft.lbs.)
Drive Flange to Hub Assy. Stud Nut	34 to 47 N-m	(25 to 35 ft.lbs.)
Tie Rod Clamp Bolt	68 to 81 N-m	(50 to 60 ft.lbs.)
Wheel Bearing Adjusting Nut	88 to 109 N-m	(65 to 80 ft.lbs.)

Tighten inner adjusting nut to 271 to 339 N-m (200 to 250 ft. lbs.) then back off 1/8 to 1/6 turn and bend tab to lock nut in place. Install outer locknut and tighten to 271 to 339 N-m (200 to 250 ft. lbs.) and bend tab to lock nut in place.

RIVET PRESSURES

Millimeter	(Inch)	Megagrams	(Tons)
11 mm	(7/16 in.) Rivet	16 to 18 Mg	(18 to 20 tons)
13 mm	(1/2 in.) Rivet	18 to 23 Mg	(20 to 25 tons)
16 mm	(5/8 in.) Rivet	41 to 45 Mg	(45 to 50 tons)

LUBRICATION

For type of lubricant, refer to LUBRICATION CTS-2412.

IH MODEL	IH CODE
FA-71	02071
FA-73	02073
FA-74	02074
FA-101	02101
FA-103	02103

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INTRODUCTION

The front axles covered in this section are I-beam type, non-driving units.

Figure 1 illustrates the steering knuckle outlined in this section.

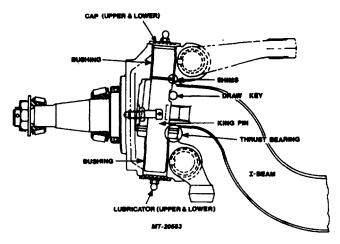


Fig. 1. Steering Knuckle with Thrust Bearing - Bolted on Cap - Lubricator in Each Cap.

KING PIN LOOSENESS (CHECKING)

As a means for providing service personnel with the simplest method for checking king pin looseness, it has been determined that the use of camber gauge SE-1417-1 is the most desirable. Instructions for the use of the camber gauge in this particular operation are as follows:

1. Raise the front wheels off the floor and support the axle at the outer ends so it cannot rock.

IMPORTANT

Adjust front wheel bearing if needed.

- Apply brake. Use pedal jack to hold brake application and lock front wheels.
- 3. Install camber gauge and measure camber while rocking the wheel at top and bottom.
- If the camber changes 1/4 degree or more, replace the king pin bushings (and king pin if needed). Check fit of king pin in I-beam.

THRUST BEARING

Steering knuckle thrust bearings, located between the knuckles and lower faces of the 1-beam, support the entire front end load (see Figure 1).

The end play must be kept within proper limits to prevent excessive wear. Shims to correct this condition are used (for limits see SPECIFICATIONS).

KING PIN BUSHING REPLACEMENT

Bronze Bushings

- 1. Remove grease caps.
- Remove the spindle nut cotter keys, locking nuts, and washers.
- 3. Remove the wheels, inner bearings and grease retainers from the spindle.
- 4. Remove the dirt shield screws and shields.
- Remove the bolts holding the brake backing plate assemblies to the steering knuckles. Lay the assemblies back over the ends of the axle Ibeam.
- 6. Remove the draw keys holding the king pins.
- 7. Remove the cap and o-ring from top and bottom of steering knuckles.
- 8. Drive out the king pin.
- 9. Remove steering knuckles, thrust bearings and any spacer shims present.
- Clean all parts thoroughly in cleaning solvent. Examine the steering knuckle carefully for any indication of damage, cracks or imperfections which might cause early failure. Replace any knuckle which is not in good condition.
- 11. Remove the old bushings using an arbor or drift.
- 12. Press new bushings into steering knuckle.
- 13. Line ream or wet hone new bushings to finished size as shown in SPECIFICATIONS. Service operations are using the power-driven, wet-type hone equipment, SE-2118 when sizing steering knuckle bushings.

If a reamer is used, it should be equipped to pilot in one bushing while reaming the other, or be long enough to ream both bushings at the same time.

- 14. Install the steering knuckles, thrust bearings, spacer shims as required, and king pins. Lubricate the king pins at installation to assure initial lubrication of parts.
- 15. Install the king pin draw keys and tighten securely. The draw key nut and lock washer should be located on the front side of the axle. The draw keys should be inspected occasionally to assure tightness. If one becomes loosened, the king pin hole as well as the draw key hole will become worn and will require replacing or machining of the I-beam to an oversize dimension for application of oversize king pins.
- 16. Install cap and o-ring in the top and bottom of the steering knuckles.
- 17. Place the brake backing plates in position; install and tighten bolts.
- 18. Install the dirt shields and retaining screws.
- 19. Clean and repack the front wheel bearings.
- 20. Install new grease seals.
- 21. Install wheels, spindle nuts and adjust wheel bearings.
- 22. Install grease caps.
- 23. Lubricate king pin bushings.

LUBRICATION

For type lubricant, refer to CTS-2412.

TIE RODS

The tie rods are of three-piece construction, consisting of a tie rod and two rod end assemblies. The ends are threaded to the rod and locked with clamp bolts. Right and left hand threads are provided for toe-in adjustment. Tension on ball stud in the rod ends is self-adjusting and requires no attention in service other than periodic inspection to see that the ball studs are tight in the steering knuckle arms.

Fittings are provided for periodic lubrication on some types of tie rod ends. Where no fittings are used, the tie rods have been lubricated at assembly and no further lubrication is necessary.

CAUTION

When tie tod, drag link or power steering linkage ends are replaced, they must be threaded into the tie rod sufficiently so that when the clamp is applied, the clamping action will be directly over the threads on the ball joint end. Be sure that the end is in far enough (past the clamp) to provide adequate clamping and the bolt in the clamp is installed next to (over) the slot in the tie rod. Fig. 2 illustrates a typical tie rod design for these axles.

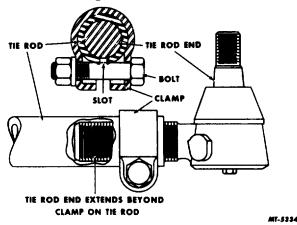


Fig. 2. Typical Tie Rod

DRAG LINK

This type of drag link requires very little care other than periodic lubrication and occasional inspection to make sure that it is properly adjusted (Fig. 3).

Adjustment is made by removing cotter pin and turning adjusting plug in the desired direction. To adjust for wear, turn adjusting plug in until it is tight, then back off to first cotter pin hole. Insert a new cotter pin of the correct size and bend ends over securely. Drag link should not be adjusted too tightly, otherwise steering will be affected. The spring is merely to accommodate wear and is not intended to act as a cushion against shock.

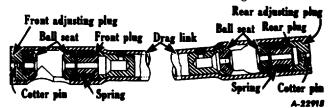


Fig. 3. Cross Section of Drag Link

SPECIFICATIONS

IH Model (IH Code)	FA-71 (02071) FA-73 (02073) FA-74 (02073) FA-101 (02101) FA-103 (02103)
Knuckle Pin Bushing Diameter	34.58 mm (1.3615") 34.54 mm (1.3600")
Knuckle Pin Diameter	34.51 mm (1.3587") 34.50 mm (1.3582")
Knuckle Pin Length	20.24 cm (7.97")
I-Beam Bore Diameter	34.56 mm (1.3607") 34.54 mm (1.3597")

Steering Knuckle Thrust Bearing-to-Lower Face of I-Beam Clearance (All Axles) Inclusive:

On Bench .127 to .254 mm (.005 to .010")

Under Load .127 to .381 mm (.005 to .015")

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TORQUE CHART

LOCATION	S	IZE	TORQUE			
			F	t-Lb		N.m
	Diameter	No. Threads	Minimum		Minimum	
Tie Rod End Nut	9/16	18	40		54	
	5/8	16	60		81	
	5/8	18	60		81	
	3/4	16	90		122	
	7/8	14	150		203	
	1	14	250		339	
	1-1/8	12	300		407	
			Minimum	Maximum	Minimum	Maximum
Tie Deal Clause Delt	F/4C	24	40	4.4	4.4	40
Tie Rod Clamp Bolt	5/16	24	10	14	14	19
	3/8	24	20	25	27	34
	7/16	20	25	30	34	41
	1/2	20	40	50	54	68
	5/8	18	40	50	54	68
Steering Arm Ball Nut	5/8	16	60		81	
9	5/8	18	60		81	
	3/4	16	90		122	
	7/8	14	150		203	
Of a subury Asses Next O	7/0	4.4	450		000	
Steering Arm Nut &	7/8	14	150		203	
Tie Rod Arm Nut	1	14	250		339	
	1-1/8	12	300		407	
	1-1/4	12	350		475	
King Pin Draw Key Nut			15	20	20	27

IMPORTANT

If cotter pin cannot be installed after attaining minimum torque, tighten to next position. Do not back off.

Torque specified is for taper and threads which are clean and oil free.

AXLE MODEL	AXLE CODE	AXLE MODEL	AXLE CODE
FA-109	02109	FA-238	02238
FA-118	02118	FA-239	02239
FA-127	02127	FA-309	02309
FA-139	02139	FA-329	02329
FA-231	02231	FA-339	02339
FA-232	02232	FA-340	02340
FA-233	02233	FA-341	02341
FA-237	02237	FA-342	02342

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INTRODUCTION

The front axles mentioned herein are the heavy duty I-beam type.

An "I-beam" type center section machined from heat treated steel forging is used for these axles. Spring pads are integral with the "I-Beam".

DISASSEMBLY

WHEEL AND HUB REMOVAL

- Raise front end of vehicle so that tires clear floor. Block up securely at this position and remove jacks. (Do not attempt to disassemble or perform axle repair with vehicle supported by jacks only.)
- Two types of wheel bearing adjusting nut lock arrangements are used on the axles covered in this section. Removal of these are as follows:
 - a. Bend-Over Type Locking Washer
 Remove grease cap and gasket. Bend locking washer to release outer lock nut and inner wheel bearing adjusting nut. Remove outer nut, locking washer and inner adjusting nut from steering levelle.
 - inner adjusting nut from steering knuckle spindle. Always install new locking washer during reassembly.



Remove grease cap and gasket. Remove outer lock nut, locking washer perforated lock ring and doweled wheel bearing adjusting nut from steering knuckle spindle.

- 3. Remove the outer wheel bearing cone.
- 4. Remove the wheel and hub assembly.

STEERING KNUCKLE REMOVAL

- 1. Remove wheel and hub.
- Disconnect tie rod and drag link. Knuckle pins may be removed from the bottom of the knuckle where adequate clearance is provided.
- 3. Remove the cap and o-ring from top and bottom of steering knuckle Fig. 1.
- 4. Remove the knuckle pin draw key.
- 5. Tap out the knuckle pin by use of a bronze drift (Fig. 2).



Fig. 1

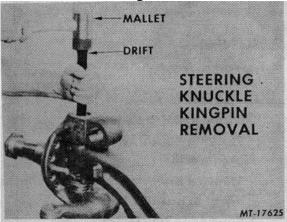


Fig. 2

6. Lift off the knuckle assembly, thrust bearing and spacing (Fig. 3).

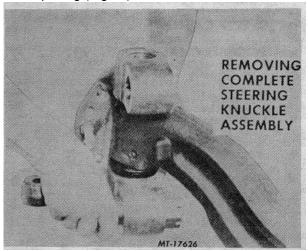


Fig. 3

REASSEMBLY

STEERING KNUCKLE BUSHING INSTALLATION

As a means for providing service personnel with the simplest method for checking king pin looseness, it has been determined that the use of camber gauge SE-1417-1 is the most desirable. Instructions for the use of the camber gauge in this particular operation are as follows:

- 1. Raise the front wheels off the floor and support the axle at outer ends so it cannot rock.
- 2. Adjust front wheel bearings.
- 3. Apply brake. Use pedal jack to hold brake application and lock front wheels.
- 4. Install camber gauge and measure camber while rocking the wheel at top and bottom.
- If the camber changes 1/4 deg. or more, replace the king pin bushings (and king pin, if needed). Check fit of king pin in "I-beam".
 Phosphate pin has a clearance of .02032 to .05842 mm (.008 to .0023 inch).

Never replace king pins or king pin bushings which are within limits shown in specifications.

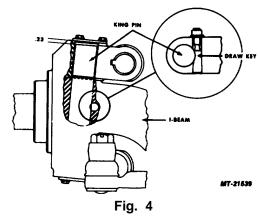
To install bronze bushings, proceed as follows:

- 1. Remove present bushings from knuckle.
- 2. Remove any nicks or burrs from knuckle bore and polish with medium grit abrasive.
- 3. Press in new steering knuckle bushings.

IMPORTANT

Since these front axles employ lip type seals in the axle king pill bore to retain lubricant and prevent the entrance of dirt and water, observe the following.

4. In Fig. 4 the upper knuckle bushings must be installed in such a manner as to permit installation of the upper seal. When replacing the bushings the upper bushing should be pressed into the knuckle so that the upper end of the bushing is 6.35 mm (.23 inch) from the upper face of the knuckle. This 6.35 mm: (.23 inch) dimension at the upper end will assure there is space for installation of the upper seal.



- 5. In most instances the lower seals will be discarded when a new repair kit is being installed. If the clearance between the upper face of the axle end and lower face of upper steering knuckle pin boss exceeds .381 mm (.015 inch) shims are available in various thicknesses to take up this clearance. However, if the stack-up of shims is in excess of 1.194 mm (.047 inch). these shims can be removed and the lower seal installed and still hold the clearance within the desired .381 mm (.015 inch) tolerance.
- Line ream or hone new bushings to size shown in SPECIFICATIONS. An SE-2218 hone may be used to size bushings.
 - If a reamer is used, it should be equipped to pilot in one bushing, while reaming the remaining one, or be long enough to ream both bushings at the same time.
- 7. After the reaming or honing operation is completed, the bushings and steering knuckles must be thoroughly cleaned of all dirt and shavings before king pin is installed.

For best results, the use of steam cleaning equipment is preferred.

KING PIN INSTALLATION

IMPORTANT

Before installing the king pin, lubricate inside of bushing and outside of king pin with IH 251 HEP grease or equivalent NLGI No. 2 multipurpose lithium grease to provide initial lubrication.

 Make certain that knuckle pin hole in axle center is clean and dry.

- 2. Position and support the steering knuckle assembly on the axle center.
- Slide the thrust bearing between the lower face of axle center and lower steering knuckle yoke (Fig. 5). Thrust bearings that are not marked "top" to indicate upper installation position must be positioned with retainer lip down.



Fig. 5

- 4. Align the steering knuckle yoke holes with axle center and thrust bearing holes.
- 5. Place a jack under the lower side of steering knuckle yoke and raise knuckle so that all clearance is taken up between lower yoke, thrust bearing and lower face of axle center end.
- Check the clearance between the top face of upper axle center end and lower face of upper knuckle pin boss. Shims are available in various thicknesses to provide a desired clearance of .508-.1270 mm (.002005 inch), Fig. 6.

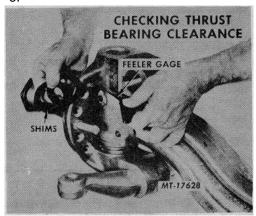
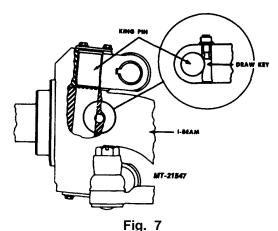


Fig. 6

Install draw key as follows:

- 1. Install draw key with threaded end of key to front side of axle, Fig. 7.
- 2. Torque draw key nut to 75-88 Newton Meters or 55-60 Ft. Lbs.
- 3. After initial torquing, rap unthreaded end of draw key sharply with a hammer.

4. Retorque draw key nut.



CAPS AND O-RINGS

Install the cap and o-ring.

Reinstall tip rad and into

Reinstall tie rod ends into the steering arms and tighten the nuts to the correct torque specification. Then install the cotter pin. (Refer to TIE ROD ENDS for replacement of tie rod ends.)

Reinstall brake components.

Clean and repack the front wheel bearing. Then install the bearing in the hub assembly using new grease seals.

Assemble the hub and bearings on the spindle being careful not to damage the oil seals or bearings. Adjust wheel bearings referring to WHEEL BEARING ADJUSTMENT. Then install wheel grease caps.

TIE ROD ENDS

The tie rods are of three-piece construction, consisting of a tie rod and two rod end assemblies. The ends are threaded to the rod and locked with clamp bolts. Right and left hand threads are provided for toe-in adjustment. Tension on ball stud in the rod ends are self adjusting and require no attention in service other than periodic inspection to see that ball studs are tight in the steering knuckle arms.

Fittings are provided for periodic lubrication on some types of tie rod ends. Where no fittings are used, the tie rods have been lubricated at assembly and no further lubrication is necessary.

CAUTION

When tie rod, drag link or power steering linkage ends are replaced they must be threaded into the tie rod sufficiently so that when the clamp is applied, the clamping action will be directly over the threads on the ball joint end. Be sure that the end is in far enough (past the clamp) to provide adequate clamping and the bolt in the clamp is installed next to (over) the slot in the tie rod as shown in Fig. 8.

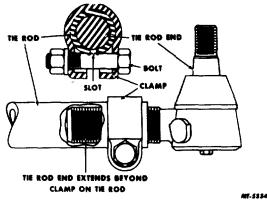


Fig. 8

DRAG LINK

This type of drag link requires very little care other than periodic lubrication and occasional inspection to make sure that it is properly adjusted (Fig. 9).

Adjustment is made by removing cotter pin and turning adjusting plug in the desired direction. To adjust for wear, turn adjusting plug in until it is tight then back off to first cotter pin hole. Insert a new cotter pin of the correct size and bend ends over securely. Drag link should not be adjusted too tightly, otherwise steering will be affected. The spring is merely to accommodate wear and is not intended to act as a cushion against shock.

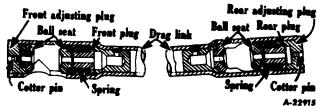


Fig. 9

LUBRICATION

For type of lubricant, refer to LUBRICATION, CTS-2412.

SPECIFICATIONS

IH Model (IH Code)	FA-109 (02109)	FA-231 (02231) FA-232 (02232) FA-233 (02233) FA-237 (02237) FA-238 (02238) FA-239 (02239) FA-341 (02341) FA-342 (02342)	FA-309 (02309)	FA-118 (02118) FA-127 (02127) FA-139 (02139) FA-329 (02329) FA-339 (02339) FA-340 (02340)
	mm (inch)	mm (inch)	mm (inch)	mm (inch)
Knuckle Pin Bushing Diameter I.D.	37.744 1.486	50.7619 1.9985	40.945 1.612	49.945 1.612
	37.719 1.485	50.7873 1.9995	40.894 1.610	40.894 1.610
Knuckle Pin Diameter	37.6987 1.4842	50.775 1.999	40.8737 1.6092	40.8737 1.6092
	37.6859 1.4837	50.749 1.998	40.8609 1.6087	40.8609 1.6087
Knuckle Pin Length	22.48 cm 8.85	28.48 cm 11.212	23.27 cm 9.16	24.54 cm 9.66
I-Beam Bore Diameter	37.744 1.486	50.8254 2.0010	40.9194 1.611	40.9194 1.611
	37.719 1.485	50.7873 1.9995	40.8940 1.610	40.8940 1.610

Steering Knuckle Thrust Bearing-to-Lower Face of I-Beam Clearance:

On Bench (Allowable) .127 to .254 mm (.005 to .010 inch)

On Bench (Desired) .508 to .1270 mm (.002 to .005 inch)

Under Load .127 to .381 mm (.005 to .015 inch)

TORQUE CHART

LOCATION	S	SIZE		TORQUE		
			<u> </u>	t. Lbs.		N.m
	Diameter	No. <u>Threads</u>	<u>Minimum</u>		<u>Minimu</u>	<u>ım</u>
Tie Rod End Nut	9/16 5/8 5/8 3/4 7/8 1 1-1/8	18 16 18 16 14 14	40 60 60 90 150 250 300		54 81 81 122 203 339 407	
	1 1/2	· -	Minimum	<u>Maximum</u>	Minimum	<u>Maximum</u>
Tie Rod Clamp Bolt	5/16 3/8 7/16 1/2 5/8	24 24 20 20 18	10 20 25 40 40	14 25 30 50 50	14 27 34 54 54	19 34 41 68 68
Steering Arm Ball Nut	5/8 5/8 3/4 7/8	16 18 16 14	60 60 90 150		81 81 122 203	
Steering Arm Nut & Tie Rod Arm Nut	7/8 1 1-1/8 1-1/4	14 14 12 12	150 250 300 350		203 339 407 475	

IMPORTANT

If cotter pin cannot be installed after attaining minimum torque, tighten to next position. Do not back off.

Torque specified is for taper and threads which are clean and oil free.



GENERAL

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CLEANING

Clean parts having ground and polished surfaces, such as knuckle pins, knuckle pin sleeves, bearings and spindles, with solvent type cleaners such as emulsion cleaners, or petroleum solvents excluding gasoline. Do not clean these parts in a hot solution tank or with water and alkaline solutions such as sodium hydroxide, orthosilicates or phosphates.

DRYING

Parts should be thoroughly dried immediately after cleaning. Use soft, clean, lintless, absorbent paper towels or wiping rags free of abrasive material, such as lapping compound, metal filings or contaminated oil. Bearings should never be dried by spinning with compressed air.

INSPECTION

It is impossible to overstress the importance of careful and thorough inspection of steering knuckle components prior to reassembly. Thorough visual inspection for indications of wear or stress and the replacement of such parts as are necessary will eliminate costly and avoidable front end difficulties.

- Inspect the steering knuckle thrust bearing, wheel bearing cones and cups. Replace if rollers or cups are worn, pitted or damaged in any way.
- 2. If wheel bearing cups are to be replaced, remove from hubs with a suitable puller. Avoid the use of drift and hammers as they may easily mutilate cup bores.
- Inspect the steering knuckles and replace if indications of weakness or excessive wear is found.
- 4. Check wear of the knuckle pins; compare with correct specification.
- 5. Check king pin bushing wear (see Bushing Installation).

6. Check the tightness of the steering connections such as tie rod arms, steering arm, etc.

CORROSION PREVENTION

Parts that have been cleaned, dried, inspected and are to be immediately reassembled should be coated with light oil to prevent corrosion. Spindles, knuckle pins or sleeves that are to be stored for any length of time should be treated with a good rust preventative and wrapped in oiled paper and boxed to keep dry and clean.

REPAIR OF FORGED PARTS

In deciding whether to repair or scrap a damaged part, always keep in mind that we, as manufacturers, never hesitate to scrap any part which is in any way doubtful.

- Straightening of bent parts should be done cold. Various components are heat-treated and hot straightening would destroy some of the heat treatment.
- Axle centers (that are bent no more than 1/2")
 may be straightened cold; if bent more than 1/2"
 they should be replaced. Bent steering arms or
 knuckles should be replaced rather than
 straightened.

FRONT WHEEL ALIGNMENT

The alignment of chassis according to the specifications should prevent misadjustment, which can affect tire wear, directional stability and steering wheel alignment. Check alignment at regular intervals and particularly after front suspension has been subjected to extremely heavy service or severe impact loads. Before checking and adjusting alignment, components such as wheel bearings, tie rods, steering gear, shock absorbers and tire inflation should be inspected and corrected where necessary.

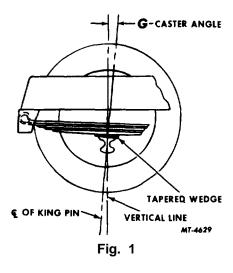
The procedure for checking and adjusting alignment should be followed; namely, checking king pin inclination, camber, caster and toe-in, in the order named. A slight modification in obtaining the proper caster and toe-in has been made and is outlined.

The caster, camber and toe-in dimensions are for vehicle at design load (frame level). If frame is not level on alignment equipment, the frame angle must be considered. This is especially important when making caster check, for the frame angle must be added to or subtracted from the caster angle to obtain a true setting.

CASTER ANGLE

Caster is the amount in degrees the top of the king pin is inclined toward the front or rear of the truck, as viewed from the side of the truck. The caster angle can range from a positive angle to a negative angle.

Positive caster, Fig. 1, is the tilting of the top of the king pin toward the rear of the truck, while negative, or reverse caster, is the tilting of the top of the king pin toward the front of the truck.

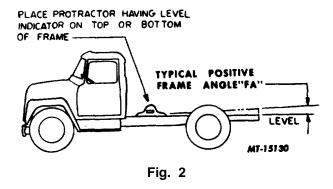


Positive caster imparts a trailing action to the front wheels, while negative, or reverse caster, causes a leading action. The correct amount of caster helps to keep the front wheels in the straight-ahead position. When in a turn, caster acts as a lever, assisting the driver to return the front wheels to the straight-ahead position.

Caster specifications are based on vehicle design load, which will usually result in a level frame. If the frame is not level when alignment checks are made, this must be considered in determining whether the caster setting is correct.

With the vehicle on a smooth, level surface frame angle should be measured with a bubble protractor placed on the frame rail. See Fig. 2. The degree of tilt from the level frame position is the angle that must be used in determining a correcting caster setting. Positive frame angle is defined as forward tilt (front end down) and negative angle as tilt to rear (front end high).

The measured frame angle should be added or subtracted, as required, from the specified level frame caster setting to obtain the caster that should actually be measured on vehicle.



- 1. Positive frame angle should be subtracted from specified setting.
- 2. Negative frame angle should be added to specified setting.

As an example, if the specified caster setting is a positive 1° and it is found that the vehicle has a positive One degree frame angle, they the measured caster should be $0 \pm 1/2^\circ$. This would result in the desired 1° + $1/2^\circ$ caster angle when the chassis settled to level frame under load.

Possible causes of incorrect caster are sagging springs, bent or twisted axle, or unequally tightened spring U-bolts. In most cases a twisted axle would be the cause if caster varies more than the specified 1/2° between left and right side.

If caster must be corrected, taper shims can be used as required between the springs and axle. Spring U-bolts should be tightened evenly and to specified torque after the addition or removal of shims.

Caster adjustment is made by inserting a wedge between the spring and axle, Fig. 1.

To <u>increase</u> caster, insert the wedge so the thick parts face the rear of the truck (to front for underslung axles).

To <u>decrease</u> caster, place the wedge so that the thick end is toward the front of the truck (to rear for underslung axles).

If an excessively thick wedge is required for a truck that has high mileage, check the contour of the springs and replace springs if necessary. Be sure center bolt drops into I-beam.

The truck will lead to the side which has the most negative caster.

CAMBER ANGLE

Camber is the amount in degrees that the wheel inclines away from the vertical at the top, as viewed from the front of the truck, Fig. 3.

"Positive" camber is an <u>outward</u> tilt or inclination of the wheel at the top.

"Negative" or reverse camber is an <u>inward</u> tilt of the wheel at the top.

The amount of camber used depends on the amount in degrees the king pin is inclined. An incorrect camber angle causes the side of the tread to wear, resulting in abnormal tire wear.

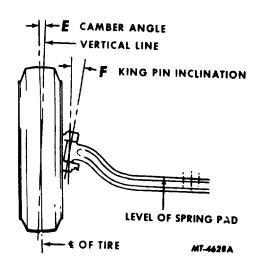


Fig. 3. King Pin Inclination and Camber Angles

Unequal camber in the front wheels will cause the truck to lead to the right or left. The truck will lead to the side which has the most positive camber.

KING PIN ANGLE (INCLINATION)

King pin inclination (angle) is the amount in degrees that the top of the king pin inclines away from the vertical toward the center of the truck as viewed from the front of the truck, Fig. 3.

King pin inclination working together with the camber angle puts the approximate center of the tire tread in contact with the road. King pin inclination has the effect of reducing steering efforts and improves directional stability in the vehicle.

There is no means of adjusting this angle; therefore, it will not change unless the front axle has been bent. Corrections or changes to this angle are accomplished by replacement of broken, bent or worn parts.

TOE-IN

Toe-in is the amount (in fractions of an inch) that the front wheels are closer together at the front than at the back as viewed from the top of the truck, Fig. 4. With the camber on the front wheels, the left front wheel tries to steer to the left and right front wheel tries to steer to the right. This is due to the wheels wanting to turn in the same direction each wheel leans. To overcome this condition, the wheels are given a certain amount of toe-in.

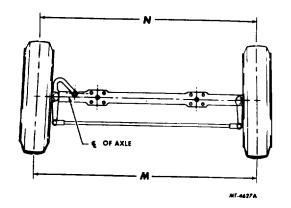


Fig. 4. Toe-In Measurement

Another reason for toe-in and the most familiar, is that when the vehicle is being driven, the forces acting on the front wheels tend to make the wheels toe out.

Incorrect toe-in will result in rapid tire wear. Excessive toe-in will produce a scuffing or "feather-edge" at the inside edge of the tire tread. Toe-out will produce a like wear but at the outside of the tire tread.

When attempting to determine the causes of excessive tire wear, first check king pin inclination, camber and caster and correct, if necessary, in the order named.

No change should be made in toe-in until the other factors of front wheel alignment are known to be within specifications.

Turn the front wheels to the exact straight-ahead position.

When setting toe-in adjustment, the front suspension must be neutralized; that is, all component parts must be in the same relative position when making the adjustment as they will be in operation. neutralize the suspension, the vehicle must be rolled forward 12 to 15 feet. By rolling the vehicle forward, all tolerances in the front suspension are taken up and the suspension is then in normal operating position. Neutralizing the front suspension is extremely important, especially if the vehicle has been jacked up in order to scribe the tires; otherwise, the front wheels will not return to the normal operating position due to the tires gripping the floor surface when the vehicle is lowered.

Actual toe-in measurements should be taken at hub height between the two points on the center of the tread at the rear of the tires, Fig. 4.

Mark the point and roll the truck ahead so that the points are in the front at hub height and measure the distance between the same two points on the tire treads.

The difference in the two measurements is the actual toe-in or toe-out.

- 1. To adjust the toe-in, turn the steering wheel so that the gear is in the mid-position.
 - 2. Loosen the clamping bolts on the tie rod.
- 3. Turn the tie rod in the direction necessary to bring toe-in within the specified limits.
 - 4. Tighten the clamping bolts on the tie rod.

NOTE

Always recheck toe-in after any change in caster or camber angles or after any alteration in tie rod adjustment.

TURNING ANGLE

Turning angle is the degree of movement from a straight-ahead position of the front wheels to either an extreme right or left position. Two factors of major importance when adjusting the angle are: tire interference with chassis and steering gear travel.

To avoid tire interference or bottoming of the steering gear, adjustable stop screws are located on the steering knuckles.

To adjust the turning angle, loosen the jam nuts and turn the steering knuckle stop screws in. Position support stands under the front axle so that the wheels are off the floor. Turn the wheels to extreme right turn until the steering gear bottoms or contact of the tire to chassis is made. Then back off the steering wheel 1/4 turn or back off the steering wheel until 1/2" to 1" clearance is obtained between the tire and chassis. Be sure to check both front tires for clearance. When the proper clearance is determined, back the wheel stop screw out and tighten the jam nut.

Repeat the same procedure on the left extreme turn also and adjust the left steering knuckle stop screw.

TURNING RADIUS ANGLE (Toe-out on Turn)

Turning radius angle is measured in degrees and is the amount one front wheel turns sharper than the other on a turn.

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When a vehicle is turned either to the right or left, the inner wheel is required to turn in a smaller circle than the outside wheel, Fig. 5.

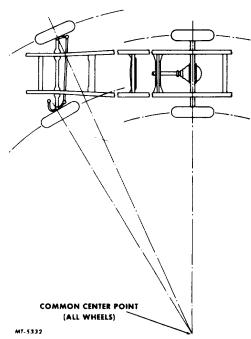


Fig. 5. Inner Wheel Turns in a Smaller Circle Than Outside Wheel

If the inner wheel is not permitted to turn in a smaller circle or greater angle, tire scuffing will result. Therefore, it is necessary for the front wheels to assume a toed-out position during a turn.

Toe-out on turns is accomplished by having the ends of the steering arms (end at tie rod) closer together than the king pins as shown in Fig. 6. The amount of toe-out depends on the length and angle of the steering arms.

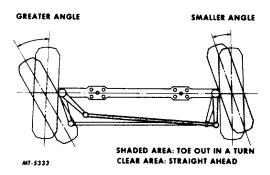


Fig. 6. Inside Wheel Turns at Greater Angle

Even though the toe-in with the wheels in the straight-ahead position may be adjusted correctly, a bent steering arm may cause the toe-out on a turn to be incorrect, causing scuffing of tires.

The turning radius angle is checked using turning radius plates SE-1447-2 or equivalent.

To check the turning radius angle, position the front wheels on the plates and in the str4ight-ahead position. After removing the locking pins from each plate, adjust the scale on the edge of the plates so that the pointers read "zero." Turn the wheels to the right until the gauge at the left wheel reads 200. Then read the angle of the right wheel. The right wheel should then be turned to an angle of 200. The left wheel should be at the same angle as was the right wheel when the wheels were turned to the left.

STEERING KNUCKLE STOP SCREWS (I-Beam Axles)

Adjustable stop screws in the steering knuckle control the turning angle or limit the movement of the front wheels. This prevents the tires from rubbing against the nearest point on the chassis or the steering gear from bottoming.

STEERING KNUCKLE STOP SCREWS (Driving Front Axles)

There is a stop screw located on each end of the axle housing for the purpose of limiting the amount of the turning angle of the wheels. These screws are not adjusted in accordance with the frame and tire interference as in conventional front axles. Instead, these screws are provided to limit the turning angle of the universal joints in the axles.

TROUBLE SHOOTING

Remember that all alignment angles are so closely related that any change of one will automatically change the others. Because of this fact, it will probably be found that there is more than one cause for the complaint. The following list is not all-encompassing but is representative of the more common causes of difficulty encountered in wheel and axle alignment and should also prove of value in locating and correcting complaints on steering or tire wear.

COMPLAINT

Shimmy (Generally exists at apes is below 30 miles per hour.)

- 2. High-Speed Wheel Tramp (Generally exists at speeds above 35 miles per hour.)
- 3. Wander or Weave

4. Hard Steering

POSSIBLE CAUSE

- a. Tire pressure incorrect.
- b. Tires of unequal size or weight.
- c. Wheel bearings loose.
- d. Steering arms loose.
- e. Steering gear loose.
- f. Too much caster.
- g. Drag link ends loose.
- h. Drag link springs weak or broken.
- i. Spring shackles loose.
- j. King pins and bushings worn.
- k. Tie rod ends loose.
- I. King pins loose in I-beam.
- a. Tire and wheel assemblies out of balance.
- Shock absorbers ineffective.
- a. Tire pressure incorrect.
- b. Tires of unequal size.
- c. Bent spindle.
- d. Wheel bearings loose.
- e. King pins and bushings worn.
- f. King pins bent.
- g. King pins tight in knuckle.
- h. Pitman arm loose.
- i. Steering gear assembly too tight or too loose.
- i. Too little caster.
- k. Too much or too little camber.
- I. Too much or too little toe-in.
- m. Drag link ends tight.
- n. Drag link springs weak or broken.
- o. Tie rod ends too tight or too loose.
- p. Front axle bent.
- q. Front axle shifted.
- r. Springs broken.
- s. Rear axle shifted.
- t. Rear axle housing bent.
- u. Frame diamond shaped.
- a. Tire pressure low.
- b. Wheel spindle bent.
- c. King pin assembly poor fit.
- d. Steering assembly too tight.
- e. Tie rod ends tight.
- f. Caster excessive.
- g. Lack of lubrication.

TROUBLE SHOOTING (Continued)

COMPLAINT POSSIBLE CAUSE

5. Uneven Tire Wear

- a. Tire pressure low.
- b. Excessive camber.
- c. Wheels out of balance.
- d. Tires overloaded.
- e. Eccentric wheels or rims.
- f. Caster incorrect.
- g. Toe-in incorrect.

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LOCKING HUBS

CHAPTER I

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CHAPTER I

DESCRIPTION

Locking hubs provide a means of controlling the engagement of the front wheels with the front driving axle. When the locking hubs are engaged or "LOCK," full power is transmitted to both wheels, Fig. 1. When both front wheels are disengaged or in "FREE" position, Fig. 2, the front wheels will turn but the axle shafts and differential will remain idle, overcoming any unnecessary wear.

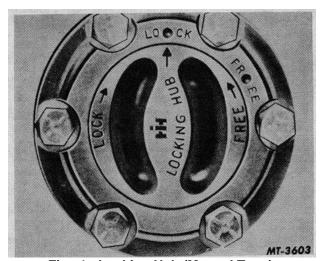


Fig. 1. Locking Hub (Manual Type)

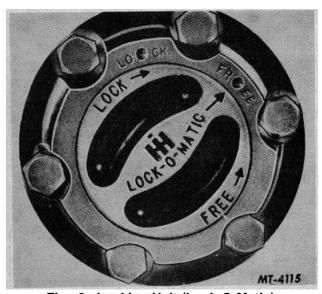


Fig. 2. Locking Hub (Lock-O-Matic)

Manual Type

There are at present two types of manual locking hubs which were and are being used on I.H. vehicles.

The original locking hub, Figs. 3, 4 and 6, is engaged or disengaged by turning the control assembly to "LOCK" or "FREE" position. If the arrow and the dot do not line up directly across from each other at the desired setting, the clutch ring and axle hub are not aligned, and moving the vehicle forward or backward slightly will permit the engagement of the clutch ring on the axle shaft.

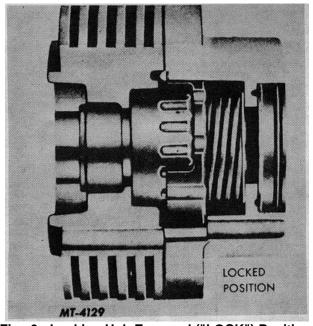


Fig. 3. Locking Hub Engaged ("LOCK") Position

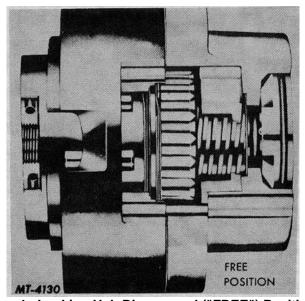


Fig. 4. Locking Hub Disengaged ("FREE") Position

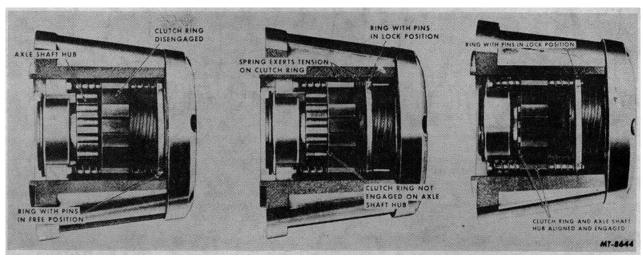


Fig. 5. Three Stage Operation of Spring Loaded Manual Locking Hub

A later version of the manual type locking hub is the spring-loaded type, Fig. 5, which is designed to aid in the engagement or disengagement of the front wheels with the axles. These hubs overcome the need of moving the vehicle slightly when the clutch ring does not mesh properly with the axle shaft hub.

This spring in these new hubs permits the control to be positioned in the desired location, and the slight movement of the vehicle will allow the clutch ring to move into "LOCK" or "FREE" position as selected on the control.

Lock-O-Matic Type

The Lock-O-Matic hub, when set in the "FREE" position, automatically locks the front wheel and axle shaft together the moment torque is applied to the front axle. The hub controls, therefore, do not require changing regardless of whether the vehicle is being operated in two or four-wheel drive. It is necessary, however, to set the control in the "LOCK" position when engine braking control is required (down steep hills, on ice, etc.).

OPERATION

Engaging Locking Hubs

To engage locking hubs, turn brass controls (one on each hub) clockwise to "LOCK" position, Figs. 1 and 3. Arrow in center of controls must point directly at dot located on rim of hub. You can feel the brass control "seat" itself when it is properly positioned. If the arrow does not point directly at the dot, the control will not seat itself. Thus, the gears will not completely engage, and the pressure may force off the end of the hub. This is

only true of hubs that are not spring loaded. Hubs that are spring loaded allow the control to be positioned in the engaged location, but engagement of the clutch ring on the axle shaft hub is not accomplished due to misalignment of components. Then when the vehicle is moved slightly, the spring-loaded clutch ring will engage with the axle shaft hub, Fig. 5 Right.

Disengaging Locking Hubs

To disengage locking hubs, turn brass controls counterclockwise to "FREE" position, Figs. 2 and 4. Here, again, the arrow must point directly at the dot on the rim, otherwise the gears may rake against each other.

The hub on the left side in Fig. 5 illustrates the spring-loaded type locking hub in the "FREE" position.

When controls are properly positioned, gears are completely engaged or disengaged and units will not be damaged.

The following CAUTION hints may prevent damage to the locking hubs:

- Use fingers only to turn controls. If controls do not move freely with your fingers, move vehicle slightly in either direction in two-wheel drive, standard gear range. If hubs do not now turn freely, look for external damage or dirt around brass controls. <u>DO NOT</u> force controls with tools.
- DO NOT drive vehicle unless controls on both hubs are properly positioned and both are set the same,

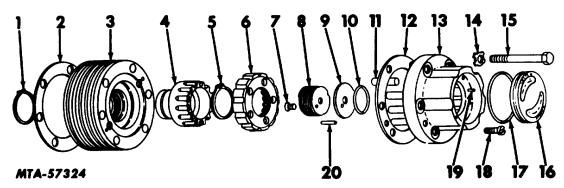


Fig. 6. Locking Hub (Manual Type with Hex Head Mounting Bolts) (Exploded View)

		Legend for Fig. 6	
<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
1	RING, Snap	11	PIN, Drive
2	GASKET, Hub	12	GASKET, Clutch Body
3	BODY, Hub	13	BODY, Clutch
4	HUB, Axle Shaft	14	WASHER
5	RING, Snap	15	BOLT, HexHead, 3/8 NF
6	RING, Clutch	16	CONTROL, Assembly
7	SCREW, Flat Head, 1/4 NC	17	SEAL, Oil, Outer
8	SCREW, Clutch	18	Not Used
9	DISC 1-3/4	19	PIN, Stop
10	SEAL, O-Ring	20	PIN, Dowel

- 3. To avoid excessive torque loads on the rear axle, <u>DO NOT</u> drive vehicle equipped with <u>manual</u> locking hubs in low range of transfer case with hubs set in "FREE" position. This does not apply to the Lock-O-Matic hub, because it automatically locks the wheel with the axle shaft when torque is applied. Therefore, no increased load is placed on the rear axle.
- During vehicle operation arrow in center of control must always point directly to one of the red dots on the rim of the hub. Also, both hubs must be set the same.

REMOVAL

Locking hubs are either mounted with hex head bolts or socket head (Allen) set screws. The locking hubs with the hex head bolts are secured with lock washers which are equipped with locking tabs.

Bend tabs out of the way of bolt head (if equipped) and remove mounting bolts.

CAUTION

Use only thin-wall sockets to remove the hex head bolts. Heavier sockets may force in the recessed wall of the locking hub. Lift off clutch body, being careful not to allow drive pins to fall out of body. Remove lock ring holding hub body onto axle shaft and pull off hub body. If it is necessary to remove drag shoe from axle spindle, loosen hex head set screw and unscrew drag shoe from spindle.

DISASSEMBLY

NOTE: All key numbers used in "DISASSEMBLY" and "REASSEMBLY" of the manual type locking hub (not spring-loaded) refer to Fig. 6.

The spring-loaded manual type locking hub disassembly procedure is much the same as the non-spring-loaded type hub, except the clutch ring assembly (Item 7, Fig. 11) is one assembly, and the ring and drive pin cannot be removed from the clutch ring. The control assembly (Item 15, Fig. 11) and the clutch screw cannot be separated like the non-spring-loaded type hub assembly.

Hub Body (Manual Type)

To disassemble hub body (3), remove snap ring (1) using the proper pliers. The axle shaft hub (4) may be pulled from hub body (3) noting from which side of the hub body the axle shaft hub is extracted, Fig. 7. Needle bearing assembly may be removed from hub body (3) if necessary.

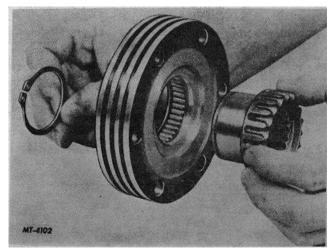


Fig. 7. Removing Axle Shaft Hub

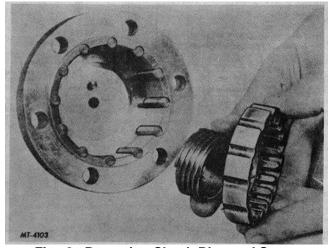


Fig. 8. Removing Clutch Ring and Screw

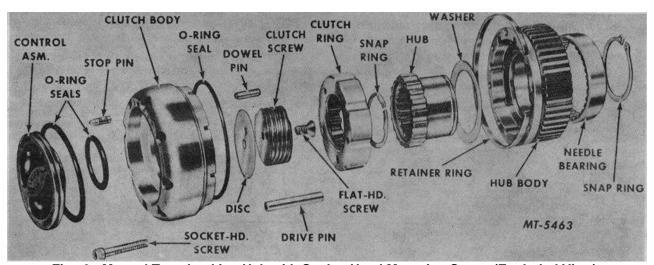


Fig. 9. Manual Type Locking Hub with Socket Head Mounting Screw (Exploded View)

Clutch Body (Manual Type)

Using a small chisel, remove the staked-over metal retaining the flat head screw (7).

NOTE

Be careful when removing this material not to damage the clutch screw (8). Remove the screw (7). Lift out clutch screw (8) and clutch ring (6). Clutch ring (6) may be separated from clutch screw (8) by unscrewing it, Fig. 8. Turn clutch body face down to take out the drive pins (11).

Remove disc (9) from bottom center of clutch body (13). Place thumb inside clutch body (13) on center of control assembly (16) and push outward, Fig. 10.

Remove O-ring seal (10) and outer oil seal (17) from control dial (16). Dowel pin (20) may be lifted out of control dial (16). The poppet ball and spring located in the control dial cannot be serviced therefore, if damaged, the control assembly (16) must be replaced.

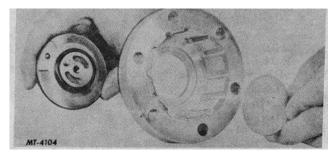


Fig. 10. Removing Control Assembly and Disc from Clutch Body

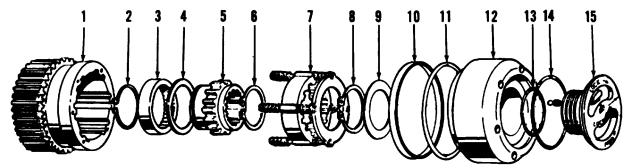


Fig. 11. Spring-Loaded Manual Type Locking Hub with Socket Head Mounting Screws (Exploded View)

	L	egend for Fig. 11	
<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
1	HUB, Body Locking	9	SHIM, Disc
2	RING, Snap	10	RING, Retainer
3	BEARING, Needle	11	RING, "O" Clutch Cap
4	SHIM, Wear	12	CAP, Clutch Body
5	HUB, Axle Shaft	13	RING, "O", Outer
6	RING, Axle Shaft, Snap	14	SEA Ĺ, Oil
7	RING, Clutch Assembly w/Springs	15	CONTROL with SPRING and BALL
8	RING, Snap		

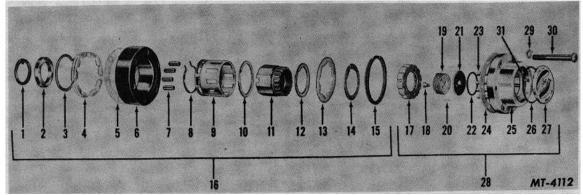


Fig. 12. Locking Hub (Lock-O-Matic) (Exploded View)

Legend for Fig. 12

Key Description		Key Description	
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6	WASHER, Spindle Lock SHOE, Drag SPRING, Friction Shoe SHOE, Friction GASKET BODY, Hub ROLLER SPRING, Centering CAGE, Roller RING, Lock HUB, Axle Shaft RING, Lock WASHER, Thrust RING, Lock RING, Lock RING, Lock BODY, Hub Assembly	17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	RING, Clutch SCREW, Flat Head SCREW, Clutch PIN, Dowel DISC "U" RING, Oil Seal PIN, Drive GASKET, Clutch BODY, Clutch "U" RING, Oil Seal CONTROL, Assembly BODY, Clutch Assembly WASHER, Lock BOLT PIN, Stop
•			

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Hub Body (Lock-O-Matic)

NOTE: All key numbers used in "DISASSEMBLY" and "REASSEMBLY" of the Lock-O-Matic hub refer to Fig. 12.

Remove lock ring (14) retaining axle shaft hub (11) into hub body (6). See Fig. 13. Pull axle shaft hub (11) and roller cage assembly (9) out of hub body noting side of hub from which gear teeth extend.

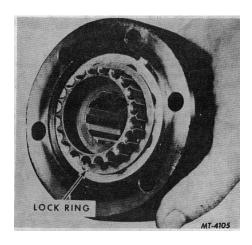


Fig. 13 Hub Body

Remove the 10 rollers (7) from the roller cage (9). Take out centering spring (8). See Fig. 14.

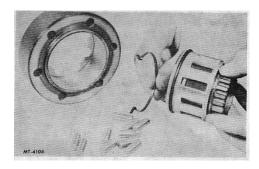


Fig. 14 Removing Centering Spring and Rollers

Remove Spirolox lock ring (12) located in second groove on axle shaft hub (11). See Fig. 15. This permits the axle shaft hub to be separated from the roller cage.

Pull the axle shaft hub (11) out of the roller cage (9) in the direction as illustrated in Fig.

16. NOTE: The corner points of the axle shaft hub must be aligned with the grooves in the friction shoes to permit removal of the hub. Remove Spirolox locking ring (10) located in roller cage in end opposite friction shoes (4).

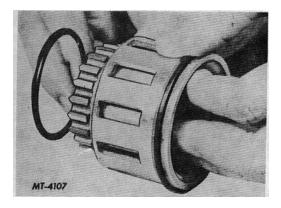


Fig. 15. Removing Spirolox Lock Ring

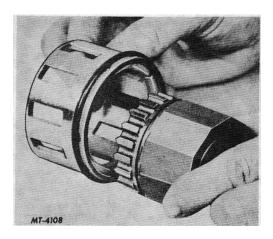


Fig. 16. Separating Axle Shaft Hub from Roller Cage

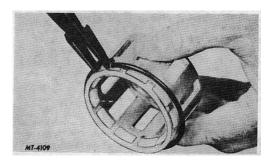


Fig. 17. Removing Friction Shoes and Spring

Remove the friction shoe spring (3) as shown in Fig. 17. Friction shoes (4) may now be lifted out of roller cage (9).

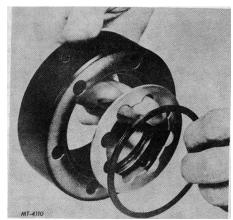


Fig. 18 Removing Spirolox Lock Ring and Thrust Washer

Remove the Spirolox lock ring (15) and thrust washer (13) from the hub body (6). See Fig. 18.

Clutch Body (Lock-O-Matic)

Disassembly of the Lock-O-Matic clutch body is identical to that of the manual type. Therefore, refer to the disassembly procedure outlined under "Clutch Body (Manual Type)" when disassembling the Lock-O-Matic hub.

CLEANING, INSPECTION AND REPAIR

Thoroughly wash all parts of the locking hub using a good cleaning solvent. Dry all parts with compressed air or a clean, lint-free cloth.

Inspect all parts for wear or damage. Check needle bearings, rollers, axle shaft hub and hub body for pits or cracks. Splines of axle shaft hub and clutch ring should be a free sliding fit. If splines are worn or damaged, these parts should be replaced. Use all new 0-ring seals and gaskets during reassembly.

REASSEMBLY

Hub Body (Manual Type) If hub body needle bearing has been removed, install new bearing being careful not to damage it.

Place axle shaft hub (4) into hub body (3) as shown in Fig. 7. Secure axle shaft hub (4) in body (3)

by installing snap ring (1) in groove in end of axle shaft hub.

Clutch Body (Manual Type)

Apply a small amount of chassis lubricant on the bearing side and in the grooves of the control assembly (16). Install new O-ring seals (10 and 17) on control assembly (16). If the hub has a seal groove, position the split towards the outside of dial. Place disc (9) on inside (clutch side) of clutch body (13). See Fig. 10.

Assemble clutch screw (8) into clutch ring (6) from back side (Fig. 8). Be certain clutch screw works freely. If it is sticky in any position, tap lightly from the back side. Drop in clutch ring and screw assembly. NOTE: Clutch screw (8) should be flush with the back edge of clutch ring (6). Insert the twelve drive pins (11). Try clutch ring for a free sliding fit on drive pins. If it doesn't move freely from top to bottom, lift out clutch ring and screw assembly and turn it to another position. If it still does not move freely, it should be removed and the clutch ring (6), clutch body (13) and drive pins (11) examined for damage.

Apply a light grade chassis lubricant to the inside face of the clutch body (13) and disc (9) from the front side of the clutch body., NOTE: Hold hand over drive pins to prevent their falling out.

Position control assembly (16) with dowel pin (20) into face of clutch body (13) so the arrow stops on the dot marked "FREE. " Install and tighten the flat head screw (7) into the control assembly (16). NOTE: If screw (7) was damaged during disassembly, it should be replaced.

To check clutch screw setting, turn control assembly (16) from "LOCK" to "FREE" position and back several times. Control assembly should "snap" into both positions. In "FREE" position clutch ring (6) should just clear bottom of clutch body (13).

NOTE: If clutch ring is set too far above bottom of clutch body when set in the "FREE" position, axle shaft hub-(4) will rub face of clutch ring.

Stake dowel pin (20) and flat head screw (7).

Turn control assembly (16) to "FREE" position and apply a thin coating of light grade chassis lubricant around the clutch screw (8) and drive pins (11).

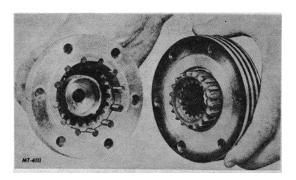


Fig. 19 Clutch Body and Hub Body Properly Assembled (Manual Type)

Fig. 19 shows the manual type clutch body and hub body ready for assembly on the vehicle.

Hub Body (Lock-O-Matic)

Install thrust washer (13) in hub body (16). Place the Spirolox lock ring (15) in its groove in the hub body (6) to hold the thrust washer in position, Fig. 18.

Position new friction shoes (4) into roller cage (9). Secure friction shoes by installing spring (3) as illustrated in Fig. 15. Install Spirolox lock ring (10) into end (opposite friction shoes) of roller cage (9).

Insert axle shaft hub (11) into roller cage (9) against Spirolox spring (10). See Fig. 16. NOTE: Points on axle shaft hub must be aligned with grooves in friction shoes to permit entry.

Install Spirolox lock ring (12) into second groove on axle shaft hub (11). See Fig. 15.

Slip the centering spring (8) into the groove in the back side of the axle shaft hub, Fig. 14. NOTE: The two ends of the spring go into the slot in the cage which is longer than the rest. Place a small amount of lightweight chassis lubricant into all the slots in the cage and into the bore of the hub body.

Hold the hub and cage assembly with the clutch end up and insert the ten rollers (7) into the cage slots. Slip axle shaft hub and cage assembly into hub body (6) from back side. Install lock ring (14) into remaining groove in axle shaft hub (11) using lock ring pliers.

Clutch Body (Lock-'O-Matic)

The reassembly instructions for the Lock-O-Matic clutch body are the same as for the manual type. See "REASSEMBLY--Clutch Body (Manual Type)."

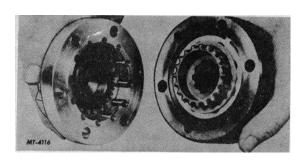


Fig. 20 Clutch Body and Hub Body Properly Assembled (Lock-O-Matic)

Fig. 20 illustrates the Lock-O-Matic clutch body and hub body ready to be assembled on the vehicle.

ADJUSTMENT

No adjustment of any kind is required on the manual or Lock-O-Matic locking hubs except for the positioning of the clutch screw during reassembly. See "REASSEMBLY--Clutch Body."

LUBRICATION

Both locking hubs should be lubricated at assembly with a thin coat of Lithium 12-Hydrox} Stearate EP grease. NOTE: Do not pack hub full of grease.

CHAPTER II

DISASSEMBLY:

- With handle in disengage position, remove handle assembly by removing the three screws "A". Do not remove the three screws "B".
- If screws "B" are removed, misalignment could occur on reassembly causing damage to cam. There is no reason to ever remove screws "B".
- 3. Remove and retain retaining ring on axle.
- 4. Remove base assembly, by removing six bolts.
- 5. If locktabs were used, the tabs must be bent out of the way of the bolt head.
- 6. Clean gasket surfaces thoroughly.
- 7. Wipe the axle spline clean and lubricate.

REASSEMBLY:

1. Install the base assembly with new gasket in place, to the vehicle hub.

- Secure base assembly to vehicle with bolts and new lock tabs.
- 3. The tab on the locktab is to be bent up against flat on head of bolt to insure against loosening.
- 4. Install retaining ring on axle shaft.
- 5. Install new "0" ring into groove on base assembly.
- 6. Apply thin film of grease to "O" ring, prior to installing handle assembly.
- 7. Place the handle assembly in position.
- 8. With the splines of the sliding gear aligned with the splines within base, push the handle assembly on the base.
- 9. Using hand pressure, compress the spring enough to allow the screw holes for screws "A" to line up with the groove in base.
- Insert three new screws "A". <u>DO NOT FORCE</u>. Screws must enter and screw into place freely.

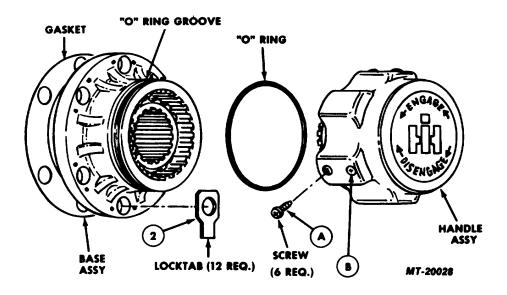


Fig. 1

AXLES - FRONT LOCKING HUBS AUTOMATIC AND MANUAL

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CHAPTER II
MANUAL HUE

CHAPTER III
DUALMATIC HUB

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AXLES-FRONT

CHAPTER I

AUTOMATIC HUB

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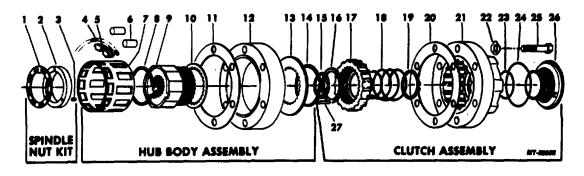


Fig. 1 Locking Hub (Automatic)

LEGEND FOR FIG. 1

<u>NO</u> .	DESCRIPTION	<u>NO</u> .	DESCRIPTION
1	LOCKWASHER	15	RING, RETAINING
2	NUT, SPINDLE	16	NUT, CLUTCH
3	SCREW, SET	17	RING AND CUP, CLUTCH
4	SPRING, GARTER	18	SPRING, COMPRESSION
5	SHOE, FRICTION	19	RING, RETAINING
6	ROLLER	20	GASKET
7	CAGE	21	CAP
8	SPRING, CENTERING	22	TAB, LOCKWASHER
9	HUB, SHAFT AXLE	23	"0" RING
10	RING, CENTERING	24	"U" RING
11	GASKET	25	CAP SCREW
12	BODY, HUB	26	DIAL, CONTROL
13	WASHER, BEARING	27	PIN, GROOVE
14	RING, RETAINING		

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OPERATION

The automatic hub, when set in the "AUTO" position, automatically locks the front wheel and axle shaft together the moment torque is applied to the front axle. The hub controls, therefore, do not require changing regardless of whether the vehicle is being operated in two or four-wheel drive. It is necessary, however, to set the control in the "LOCK" position when engine braking control is required (down steep hills, on ice, etc.).



Fig. 2 Dial

Control DO NOT DRIVE unless controls on both hubs are set properly and both are set the same!

For the first 320 km (200 miles) operate your new vehicle with the automatic hubs in "LOCK" position to assist in initial break-in of the front driving axle. Place transfer case control in 2-wheel drive position.

Always shift transfer case to 2WH before attempting to disengage the locking hubs.

This will help to eliminate drive line wrap up which results from 4W drive operation. Also, this will allow automatic hub to disengage by rotating the control dial.

IMPORTANT

Torque wind up may be relieved by turning hard right or left and backing up a short distance while pushing the transfer cue lever into 2WD.

LUBRICATION

When reassembling the locking hub, lubricate as follows: Lubricate dial, seals, splines, threads, rollers, cage, centering spring and body with IH 251 HEP grease.

Fill area between and around friction shoes with approximately two tablespoons of grease. All remaining surfaces require only a light coating.

Excessive grease can create malfunction of hub.

SERVICING

This locking hub is serviced in two major assemblies, namely, a clutch half and body half.

Since all individual components are not provided, refer to the Scout Parts Catalog when ordering.

To disassemble: 1. Bend lock tabs out of way.

- 2. Remove six (6) bolts.
- 3. Remove cap assy.
- 4. Remove snap ring from axle shaft.
- 5. Remove body assy.

To reassemble:

- 1. Clean gasket surface.
- 2. Reverse disassembly procedure using new gasket and lock tabs.

TORQUE SPECIFICATION

Torque hub assembly mounting bolts to 32-40 ft. lbs. 43-54 N-m.



AXLES-- FRONT

CHAPTER II

MANUAL HUB

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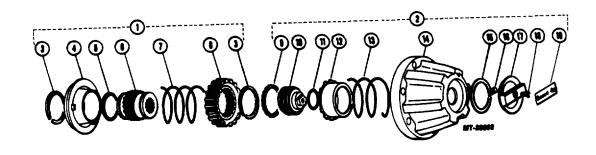


Fig. 1 Locking Hub (Manual)

LEGEND FOR FIG. 3

NO.	DESCRIPTION	NO.	DESCRIPTION
1	CLUTCH AND BEARING ASSY.	11	SEAL "O" RING
2	CAP ASSY.	12	CUP, CLUTCH
3	RING, RETAINING	13	SPRING, COMPRESSION
4	BEARING, HUB	14	CAP, HUB
5	WASHER	15	WASHER
6	HUB	16	DETENT, DIAL
7	SPRING, COMPRESSION	17	DIAL, CONTROL
8	RING, CLUTCH	18	SCREW
9	NUT, CLUTCH	19	LABEL
10	SCREW, DIAL		

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OPERATION

When the locking hubs are engaged in "4 x 4" and transfer case is in 4W, full power is transmitted to both wheels. When both front wheels are disengaged or in "4 x 2" position and transfer case in 2W, shafts and differential will remain idle, overcoming any unnecessary wear.

For the first 320 km (200 miles) operate your new vehicle with the locking hubs in "4 x 4" position to assist in initial break-in of the front driving axle. Place transfer case control in 2wheel drive position.



Fig. 2 Dial Control

Always shift transfer case to 2H before attempting to disengage the locking hubs.

DO NOT DRIVE unless controls on both hubs are set the same!

To avoid excessive torque loads on the rear axle, DO NOT drive vehicle in low range of transfer case with locking hubs set in "4 x 2" position.

LUBRICATION

When reassembling the locking hub, lubricate as follows: Lubricate dial, seal, splines, threads, ring and bearing with IH 251 HEP grease.

SERVICING

This locking hub is serviced in two major assemblies, namely, a clutch half and cap assembly. Since all individual components are not provided, refer to the Scout Parts Catalog when ordering.

To disassemble:

- 1. Bend lock tabs out of way.
- 2. Remove six (6) bolts.
- 3. Remove cap assy.
- 4. Remove snap ring from axle shaft.
- 5. Remove clutch assy.

To reassemble

- 1. Wipe mounting surfaces clean.
- Reverse disassembly procedure using new lock tabs. A gasket <u>is not</u> used with this assembly; as the clutch assembly seals automatically with the wheel hub.

TORQUE SPECIFICATION

Torque hub assembly mounting bolts to 32-40 ft. lbs. 43-54 N-m.

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AXLES - FRONT

CHAPTER III

DUALMATIC HUB

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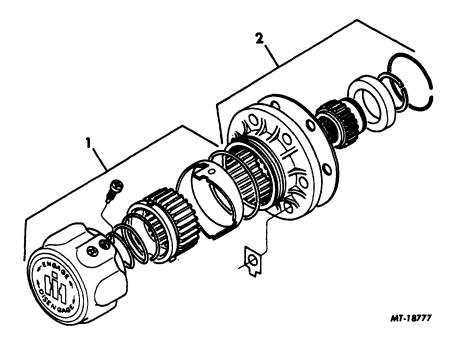


Fig. 1 Locking Hub (Dualmatic)

LEGEND FOR FIG. 1

NO. DESCRIPTION

1 CLUTCH ASSY.



Fig. 2 Dial Control

NO. DESCRIPTION

2 BODY ASSY.

OPERATION

WHEN TO USE "DISENGAGE" OR "ENGAGE" POSITION: Use "DISENGAGE" for all driving that does not require four-wheel drive power and traction.

Use "ENGAGE" whenever four-wheel drive is used.

To avoid excessive torque loads on the rear axle, DO NOT drive vehicle in low range of transfer cause with locking hubs set in "DISENGAGE" position.

For the first 320 km (200 miles) operate your new vehicle with the locking hubs in "ENGAGE" position to assist in initial break-in of the front driving axle. Place transfer case control in 2-wheel drive position.

DO NOT DRIVE unless controls on both hubs are set properly and both are set the same!

Always shift transfer case to 2WH before attempting to disengage locking hubs.



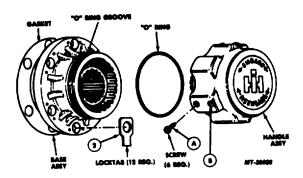
USE FINGERS ONLY TO TURN CONTROLS. If controls do not turn freely with your fingers, move the vehicle either way a few inches in 2-wheel drive standard gear range to relieve pressure against the gears. If hubs do not now turn freely, look for external damage.

SERVICING

This locking hub is serviced in two major assemblies, namely, a clutch half and body half. Individual components are not provided. Refer to Scout Parts Catalog when ordering.

DISASSEMBLY

- 1. With handle in disengage position, remove handle assembly by removing the three screws "A". Do not remove the three screws "B".
- If screws "B" are removed, misalignment could occur on reassembly causing damage to cam. There is no reason to ever remove screws "B".
- 3. Remove and retain retaining ring on axle.
- 4. Remove base assembly, by removing six bolts.
- 5. If locktabs were used, the tabs must be bent out of the way of the bolt head.
- 6. Clean gasket surfaces thoroughly.
- 7. Wipe the axle spline clean and lubricate.



REASSEMBLY

- 1. Install the base assembly with new gasket in place, to the vehicle hub.
- Secure base assembly to vehicle with bolts and new lock tabs.
- 3. The tab on the locktab is to be bent up against flat on head of bolt to insure against loosening.
- 4. Install retaining ring on axle shaft.
- 5. Install new "O" ring into groove on base assembly.
- 6. Apply thin film of grease to "0" ring, prior to installing handle assembly.
- 7. Place the handle assembly in position.
- 8. With the splines of the sliding gear aligned with the splines within base, push the handle assembly on the base.
- Using hand pressure, compress the spring enough to allow the screw holes for screws "A" to line up with the groove in base.
- Insert three new screws "A". DO NOT FORCE. Screws must enter and screw into place freely.

TORQUE SPECIFICATION

Torque hub assembly mounting bolts to 32-40 ft. lbs. 43-54 N-m.

AXLE-REAR



REAR AXLE ELECTRIC SHIFT (FOR TANDEM AND TWO SPEED AXLES)

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ELECTRIC SHIFT

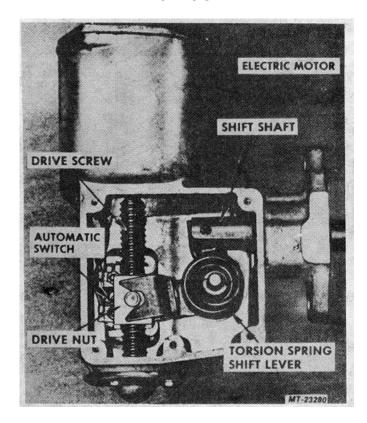


Fig. 1 Electric Shift Motor for Tandem and Two-Speed Axles (Cover Removed)

GENERAL

The electric shift motor (Fig. 1) used on IH tandem or two-speed axles performs either of the following two functions:

- Shifts a tandem axle power divider unit for "lock-out" or "lock-in" operation.
- 2. Shifts a two speed axle for "high" or "low" range differential operation.

DESCRIPTION AND OPERATION

ELECTRIC SHIFT MOTOR

The electric shift motor is mechanically connected to the axle shift fork and shifts the axle assembly for either of two driving modes the driver selects. Driver selection is through the electric shift system (Fig. 2). The shift motor consists of a reversible electric motor, automatic switch, drive screw assembly, and a torsion spring shift lever. In operation the automatic switch starts and stops motor as required. The motor rotates a drive screw which causes a drive

nut to travel the length of the drive screw. This drive nut operates the torsion spring shift lever and provides the motion to move shift shaft and fork to change axle operation.

CONTROL SWITCH

The control switch can be either the toggle type on instrument panel or the push/pull type as used on the transmission shift lever. The switch controls the electric shift system to operate the electric shift motor. (It also energizes the electro-magnet in the speedometer adapter for two-speed axles).

WIRING HARNESS

Electric wiring for the shift system (Fig. 2) is contained in its own wiring harness. Individual wires are coded for ease of assembly and any subsequent checking. Fuses are connected in the system to protect the various components. If a short circuit occurs the fuses will open and cut off current to the system.

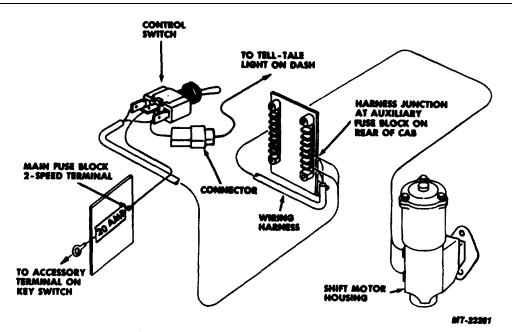


Fig. 2 Electric Shift System (Tandem Axle Power Divider Lock Type Shown)

SPEEDOMETER ADAPTER

The speedometer adapter (Fig. 3), which is used with two-speed axles only, compensates for drive shaft speed variations between high and low axle ratios. A spring holds adapter in high range position and an electro-magnet holds adapter in low range position.

SYSTEM OPERATION

TANDEM AXLES

Power Divider "Lock-Out" Operation (Fig. 4)

With the control switch on instrument panel at "lock-out" position, shift motor operates to rotate drive screw in a clockwise direction and move drive nut down. When the drive nut has traveled a sufficient distance to wind the torsion spring, a contact bumper (on drive nut) breaks electrical connections on the automatic switch which stops the motor. To make certain that vibration does not move nut, a ball screw detent spring holds nut at the end of its travel on the screw.

The drive nut moves the spring winding lever down which winds the torsion spring. Thus an increased load is placed on the spring and in this position the axle is ready to shift into "lock-out" as on as the load (torque) on the axle is relieved (Vehicle stopped and transmission engaged).

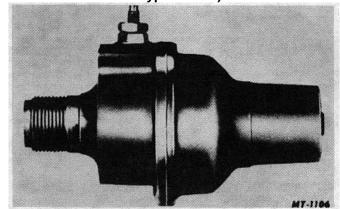


Fig. 3 Speedometer Adapter (For Two-Speed Axle Shift System'

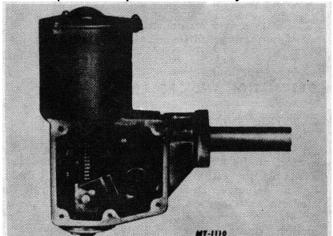


Fig. 4 Shift Unit in "Lock-Out" Position

The torsion spring is assembled under a preload of 50 to 80 pounds pressure. When spring winding lever is moved so that spring is wound, the pressure is increased to 90 to 135 pounds. This additional spring load is used to shift the axle and when the shift is complete the initial 50 to 80 pounds preload again becomes effective in holding the power divider in the "lock-out" position.

Power Divider "Lock-In" Operation (Fig. 5)

When control switch is flipped to "lock-in" position, the shift motor rotates to operate drive screw in a counter clockwise direction. The drive nut travels to the top of the drive screw (Fig. 6) thus winding the torsion spring for shift to "lock-in" position in the same manner as described above for "lock-out" position.

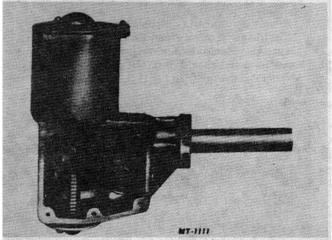


Fig. 5 Shift Unit In "Lock-In" Position TWO SPEED AXLES

The operation of the shift system for two-speed axles is similar to the above except that a speedometer adapter is used in the system to permit the shift between high or low range to be made without stopping the vehicle.

DISASSEMBLY

ELECTRIC SHIFT MOTOR

Remove Shift Motor From Differential Carrier.

- Disconnect wiring harness from shift motor.
 Note and tag the mounting position of the two wires.
- 2. Remove cover from shift motor and drain lube from shift motor housing (Fig. 6).
- When cover is removed you will note that shift motor drive nut will be at top or bottom of drive screw depending on position of shift control switch. Hand turn drive screw to center drive nut on screw. This step is necessary to prevent damage to drive nut contact bumper during disassembly.

IMPORTANT

On tandem axles, the electric shift motor and the shift fork housing are removed from the axle as a complete assembly and moved to work bench for further disassembly. On two-speed axles, the electric shift motor must be partially disassembled on the axle to separate shift motor and shift shaft and then moved to work bench for further disassembly.

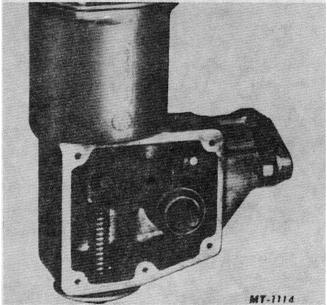


Fig. 6 Electric Shift Motor With Cover Removed

 To separate shift motor from shift shaft, lift out torsion spring shift lever (Fig. 7) from shift motor housing. Do not disassemble torsion spring shift lever assembly unless parts replacement is necessary.

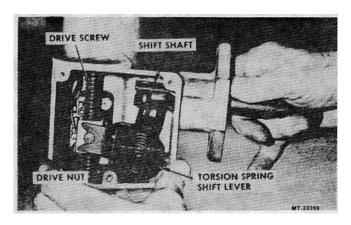


Fig. 7 Separating Shift Shaft from Shift Housing

Remove flange stud nuts and separate shift motor from shift fork housing (tandem axles) or from carrier (two speed axles).

Disassemble Shift Motor

 Remove drive screw bearing cover on bottom of housing and push down on drive screw assembly until bearing is free from housing. Insert screw driver in slot of drive screw and remove bearing retainer nut and bearing (Fig. 8).

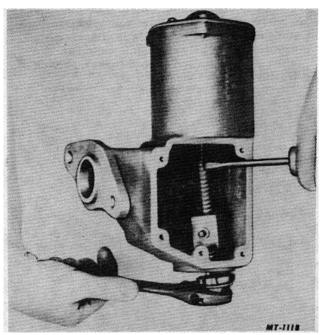


Fig. 8 Removing Drive Screw And Bearing

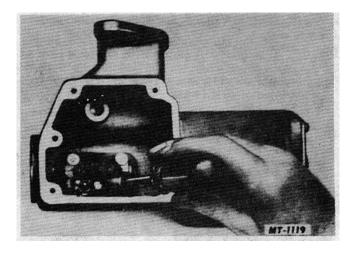


Fig. 9 Disconnecting Internal Motor Leads

2. Remove locknuts to disconnect motor leads (Fig. 9) from automatic switch. Remove

mounting screws and cable clips and detach motor assembly from housing (Fig. 10).

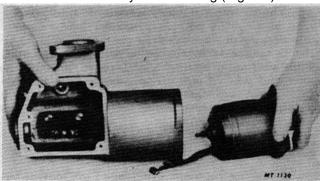


Fig. 10 Separating Electric Motor From Housing IMPORTANT

Do not immerse motor assembly in cleaning solutions.

 Remove locknuts, insulator and insulator bushings from automatic switch mounting studs. Remove screw from center of automatic switch and detach switch assembly from housing (Fig. 11).

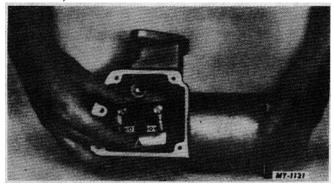


Fig. 11 Removing Automatic Switch From Housing INSPECTION AND REPAIR

AUTOMATIC SWITCH

Inspect switch for free movement of contacts. Contacts should close firmly under spring tension. If parts are fulty, replace as an assembly.

DRIVE SCREW ASSEMBLY

Check drive screw for free turning in nut. When nut reaches end of screw, screw should continue to turn but nut should not jam or run off end of screw. Rotate screw in opposite direction to see that nut moves to other end of screw and stops without binding. Contact bumper mounted nut should be a press fit. If any part of drive screw assembly is faulty, replace drive screw assembly.

TORSION SPRING SHIFT LEVER

Inspect torsion spring shift lever for worn or broken parts. Do not disassemble spring from lever assembly unless parts are to be replaced. To disassemble the spring-lever unit, position unit in a vise as shown (Fig. 12). As an aid to disassembly, insert a short steel rod in hub of spring ("A" Fig. 12).

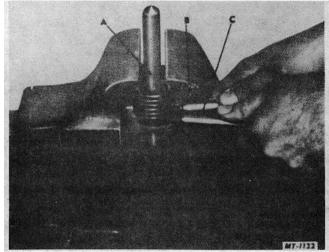


Fig. 12 Removing Torsion Spring From Lever
Assembly
CAUTION

Steel rod is also a precautionary measure to prevent personal injury if torsion spring should slip out of control.

Next with two lengths of tubing ("B" and "C" Fig 12) over spring ends, pull spring ends apart to remove preload; then raise spring above lever assembly and allow spring ends to return to their unsprung position (Fig. 13).

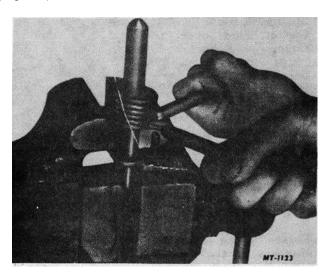


Fig. 13 Relieving Torsion Spring Tension ELECTRIC MOTOR

The motor is lubricated and sealed for life. No maintenance or lubrication is required and if motor is faulty it should be replaced as a complete assembly. If faulty motor is suspected, check free running operation and torque at test bench as follows:

Operate motor at rated voltage (See Specifications) and note current draw. If motor will not rotate at specified speed or current draw is excessive, replace motor.

If free running test is satisfactory, make torque test as follows.

IMPORTANT

Do not allow motor to overheat during the torque test or damage to motor can result.

Clamp motor in a vise and place a small crescent wrench on rectangular end of armature shaft. Apply rated voltage to operate motor while holding wrench by hand. Allow wrench to turn slowly making sure that torque is present the full 360 degree turn of the wrench. If part of armature winding is faulty, torque will not be present for part of the 360 Degree turn. This condition indicates a dead spot in motor. Replace motor as an assembly.

MOTOR TEST SPECIFICATIONS

The following charts show the electric shift motor test specifications for the running and loading conditions.

MOTOR FREE RUNNING TEST

SET		READ	
Motor Rated Voltage (volts)	Test Voltage (volts)	Speed (Min. rpm)	Current (Max. amps.
12	6	10,000	11.5
12	12	10,000	8.0
24	24	10,000	6.0

MOTOR TORQUE TEST

SET		READ	
Motor Rated Voltage (volts)	Test Voltage (volts)	Torque (Min. inlbs.)	Current (Min. amps.)
6	6	6	85
12	12	6	42
24	24	6	32

CONTROL SWITCHES

Control switches whether toggle or push/pull type are serviced as a complete assembly. Inspect switch for loose connections and other visual defects that may cause short circuit or electrical failure. Replace as required.

SPEEDOMETER ADAPTER

The speedometer adapter which is required for two-speed axles only is lubricated and sealed for the life of the unit. No maintenance is required. Replace a faulty unit.

REASSEMBLY

ASSEMBLE TORSION SPRING SHIFT LEVER CAUTION

The torsion spring shift lever is assembled under spring tension. Follow assembly instructions to avoid personal injury.

- Clamp end of lever assembly in vise and place torsion spring over lever hub. Insert a short steel rod in hub of spring and lever as an assembly tool. Tool is a precautionary measure to prevent injury if torsion spring should slip out of control.
- Next slide two lengths of tubing over the spring ends (Fig. 13). Pull spring ends together and retain tension in spring by hooking one spring end to one side of lever tab and other spring end to opposite side of tab (Fig. 12).

ASSEMBLE SHIFT MOTOR (Fig. 14)

- Position automatic switch (7) in shift motor housing (5) and install screw (15) in center of switch. Install insulator bushings (21), insulator (24) and locknuts on switch mounting studs.
- Place gasket (4) and electric motor (3) in shift motor housing and secure with mounting screws.
- 3. Connect motor leads to automatic switch terminals and install locknuts (16).
- 4. Position drive screw assembly (9) in shift motor housing and install bearing (17) and locknut (18) on end of drive screw. When tightening locknut hold drive screw with screw driver blade in drive slot. Position drive screw to engage drive slot with motor armature shaft and place bearing in housing.

Be sure bearing is seated squarely in bearing bore. Install bearing cover (20) and gasket (19) and secure with mounting screws.

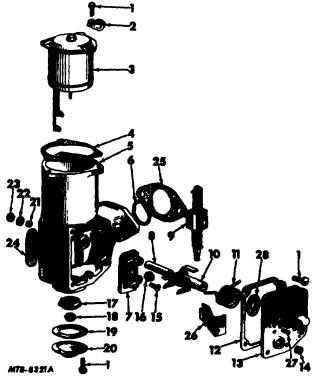


Fig. 14 Electric Shift Motor (Exploded View)
LEGEND FOR FIGURE 14

- 1 Screw, Motor Mounting
- 2 Not Used
- 3 Motor, Assembly
- 4 Gasket, Motor Cover to Shift Housing
- 5 Housing, Shift Motor
- 6 Seal, Shift Housing and Shaft
- 7 Switch, Automatic Shift Control
- 8 Shaft, Lever
- 9 Screw, Drive Assembly
- 10 Lever, Shift
- 11 Spring, Torsion
- 12 Gasket, Side Cover
- 13 Cover
- 14 Plug, Pipe
- 15 Screw. Slotted
- 16 Nut, Inner Terminal
- 17 Bearing, Drive Screw
- 18 Nut, Drive Screw End
- 19 Gasket, Bearing Cover
- 20 Cover, Bearing
- 21 Bushing, Outer Terminal
- 22 Pin, Drive Screw
- 23 Nut. Hex. Terminal
- 24 Insulator, Switch to Housing
- 25 Gasket, Eliminator 50 cc Tube
- 26 Spring, Cover Detention
- 27 Rivet, Spring Mounting
- 28 Washer, Torsion Spring

IMPORTANT

Be sure contact bumper on drive nut is positioned toward automatic switch and drive nut is at center of drive screw.

5. Install torsion spring shift lever (10 and 11) in housing and engage lever ends with drive nut on drive screw. Secure in housing with lever shaft (8). Operate drive screw assembly by hand to be sure shift motor assembly has been assembled correctly. Do not install cover at this time since torsion spring shift lever must be removed to engage with end of shift shaft when installing.

INSTALL SHIFT MOTOR

On Tandem Axles

- To connect electric shift motor to shift shaft of shift housing, place seal and retainer over shift shaft and insert shaft end into mounting flange of shift motor housing.
- Remove torsion spring lever shaft and position loosened torsion spring shift lever spring ends into slotted end of shift shaft. <u>Ends of torsion</u> <u>spring must be positioned in shift shaft end</u> as shown in Fig. 15.

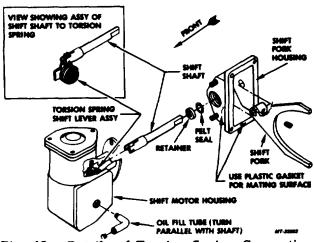


Fig. 15 Details of Torsion Spring connection

- When assured shift shaft is engaged with torsion spring shift lever assembly, apply continuous bead of plastic gasket to one flange mating surface and mount shift motor assembly to power divider shift fork housing studs. Secure with mounting nuts and torque nuts to 41-50 Nm (30-38 ft. lbs.).
- 4. Install shift motor housing cover and gasket. Secure with mounting screws.

- 5. Again using plastic gasket on one mating surface place, complete assembly on differential carrier and secure with four mounting bolts. Torque to 41-50 N-m (30-38 ft. lbs.).
- 6. Connect wiring harness to shift motor terminals long or red wire connects to bottom terminal.

On Two Speed Axles

The electric shift motor connect to the carrier of a two speed axle in a similar manner. The important assembly technique to note is that shift fork shaft pin is located between torsion spring ends as shown in Fig. 15

LUBRICATION

TYPE LUBRICANT

Use SAE 10 motor oil for temperatures above - 22C (00 F). For temperatures below this level mix three parts of SAE10 oil with one part kerosene. This cold weather mixture can be safely used up to 0°C (32° F).

CHECK AND LEVEL INTERVAL

Each 16000 kilometers (10000 miles) or 3 months, remove pipe plug in shift unit housing cover to check lube level. Tube should be level with bottom of filler hole.

LUBE CHANGE INTERVAL

At least twice a year remove shift unit housing cover and drain old lubricant. Wash parts thoroughly and air dry. Reinstall cover. Remove filler plug in cover and fill through plug opening until lube is level with bottom of filler hole.

TROUBLE SHOOTING

If axle will not shift, test electric shift system and components with test lamp as follows: (Test lamp voltage should be same as system voltage) Refer to Figs. 16 and 17 for terminal references.

Check for Blown Fuse

Disconnect fuse lead wire (Terminal "A").Connect test lamp across Terminal "A" and ground on vehicle frame. Turn on key switch and observe test lamp operation:

- 1. If lamp lights and stays on continuously, fuse and lead wire from key switch is OK.
- 2. If lamp does not light, check for poor electrical connections, broken lead wire or blown fuse.
- If fuse replacement does not restore shifting, check for defect at components.

<u>Check Dash Panel Toggle Switch and Wiring Harness</u> (Power Divider Lock)

If trouble is suspected in dash panel toggle switch or wiring harness, visually check as follows: Check wiring harness for damaged or worn insulation that may cause an unintentional grounding. Check for short circuits between wires or wire terminals.

To determine if defect is in toggle switch, disconnect lead wires at shift unit (Terminals "B" and "C" Fig. 16). Turn key switch on and alternately connect test lamp leads to disconnected lead wires. Operate toggle switch on dash and observe lamp for the following conditions:

When test lamp is connected to shift unit <u>black</u> wire, lamp should light in "lock-out" position toggle switch. Test lamp should go out when toggle switch is flipped to opposite position.

When test lamp is connected to shift unit white wire,. lamp should light in "lock-in" position of toggle switch. Test lamp should go out when toggle switch is in opposite position.

If test lamp indications are correct in the above tests, current supply to shift unit is satisfactory and toggle switch is OK.

If test lamp does not light, or burns poorly, defect may be a short circuit in wiring harness, toggle switch or broken wire. Harness connectors may also be faulty.

<u>Check Gear Shift Lever Switch and Wiring Harness</u> (Two-Speed Shift)

If trouble in lever switch or wiring harness is suspected, visually check as follows: Check wiring harness for damaged or worn insulation that may cause unintentional grounding. Check for short circuits between wires or wire terminals.

To determine if defect is in lever switch, disconnect lead wires at shift unit terminals (B and C Fig. 17). Turn key switch on and alternately connect test lamp leads to disconnect lead wires. Operate lever switch and observe test lamp for the following conditions: When test lamp is connected to shift unit red wire, lamp should light in the "high gear" or up position on the gear shift lever switch. Test lamp should go out when gear shift lever switch is pushed down.

When test lamp is connected to shift unit black wire, lamp should light in the low gear or down position on the gear shift lever switch. Test lamp should go out when gear shift lever switch is pulled up.

If test lamp indications are correct in the above tests, current supply to shift unit is satisfactory and lever switch OK.

If test lamp does not light or burns poorly, defect may be a short circuit in wiring harness or lever switch or a broken wire. Harness connectors may also be faulty.

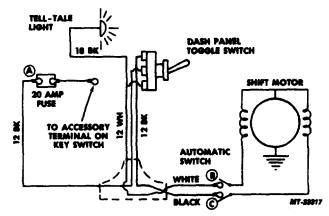


Fig. 16 Schematic For Tandem Axle Power Divider Lock Electrical System

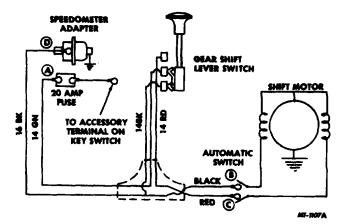


Fig. 17 Schematic For Two-Speed Axle Shift Electrical System

<u>Check Speedometer Adapter Operation</u> (For Two-Speed Axles Only)

The speedometer adapter is energized in low axle range only. Before condemning speedometer adapter operation, be sure ground connection is satisfactory.

To test speedometer adapter circuit with a test lamp, disconnect lead wire at terminal "D" (Fig.17). Connect test lamp to terminal "D" lead wire and ground on vehicle frame. Turn ignition switch on and observe test lamp operation.

The test lamp should light in low range or down position of lever switch. Lamp should go out when lever switch is pulled up.



If lamp indications are correct, current supply to adapter is correct. If lamp indications are correct and axle shifts normally, but speedometer adapter does not operate properly, replace adapter.

If test lamp indications are not correct, the trouble is in the wiring harness or gear shift lever switch.

An alternate method of checking for defect in control switch whether toggle type or push/pull lever type is to obtain a new switch and temporarily install in system.

Check Electric Shift Unit

If electrical wiring system is satisfactory but axle still does not shift, the trouble may be in the shift unit or electric motor. Disassemble shift unit, test motor and repair as covered in previous paragraphs.



REAR AXLE

STRAIGHT-AIR PISTON TYPE SHIFT UNIT

(For Two and Three-Speed Planetary Type Differentials)

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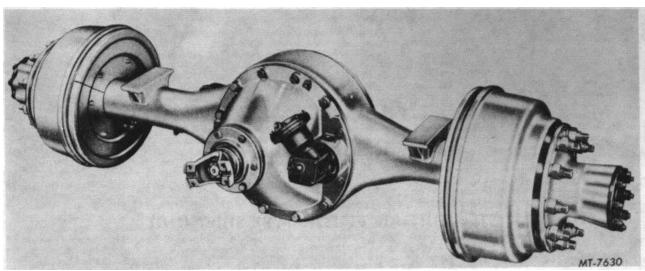


Fig. 1 Two-Speed Planetary Type Axle.

DESCRIPTION AND OPERATION

Two-Speed Single and Tandem Axle Systems

The shift system basically includes (1) a 2-position, manually operated air shift control valve, (2) a quick release valve and an axle shift unit (two units on tandem axles), Figs. 1 & 2. The entire system operates at reservoir tank air pressure.

On vehicles not equipped with automatic safety brakes, an ignition-controlled solenoid valve exhausts the system, which downshifts the axle when the ignition switch is turned off. The electrical circuit is protected by a circuit breaker.

In operation, the air shift control valve (in gear shift knob) supplies air pressure through the quick release valve to the axle shift unit(s). Air pressure in the shift unit(s) shifts the axle(s) into high range. To shift axle(s) to low range, air pressure is exhausted at control valve, which exhausts air pressure at quick release valve, allowing shift unit(s) to return to low range.

For low range operation, the shift control lever is in "LIX" (valve closed) and no air pressure is present in air lines to shift unit(s). Axle(s) is held in low range by shift unit return spring(s).

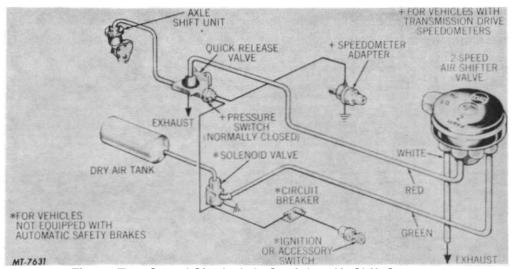


Fig. 2 Two-Speed Single Axle Straight - Air Shift System.

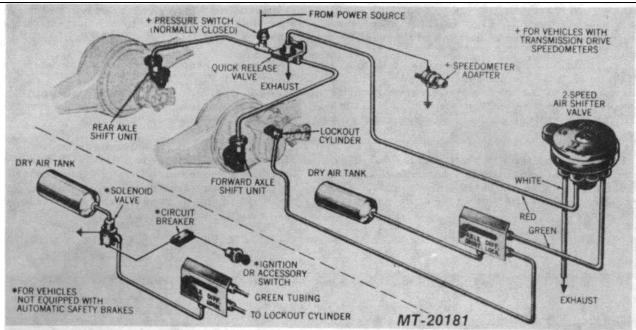


Fig. 3 Two-Speed Tandem Axle Straight-Air Shift System.

For high range operation, the shift control lever is in "HI" (valve opened) to allow air pressure through quick release valve to shift unit(s). Axle(s) is held in high range by air pressure in the shift unit(s).

For vehicles with transmission drive speedometer adapter. Operation is controlled by an

electrical switch (normally closed... opened by air pressure)mounted on the quick release valve.

Three-Speed Tandem Axle System

The three-speed straight-air shift system basically includes: (1) a 3-position, manually

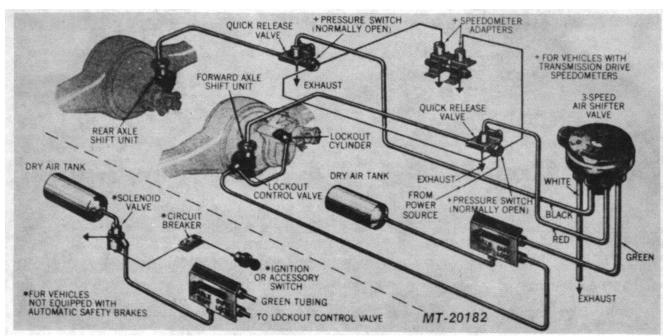


Fig. 4 Three-Speed Tandem Axle Straight-Air Shift System.

operated air shift control valve, (2) two quick release valves, (3) two axle shift units and (4) a lockout system, Fig. 4. The entire system operates at reservoir tank air pressure.

On vehicles not equipped with automatic safety brakes an ignition-controlled solenoid valve exhausts the system, which downshifts the axles when the ignition switch is turned off. The electrical circuit is protected by a circuit breaker.

In operation, the air shift control valve(in gear shift knob) supplies air through the quick release valves to the axle shift units. Air pressure in the shift units shifts the axles to high range.

To shift axles to low range, air pressure is exhausted at the control valve, which allows shift unit air pressure to exhaust at quick release valves.

For low range operation, the shift control lever is in "LO" (valve closed) and no air is present in air lines to either shift unit. Axles are held in low range by shift unit return springs.

When operating in intermediate range, the shift control lever is in "INT" (valve opened) to allow air pressure through the forward axle quick release valve to the shift unit. Forward axle is in high range and rear axle is in low range.

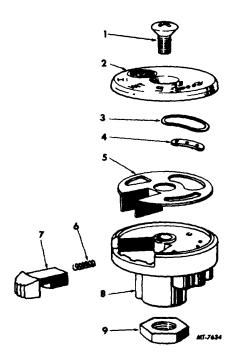


Fig. 5 Air Shift Control Valve (Exploded View - Type A).

Legend	for	⊦ig.	5
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SCREW, cover
COVER, control valve
O-RING
GUIDE, O-ring
PLATE, shifter
SPRING, shift lever
LEVER, shift
HOUSING, control valve
NUT, jam

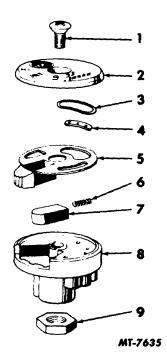


Fig. 6 Air Shift Control Valve (Exploded View - Type B).

Legend for Fig. 6

Kev	Description
1.	SCREW, cover
2.	COVER, control valve
3.	0- RING
4.	GUIDE, O-ring
5.	PLATE, shifter
6.	SPRING, valve lock
7.	LOCK, valve
8.	HOUSING, control valve
9.	NUT, jam

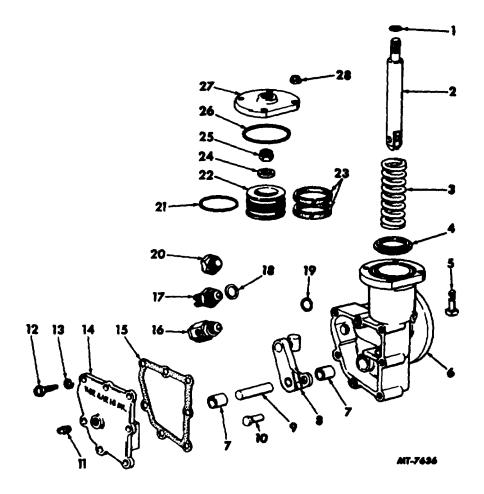


Fig. 7 Piston Air Shift Unit (Exploded View)

Legend for Fig. 7

Key	<u>Description</u>	<u>Key</u>	Description
1.	SEAL, Push Rod O-Ring	15.	GASKET, Housing Cover
2.	ROD, Push	16.	VALVE, Lockout Control
3.	SPRING, Compression	17.	SWITCH
4.	CUSHION, Piston Stop	18.	WASHER, Nylon
5.	BOLT, Piston Housing Cover	19.	SEAL, O-ring
6.	HOUSING, Air Shift	20.	PLUG, Housing
7.	BEARING, Actuating Lever	21.	SEAL, Piston Ö-ring
8.	LEVER, Actuating	22.	PISTON
9.	PIN, Actuating Lever	23.	OILER, Piston Felt
10.	PIN, Clevis	24.	WASHER, Piston
11.	PLUG, Cover	25.	NUT, Lock
12.	BOLT, Housing Cover	26.	SEAL, Piston Housing O-ring
13.	WASHER, Lock	27.	COVER, Piston Housing
14.	COVER, Unit Housing	28.	NUT, Lock



For high range operation, the shift control lever is in "HI" (valve opened) to allow air pressure through both quick release valves to the shift units. Box axles are held in high range by shift unit air pressure.

Shifts made between "LO" and "INT" operate forward axle only. Shifts made between "INT" and "HI" operate rear axle only. Skip shifts "LO" to "HI" can be made by quickly moving shifter knob through "INT", shifting both axles. The lockout system includes a lockout valve located in the cab and a lockout control valve mounted in the forward axle shift unit.

The lockout will operate only in "LO" range, when the shift unit actuating lever depresses the lockout control valve. This permits air pressure to be applied to the power divider lockout cylinder. In "INT" and "HI" range, the control valve at the shift unit is closed and blocks air supply to the lockout cylinder, thus. preventing engagement of the lockout.

For vehicles with transmission drive speedometers, the system incorporates speedometer adapters. Operation is controlled by electrical switches (normally opened... closed by air pressure) mounted on the quick release valves.

REMOVAL

Shift Control Valve

To remove shift control valve, shut off air , supply to control valve. Remove air lines from control valve. Loosen jam nut and unscrew valve body from gear shift lever.

NOTE: Shift control valve can be disassembled for service without removing assembly from gear shift lever.

Shift Unit

To remove shift unit, bleed air from shift unit cylinder and disconnect air supply line at unit housing cover.

Remove stud nuts securing unit to axle carrier housing. Remove shift unit from carrier.

Remove shift fork seal and spring.

DISASSEMBLY

Shift Control Valve Type A

NOTE: Key numbers used in "Disassembly" and "Reassembly" of Type A air shift control valve refer to Fig. 5.

Remove screw (1) from cover (2). Lift off cover and remove shift lever (7), spring (6), shifter plate (5), O-ring guide (4) and O-ring (3) from valve housing (8).

Shift Control Valve Type B

NOTE: Key numbers used in "Disassembly" and "Reassembly" of Type B air shift control valve refer to Fig. 6.

Remove screw (1) from cover (2). Lift off cover and remove O-ring (3), O-ring guide(4), shifter plate (5), valve lock (7) and valve lock spring (6) from valve housing (8).

Air Piston Shift Unit

To disassemble the air-piston shift unit, Fig. 8, proceed as follows.

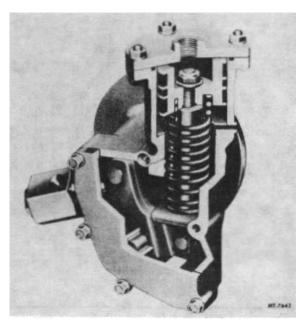


Fig. 8 Forward Rear Axle Z-Speed Air Piston Shift Unit.

NOTE: Key numbers used in disassembly and reassembly of shift unit, refer to Fig. 7.

Remove bolts (12) and lockwashers (13, if used) securing housing cover (14) to housing (6). Remove cover and gasket (15) and drain lubricant, Fig. 9. Discard gasket.

Place shift unit assembly in vise and remove nuts (28) and bolts (5) securing piston

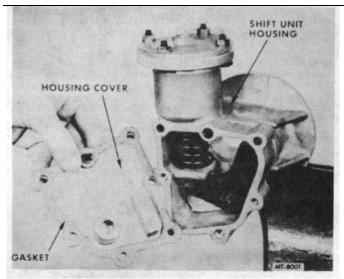


Fig. 9 Removing Shift Unit Housing Cover.

housing cover (27) to shift unit housing (6). Lift off cover and O-ring seal (26), Fig. 10. Discard O-ring seal as new seal is to be installed at reassembly.

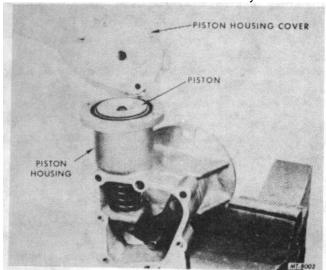


Fig. 10 Removing Piston Housing Cover.

Install a suitable puller tool over piston bore and hook tool legs under flange, Fig. 11. Place a 9/16" socket on self-locking nut and tighten puller screw down on socket.

CAUTION: Be certain puller tool screw is vertically aligned with piston push rod and that puller legs are adequately clamped under flange before applying pressure with tool.

Tighten puller tool screw until tension on clevis pin (10) is relieved. Remove clevis pin, Fig. 11.

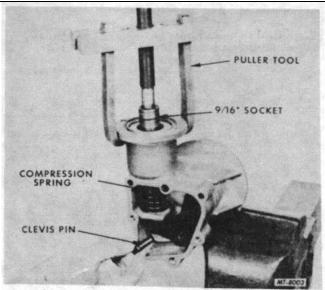


Fig. 11 Removing Clevis Pin.

Loosen puller tool screw until spring pressure is relieved and remove tool.

Lift piston (22), push rod (2) and compression spring (3) out through top of cylinder, Fig. 12.



Fig. 12 Removing Piston Assembly.

Remove actuating lever (8) from housing (6), Fig. 13.

Remove compression spring (3) from push rod (2). Remove piston stop cushion (4) from housing (6).

Remove and discard felt oilers (23) and 0ring seal (21) from piston (22). Piston can be separated from push rod (2) by removing self-locking

locking nut (25) and washer (24).

Remove lockout control valve (16) from forward rear axle unit.

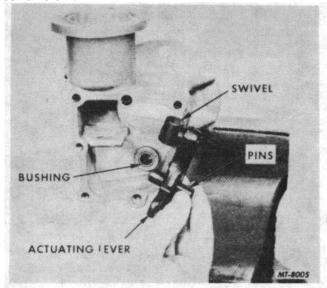


Fig. 13 Removing Actuating Lever from Housing.

CLEANING, INSPECTION AND REPAIR Shift Control Valve

Each 48,270 Km (30,000 miles) disassemble, inspect and clean all control valve parts. Lubricate moving parts with barium base grease (BW-204M or Parker "O" Lube). No other type lubricant should be used.

Shift Unit

Thoroughly clean all parts.

Examine shift fork seal for wear or damage. Seal should be a tight fit on shift fork. Check shift fork seal spring tension and distortion.

Check piston for a grooved or worn condition.

Inspect housing for cracks. Check piston bore for worn or grooved condition. Examine piston stop cushion for cracked or worn condition.

Examine push rod and actuating lever for elongated holes, worn or damaged condition.

Check compression spring tension and for damaged or worn condition.

Check bushings in housing and housing cover for damage or wear.

Check for wear on bearing surface of actuating lever pins and swivel. Examine clevis pin for damage or wear.

Use new piston felt oilers, O-rings and gaskets during reassembly.

REASSEMBLY

Shift Control Valve - Type A

NOTE: Lubricate all moving parts with barium base grease (BW-204M or Parker "O" Lube during assembly.

1. Place shifter (5) in mounting position on valve housing (8), Fig. 14.

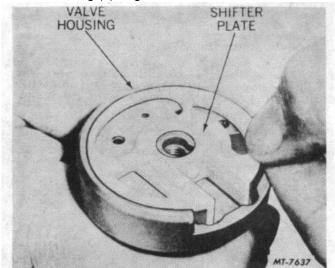


Fig. 14 Installing Shifter Plate.

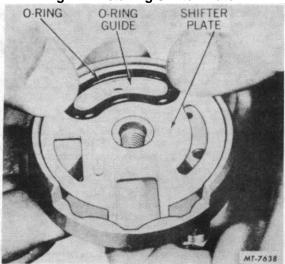


Fig. 15 Installing Guide and O-ring.

- 2. Preassemble guide (4) and O-ring (3), then place this assembly in mounting position in shifter plate (5), Fig. 15.
- Hold shifter plate (5) in position with one hand, then install spring (6) and shifter lever (7), Fig. 16. Install cover (2) and fasten with screw (1). Tighten screw to 10.2-11.3 N-m (90-100 in. lbs.) torque.

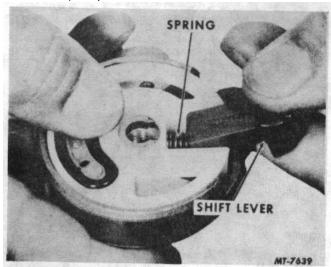


Fig. 16 Installing Spring and Shift Lever.

Shift Control Valve - Type B

NOTE: Lubricate all moving parts with barium base grease (BW-204M or Parker "O" Lube) during assembly.

1. Place shifter plate (5) in housing (8), Fig. 17.

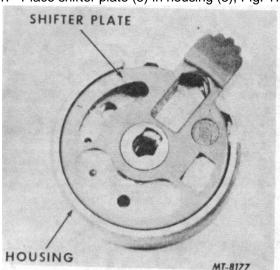


Fig. 17 Shifter Plate Installed in Housing.

2. Insert spring (6) in valve lock (7). Position valve lock in shifter plate (5), Fig. 18.

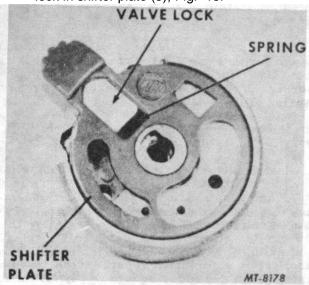


Fig. 18 Valve Spring and Lock Installed in Shifter Plate.

3. Position O-ring guide (4) and O-ring (3) in shifter plate (5), Fig. 19.

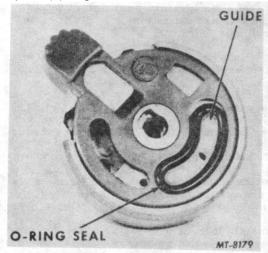


Fig. 19 O-Ring and Guide Installed in Housing.

4. Install cover (2) on housing (8) and secure with screw (1). Tighten screw to 10.2-11.3 N-m (90-100 in. lbs.) torque.

Shift Unit

Thoroughly saturate new piston felt oilers (23) by soaking them in clean SAE30W engine oil for one hour.

Lubricate new piston 0-ring seal (21) with

SAE-30W engine oil and install in center groove on piston (22). Install saturated felt oilers, one each, in remaining grooves on piston. Install new O-ring seal (1) on push rod.

Place piston assembly on push rod (2) and secure with washer (24) and new self-locking nut (25). Tighten nut to 15.4 N-m (135 in. lbs.) torque. Insert push rod through compression spring (3).

Insert piston stop cushion (4) into piston cylinder bore.

Install actuating lever (8) in housing (6).

Place push rod, spring and piston assembly into piston cylinder bore of housing. Position suitable puller tool on housing with a 15 mm (9/16") socket on piston self-locking nut as in "DISASSEMBLY". Tighten puller tool screw sufficiently to push piston assembly into cylinder bore far enough to permit installation of clevis pin (10) attaching push rod to actuating lever (8). Install clevis pin.

CAUTION: Be certain that puller tool is properly aligned before pressure is applied to compression spring. Also be careful not to damage felt oilers or piston O-ring seal as piston is pushed into cylinder bore.

With clevis pin properly installed back out puller screw until tool can be removed.

Install new unit housing gasket (15) and secure cover (14) to housing with bolts (12) and, if used, lockwashers (13). Tighten cover bolts to 11.3 N-m (100 in. lbs.) torque.

Lubricate new O-ring seal (26) and install in groove in piston end of housing (6). Position piston housing cover (27) on housing and secure with bolts (5) and nuts (28). Tighten nuts to 13.5 N-m (120 in. lbs.) torque.

Install lockout control valve and seal in forward rear axle unit.

MAINTENANCE

Speedometer Adapter

The speedometer adapters, Figs. 20 & 21, are lubricated and sealed for life of the unit. No maintenance is required. Replace a faulty unit. For dual adapters, it is not necessary to replace both units, if only one unit has failed.

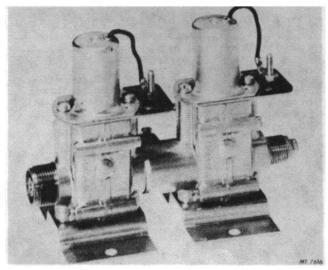


Fig. 20 Speedometer Adapter (3-Speed).

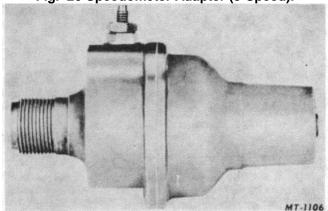


Fig. 21 Speedometer Adapter (2-Speed).

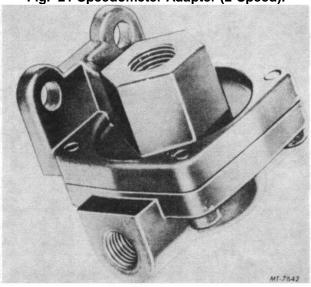


Fig. 22 Quick Release Valve.

Quick Release Valve

If quick release valve, Fig. 22, fails to operate properly, it may be repaired as follows: Disassemble valve. Inspect valve body, valve seat and spring (if used) for evidence of faulty operation. Replace faulty parts, then reassemble valve.

Speedometer Adapter Pressure Switch

Replace pressure switch, Fig. 23, as an assembly.

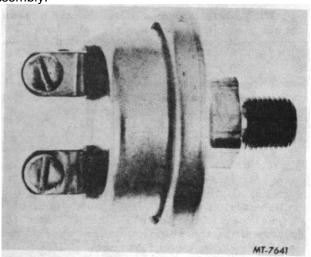


Fig. 23 Speedometer Adapter Pressure Switch.

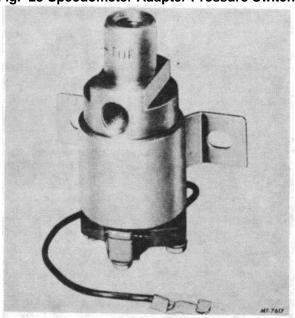


Fig. 24 Solenoid Valve.

Solenoid Valve

Replace solenoid valve, Fig. 24, as an assembly. The valve should not be serviced.

Lockout Control Valve

If lockout control valve, Fig. 25, fails to operate properly, unscrew cap nut and remove internal parts. Inspect plunger and valve parts for evidence of faulty operation. Replace faulty parts, then reassemble valve.

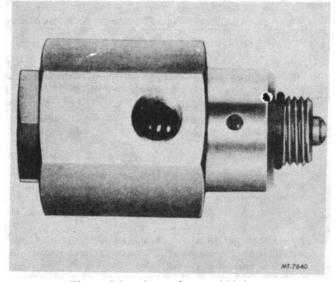


Fig. 25 Lockout Control Valve.

INSTALLATION

Shift Control Valve

Install jam nut on shift lever. Thread housing on shift lever and tighten.

NOTE: Shift control valve should be positioned with "INT" at 11:00 cloak. Connect and tighten air lines; see Figs. 2, 3 or 4.

Shift Unit

Position shift fork seal on differential carrier mounting stud and install seal spring.

Install shift unit on mounting studs. Be certain shift fork actuating lever engages slot in shift fork. Install stud nuts and lockwashers. Tighten mounting nuts to 81 N-m (60 in. lbs.) torque.

Fill unit with lubricant (see "SHIFT UNIT LUBRICATION").

SHIFT UNIT LUBRICATION

Keep filled to plug level. Twice each year remove cover, drain and flush. Use SAE-10 engine oil for temperatures -22 deg. C (0 deg. F) and up. For temperatures below -22 deg. C (0 deg. F), use 3 parts SAE-10 engine oil to 1 part kerosene. This mixture can safely be used in temperatures up to 0 deg. C (32 deg. F).

TROUBLE SHOOTING

A simple method for quickly locating troubles in the shift system can be accomplished by listening for possible air leaks and for sound which would indicate shift unit operation. Proceed as follows:

Two-Speed Single and Tandem Axle Systems

Turn ignition switch "ON" to energize and open solenoid valve. Move shift lever to "HI". In this position, air pressure should be present in the entire system. Check for air leaks. With shift lever in "LO" position, air pressure should be present up to the shift control valve.

To check axle for shifting, operate shift lever back and forth from "LO" to "HI". If the shift unit is operating, a definite reaction will be evident by sound of internal parts movement.

If air pressure is satisfactory and shift units do not operate, repair as previously instructed.

To locate troubles in speedometer adapter operation, trace electrical circuit from ignition switch through circuit breaker, pressure switch to the adapter. Also make sure adapter ground is satisfactory.

Power divider lockout (tandem axle) will operate in "HI" or "LO" range. With lockout engaged, air pressure is present through the cab lockout valve to the lockout cylinder.

Three-Speed Tandem Axle System

Turn ignition switch "ON" to open solenoid valve, and check for air leaks.

With shift lever in "LO", air pressure should be present only up to air shift control valve.

With shift lever in "INT", air pressure should be in forward axle air line only (through quick release valve and to forward axle shift unit).

With shift lever in "HI", air pressure should be present in the entire system from reservoir, through solenoid valve, air shift control valve, quick release valves to both axle shift units.

To check forward axle for shifting, operate shift lever back and forth from "LO" to "INT". If the shift unit is operating, a definite reaction will be evident by sound of internal parts movement. Check rear axle shift unit in the same manner, except move shift lever back and forth from "INT" to "HI".

If air pressure is satisfactory and shift units do not operate, repair as previously instructed.



REAR AXLE

ELECTRICALLY CONTROLLED AIR TORSION SPRING SHIFT UNIT

(For Two and Three-Speed Planetary Differentials)

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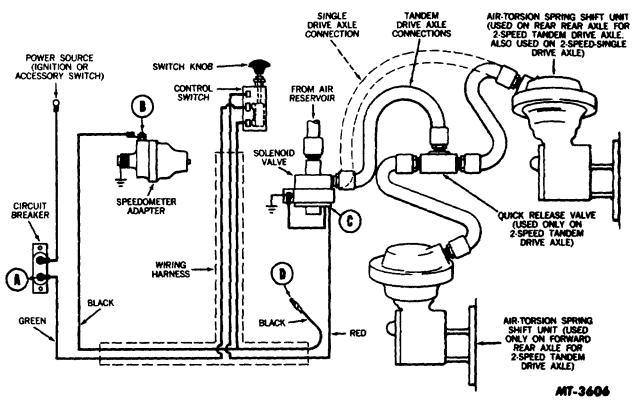


Fig. 1 Electrically Controlled 2-Speed Air Shift System (Single and Tandem Axles)

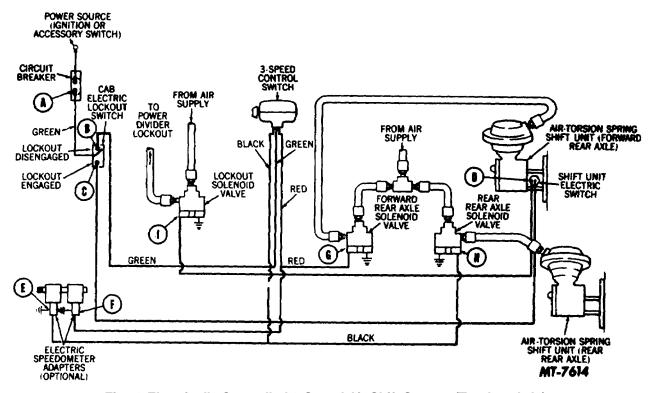


Fig. 2 Electrically Controlled 3-Speed Air Shift System (Tandem Axle)

DESCRIPTION

The air shift mechanism is the means by which the vehicle operator can change the rear axle from "High" to "Low" or "High" to "Intermediate" to "Low" axle ratios or vise versa merely by operating a conveniently located control switch.

The principle components of the air-torsion spring shift system area control switch, speedometer adapter, circuit breaker, solenoid valve, air shift unit and a quick release valve. The function of these components is discussed in the following paragraphs.

Control Switch

The 2-speed control switch, Fig. 3, is of the push-pull type and is manually operated by the vehicle operator. This switch controls current flow through the electrical system to operate speedometer adapter and solenoid valve.

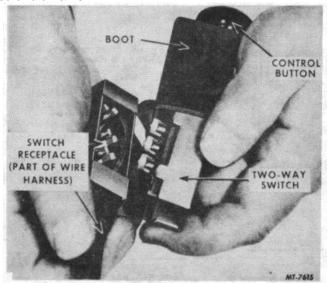


Fig. 3 2-Speed Control Switch

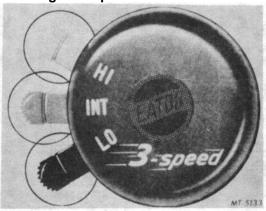


Fig. 4 3-Speed Control Switch

The 3-speed control switch, Fig. 4, is a 3-position switch mounted on the gear shift lever and is manually operated by the vehicle driver. The switch controls current flow through the electrical system to operate the speedometer adapters and solenoid valves.

Speedometer Adapter

The 2-speed speedometer adapter, Fig. 5, compensates for drive shaft speed variations between high and low axle ratios. A spring holds the adapter in high-range position, and an electromagnet holds it in low-range position.

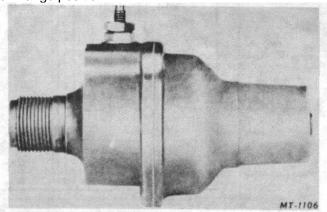


Fig. 5 2-Speed System Speedometer Adapter

In the 3speed system two speedometer adapters, Fig. 6, are mounted in the system and compensate for drive shaft speed variations between low, intermediate and high axle range. In low range the adapters are unexcited. In intermediate range one adapter is energized to 1: 1 ratio, while the other adapter is unexcited. In high range both adapters are energized to 1: 1 ratio. The above arrangement is accomplished by connecting each adapter in parallel to one of each of the two solenoid valves in the system.

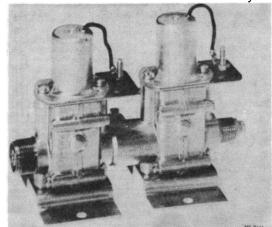


Fig. 6 3-Speed System Speedometer Adapter

NOTE: For systems that use the front wheel drive speedometer, the above-mentioned speedometer adapters are not required in the electrical system.

Solenoid Valve

The 2-speed solenoid valve provides the link between the electrical control system and the air-torsion spring shift unit. When the control switch knob is up, air is allowed to travel to the air shift unit to shift the axle into high range. When the control knob is pushed down, the solenoid valve shuts off the air pressure supply and allows the air-torsion spring shift unit to bleed air back through the solenoid valve exhaust port. This action allows the axle to shift into low range.

In the 3-speed system two solenoid valves, Fig. 7, provide the link between the electrical control system and the air-torsion spring shift units. When the solenoids are energized, air is allowed to travel to the air shift units and, thus, shift the axles. When the solenoid valves are de-energized by movement of the control switch, air pressure supply is shut off allowing the air-torsion spring shift unit to bleed air through the solenoid valve exhaust port. In units with an electric lockout, an additional solenoid valve controls air pressure supply to operate the lockout unit mounted on the power divider.

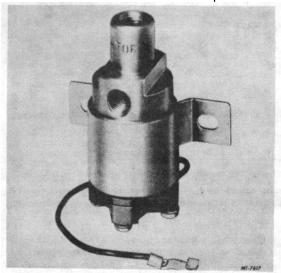


Fig. 7 3-Speed System Solenoid Valve

Air-Torsion Spring Shift Unit

The air-torsion spring shift unit, Fig. 8, is mechanically connected to the axle shift fork and shifts the axle. This unit includes an air chamber and a torsion spring drive assembly. A diaphragm operated by air pressure moves a push rod. The end of the push rod connects to the spring winding lever. This lever is part of the torsion spring drive assembly,

which acts to move the shift fork and change the axle range as described under "OPERATION".

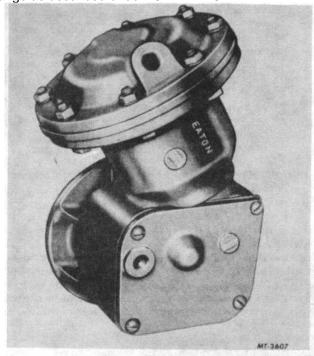


Fig. 8 Air-Torsion Spring Shift Unit

Quick Release Valve for 2-Speed Tandem Drive Axles

When the air shift unit is used on 2-speed tandem drive axles, a quick release valve is incorporated between the two air shift units and the solenoid valve (see Fig. 1). This allows a rapid release of the air pressure from the two shift units when the axle is shifted into low range.

Wiring Harness and Circuit Breaker

Electric wiring in the system is a completely assembled unit including a circuit breaker. Individual wires in the harness are identified by various colors, Figs. 1 and 2. The circuit breaker is connected to the wire leading from the power source. If a short circuit occurs, the circuit breaker will open and cut off electrical current to the system.

Lockout for 3-Speed Electric Switch Type System

The electric type lockout consists of two electric switches and a solenoid valve (see Fig. 2). One switch is located in vehicle cab

and the other is mounted on the forward rear axle shift unit, Fig. 9. This type system permits lockout to engage in low range only.

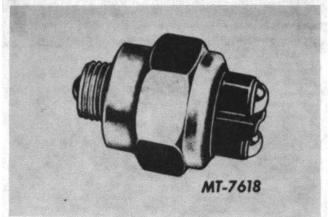


Fig. 9 Electric Lockout Switch at Forward Shift Unit

When cab switch is in "Lockout Engaged" position, electrical circuit to 3-speed control switch is opened, rendering control switch inoperative. Also, the electrical circuit to shift unit electric switch is energized but will not close to operate solenoid until axle is in low range. This prevents completion of the electrical circuit to the lockout solenoid valve until the axle is in low range.

OPERATION

2-Speed System (High Range)

With the control switch in the down position, the axle will be in low range. When the operator pulls up the control switch knob, current to the solenoid valve will open an air passage and permit air pressure to be applied to the air shift unit diaphragm.

Diaphragm movement operates the pushrod, which, in turn, moves the spring winding lever. The spring winding lever increases the load placed on the torsion spring. When this condition occurs, the axle is ready to shift into high range. When the load (torque) on the gears is relieved by opening and closing the throttle or declutching, the axle will shift. The torsion spring is assembled in the shift unit under a preload of 50 to 80 lbs. pressure. When the spring winding lever is moved to wind the spring, the pressure of the spring is increased to 90 to 135 lbs. This additional pressure is used to shift the axle, and when the shift is completed, the initial 50 to 80 lbs. preload again becomes effective and holds the axle in high range.

Low Range

When the control switch knob is pushed down, the solenoid valve shuts off the air supply. Air pressure in the air-torsion spring shift unit bleeds back through the solenoid valve and air lines. Pressure on the diaphragm is released. Push rod moves toward diaphragm and moves spring winding lever. Additional load (in opposite direction of shifting to high range) is placed on the torsion spring, providing a condition ready for the axle to shift into low range when the load (torque) on the gears is relieved by opening or closing the throttle or declutching.

Tandem Drive 2-Speed Axle System

Operation of the air-torsion spring shift system on tandem drive 2-speed axles is similar to the single 2speed axle system, except that two air shift units are used (see Figs. 1 and 10). Also, a quick release valve is incorporated in the air system (between the solenoid valve and air shift units) to bleed air pressure from both air shift units and lines, Fig. 1.

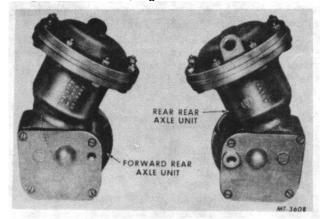


Fig. 10 Air-Torsion Spring Shift Units for Tandem Drive 2-Speed Axles

3-Speed System (High Range)

When shifting from "LO" to "HI" range, both axles are shifted to high range. Operation is as follows:

When the control switch is moved to "HI" position (high axle range), current to the two solenoid valves allows air to pass from its supply through the valves and be applied to the air shift diaphragm on both forward and rear rear driving axles.

Diaphragm movement operates the push rod on each unit, which, in turn, moves the spring winding levers. The spring winding

levers increase the load placed on the torsion springs. When this occurs, the axles are ready to shift to high range. When torque on the gears is relieved by closing and opening the throttle or declutching, the shift is completed.

When shifting from "INT" to "HI" range, the rear rear axle shifts as described above. Since the forward rear axle is already in high range at the "INT" position, it does not shift.

Intermediate Range

When shifting from "HI" to "INT" range, the forward rear axle remains in high range and the rear rear axle shifts to low range. Operation is as follows:

When the control switch is moved to the "INT" position (intermediate range), the forward rear axle solenoid valve remains open, allowing the shift unit to retain its air. The forward rear axle remains in high range.

The rear rear axle solenoid valve is deenergized, closing off the air supply to the rear rear axle shift unit. Air pressure in the rear rear axle shift unit bleeds back through the solenoid valve and air lines, releasing diaphragm press ire. Push rod moves toward diaphragm and moves spring winding lever. Additional load is thereby placed on torsion spring, readying the rear rear axle for shift to low range.

Thus, when torque on the gears is relieved by closing and opening the throttle or declutching, the rear rear axle is shifted to low range, the forward rear axle remains in high range, and the shift to intermediate is complete.

When shifting from "LO" to "INT" range, the rear rear axle remains in low range and the forward rear axle shifts to high range. Operation is as follows:

When the control switch is moved to the "INT" position (intermediate range), the rear rear axle solenoid valve remains closed. The rear rear axle stays in low range.

The forward rear axle solenoid valve is energized and opens. Air passes through the valve and is applied to the air shift diaphragm.

Diaphragm movement operates the push rod on the shift unit, which, in turn, moves the spring winding lever. The spring winding lever increases the load placed on the torsion springs, readying the forward rear axle for shift to high range.

Thus, when torque on the gears is relieved by closing and opening the throttle or declutching, the forward rear axle is shifted to high range, the rear rear axle remains in low range, and the shift to intermediate is complete.

Low Range

When shifting from "HL" to "LO", both axles are shifted to low range. Operation is as follows:

When the control switch is moved to "LO" position (low range), both solenoid valves shut off the air supply. Air pressure in the air torsion spring shift units bleeds back through the solenoid valves and air lines. Pressure on diaphragm is released. Push rod moves toward diaphragm and moves spring winding lever, thereby placing additional load on torsion spring. This readies the axle for shift to low range. When torque on gears is relieved by closing and opening the throttle or declutching, the shift to low range is complete

When shifting from "INT" to "LO", the forward rear axle shifts as described above. Since the rear rear axle is already in low range at the "INT" position, it does not shift,

SHIFT UNIT REMOVAL

Disconnect air line connection from shift unit cover. Remove unit housing to differential carrier stud nuts. Lift shift unit off studs and remove shift fork seal and spring.

NOTE

Shift unit need not be completely disassembled to replace torsion spring drive assembly. Air pressure applied to opening in diaphragm cover will move push rod sufficiently to remove or install the pin which connects push rod to spring winding lever.

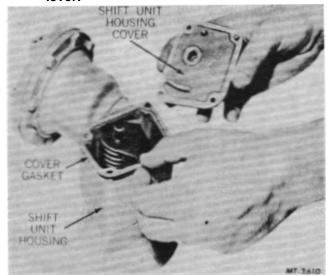


Fig. 11 Removing Shift Unit Housing Cover

SHIFT UNIT DISASSEMBLY

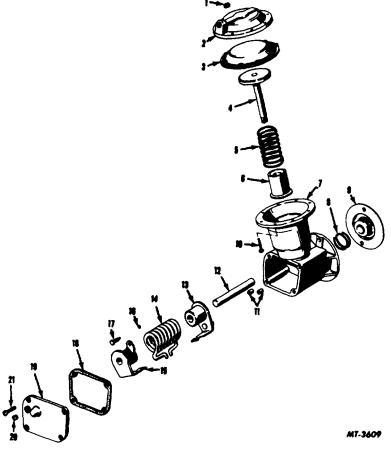


Fig. 12 Air-Torsion Spring Shift Unit (Exploded View) Legend for Fig. 12Z

Key.	<u>Description</u>	Key.	<u>Description</u>
1. 2. 3. 4. 5. 6. 7. 8.	NUT, hex. lock 1/4 NF COVER, diaphragm DIAPHRAGM ROD, push SPRING, push rod STOP, push rod HOUSING, shift unit SPRING, shift fork seal rot. SEAL, shift fork	15. 16. 17. 18. 19. 20. 21.	LEVER, spring winding "O" RING PIN GASKET, housing cover COVER, housing PLUG, cover pipe SCREW VALVE, lockout control (3-speed only) SWITCH, lockout electric (3-speed only)
10. 11.	, ,		
12. 13. 14.	SHAFT, actuating lever LEVER, shift fork actuating SPRING, torsion	*	Parts not illustrated
2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12.	COVER, diaphragm DIAPHRAGM ROD, push SPRING, push rod STOP, push rod HOUSING, shift unit SPRING, shift fork seal rot. SEAL, shift fork BOLT, cover to housing BUSHING, dowel SHAFT, actuating lever LEVER, shift fork actuating	16. 17. 18. 19. 20. 21.	"O" RING PIN GASKET, housing cover COVER, housing PLUG, cover pipe SCREW VALVE, lockout control (3-speed o SWITCH, lockout electric (3-speed PLUG, (for switch or valve hole 2- speed forward axle only)

Remove screws (21), housing cover (19) and cover gasket (18) from shift unit housing (7). See Fig. 11.

NOTE

All key numbers used in disassembly and reassembly procedures refer to Fig. 12.

Remove bolts (10), locknuts (1), diaphragm cover (2) and diaphragm (3) from shift unit housing (7). See Fig. 13.

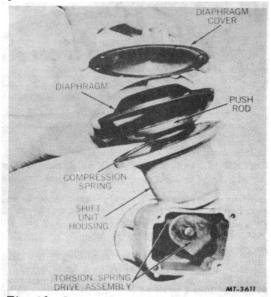


Fig. 13 Removing Diaphragm

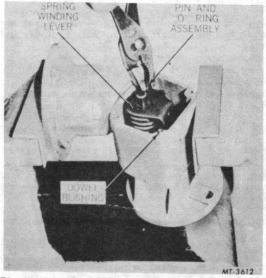


Fig. 14 Removing Pin and "O" Ring Assembly

Place housing assembly in vise, positioned as shown in Fig. 14. Compress spring (5) until pin (17), which connects push rod (4) and spring winding lever (15) together, can be removed. Remove pin and "O" ring assembly, Fig. 14.

CAUTION

Carefully open vise until tension on compression spring (5) is completely relieved to prevent possible injury.

Remove housing assembly from vise.

Remove push rod (4), compression spring (5) and push rod stop (6) from shift unit housing, Fig. 15.

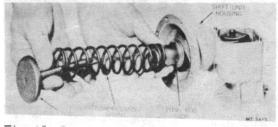


Fig. 15 Removing Push Rod

Remove lever shaft (12) and lift torsion spring drive assembly from shift unit housing, Fig. 16. NOTE: Do not disassemble these parts unless replacement is necessary. If disassembly is necessary, insert lever shaft (12) in torsion spring drive assembly. Clamp lever shaft in vise jaws, Fig. 17.

Turn spring winding lever (15) and pull to disengage end of torsion spring (14) from shift fork actuating lever (13). Components can now be disassembled.

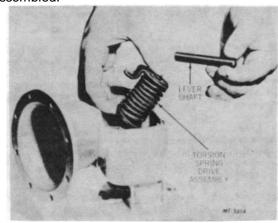


Fig. 16 Removing Torsion Spring Drive Assembly

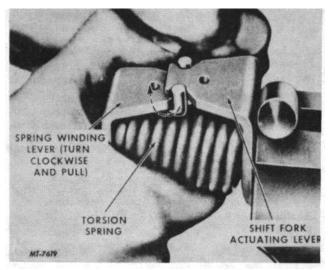


Fig. 17 Disassembling Torsion Spring Drive Assembly

SHIFT UNIT CLEANING, INSPECTION AND REPAIR

Before disassembling shift unit, remove all dirt, grease and foreign material from the exterior of the unit. Wash with a good cleaning solvent.

NOTE

Do not allow diaphragm to come in contact with cleaning fluid.

Inspect shift fork seal (9) for good condition and tight fit on shift fork. A spring (8) is used to assure a closer fit of seal around shift fork. If spring is not present on axle being serviced, install one when reassembling unit.

NOTE

On tandem axles shift fork seal on forward rear axle is brown in color.

Check condition of shift unit diaphragm (3). Be certain it is not cracked, torn or deteriorated.

Inspect push rod (4) and spring winding lever (15) for worn or elongated holes at point where they connect together. Also, check pin (17)for worn or grooved condition. Examine spring winding lever (15) for broken or cracked weld. Replace all faulty parts.

Inspect torsion spring (14) for distortion or other visual defects. Replace if faulty. Check shift fork actuating lever (13) for broken or cracked welds or other defects. Replace if necessary.

SHIFT UNIT REASSEMBLY

To reassemble torsion spring drive unit, clamp end of lever shaft (12) in vise jaws. Position shift fork actuating lever (13), torsion spring (14) and spring winding lever (15) on shaft (12) as shown in Fig. 18. Grasp spring winding lever by hand; turn lever and push until end of torsion spring (14) engages shift fork actuating lever (13).

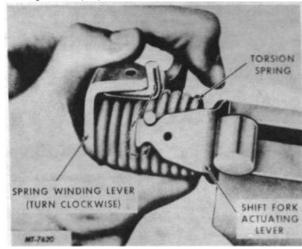


Fig. 18 Reassembling Torsion Spring Drive Assembly

Place torsion spring drive assembly in shift unit housing (7). Insert lever shaft (12) through torsion spring drive assembly and into hole provided in housing.

Place push rod stop (6) compression spring (5) and push rod (4) in shift unit housing (7). Place housing assembly in vise as shown in Fig. 9. Close vise to compress spring (5) until pin (17) can be installed to connect push rod (4) to spring winding lever (15). Install "O" ring (16) on pin (17). Insert pin assembly in openings provided in spring winding lever and push rod end. Remove housing assembly from vise.

Place diaphragm (3) and cover (2) on shift unit housing (7) and secure with bolts (10) and locknuts (1). Tighten locknuts to a torque of 50 to 60 in. Ibs. After initial torquing, recheck torque and, if necessary, retighten until torque of 50 to 60 in. Ibs. is permanently maintained.

Install dowel bushings (11), if removed; also, gasket (18) and housing cover (19) on shift unit housing (7). Secure cover (19) with screws (21). Tighten screws to 35 to 40 in. lbs.

SHIFT UNIT INSTALLATION

Place shift fork seal (9) on differential carrier studs. Place shift unit on mounting studs and be certain shift fork actuating lever engages slot in shift fork. Install stud nuts and lockwashers. Connect air line to shift unit cover.

CONTROL SWITCH REMOVAL AND DISASSEMBLY 2-Speed System

For inspection or replacement, the control switch, Fig. 3, can easily be removed by sliding the rubber boot up to the knob; then separate switch from harness.

3-Speed System

Type "A" control switch, Fig. 19, can be disassembled for service without removing the assembly from the gear shift lever.

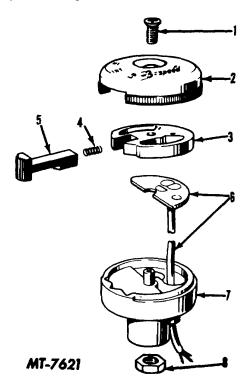


Fig. 19 Type "A" Control Switch (Exploded View) Legend for Fig. 19

Key Description

- 1. SCREW, cover
- 2. COVER
- 3. PLATE, actuating, contact and spring assembly
- 4. SPRING, shifter knob
- 5. KNOB, shifter
- 6. INSULATOR, contacts and wiring harness assembly
- 7. PLATE, base
- 8. NUT, jam
 - 1. Remove screw (1) from cover (2), then lift off cover and remove shifter knob (5) and

- spring (4). Remove actuating plate, contact and springs (3) as an assembly.
- 2. If insulator and contacts (6) or wiring harness require replacement, lift insulator and disconnect wires at contacts. To remove base plate (7), loosen jam nut (8) and unscrew plate.

Type "B" control switch, Fig. 20; remove and disassemble as follows-

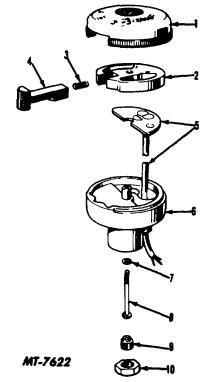


Fig. 20 Type "B" Control Switch (Exploded View) Legend for Fig. 20

Key Description

- 1. COVER
- 2. PLATE, actuating, contact and spring assembly
- 3. SPRING, shifter knob
- 4. KNOB, shifter
- INSULATOR, contacts and wiring harness assembly
- 6. PLATE, base
- 7. LOCKWASHER
- 8. SCREW, cover
- 9. SCREW, set
- 10. NUT, jam

- Disconnect wires at chassis end of wiring harness. Loosen jam nut (10) and unscrew switch from gear shift lever.
- Remove set screw (9) and cover screw (8) from mounting side of base plate (6), then lift off cover (1), shifter knob (4) and spring (3). Remove actuating plate, contact and spring (2) as an assembly. Remove insulator, contacts and harness assembly (5) from base plate (6).

CONTROL SWITCH CLEANING, INSPECTION AND REPAIR

2-Speed System

Inspect switch for loose connections and other visual defects that may cause a short circuit or electrical failure. If switch is faulty, replace as a unit.

3-Speed System

Inspect all parts for cracks or damage. Inspect contacts for burned or corroded condition. Check for faulty wiring connections. Replace individual parts if they are faulty. Replace insulator, contacts and wiring harness as an assembly.

CONTROL SWITCH REASSEMBLY AND INSTALLATION

2-Speed System

To install the 2-speed shift control switch, attach switch to harness; then pull rubber boot down into position.

3-Speed System

Switch parts should be assembled clean and dry. Do not lubricate switch parts.

Assemble and Install Control Switch

NOTE

Type "A" control switch can be assembled with base plate mounted on or off gear shift lever.

- If base plate was removed, install jam nut on shift lever. Thread base plate on shift lever and tighten jam nut. Pass wiring harness through base plate. Connect wires to insulator contacts. Position insulator in recessed area of base plate, Fig. 21.
- Place actuating plate, contact and spring assembly in mounting position on insulator. Install knob spring, shifter knob, Fig. 22, and cover; then fasten with cover screw.

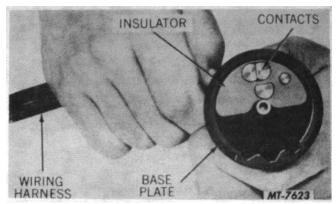


Fig. 21 Positioning Insulator in Base

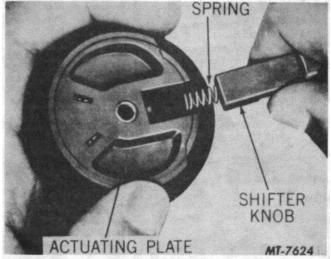


Fig. 22 Installing Shifter Spring and Knob NOTE

Type "B" base plate and cover must be assembled before installing control switch on gear shift lever.

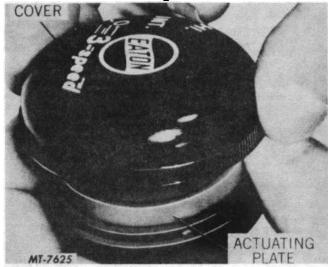


Fig. 23 Installing Cover

- 1. With wiring harness connected to insulator contacts, pass wiring harness through base plate, positioning insulator in recessed area of base plate, Fig. 21.
- Place actuating plate, contact and spring assembly in mounting position on insulator. Install knob spring and shifter knob, Fig. 22, and cover, Fig. Z3; then fasten with cover screw and lockwasher. Install set screw to secure cover screw.
- Install jam nut on shift lever. Thread control switch assembly on gear shift lever. Tighten jam nut. Connect wiring harness at chassis end.

MAINTENANCE

Speedometer Adapter

The speedometer adapter, Figs. 5 and 6, are lubricated and sealed for life of the unit. No maintenance is required. Replace when unit becomes faulty. In the 3-speed system it is not necessary to replace both units if only one has failed.

Quick Release Valve (for 2-Speed Tandem Drive Axles

If quick release valve fails to operate properly, it may be repaired as follows: Disassemble valve; inspect valve body, valve seat and spring for evidence of faulty operation. Replace all worn parts and reassemble.

Control Switch

If 2- speed control switch is faulty, replace as a unit.

Solenoid Valve

Replace faulty solenoid valve as an assembly. The valve is a sealed unit and cannot be serviced.

SHIFT UNIT LUBRICATION

Keep filled to plug level. Twice each year remove cover, drain and flush. Use SAE 10 engine oil for temperatures 0° F and up. For temperatures below 0°F, use 3 parts SAE 10 engine oil to 1 part kerosene. This mixture can safely be used in temperatures up to 32'F.

TROUBLE SHOOTING

2-Speed System

If axle will not shift, test system and components as follows:

NOTE

Test lamp voltage should be same as system rated voltage. Refer to Fig. 1 for terminal references.

Check Circuit Breaker Operation

Disconnect circuit breaker lead wire (terminal "A"), connect test lamp across terminal "A" and ground on vehicle frame. Turn on ignition switch (or accessory switch for diesel engines) and observe test lamp operation.

- 1. If lamp lights and stays on continuously, circuit breaker and lead wire are satisfactory.
- 2. If lamp does not light, check for poor electrical connections or broken lead wire. If lead wire and electrical connections are satisfactory, circuit breaker is faulty.
- If lamp does not light immediately, then starts to flash on and off (also a faint clicking of the circuit breaker may be heard), the circuit breaker is faulty.

Check Control Switch and Wiring Harness

If trouble in control switch or wiring harness is suspected, visually check as follows: Check harness for damage or worn insulation that may cause a ground connection, especially where harness passes through cab floor. Check for short circuits between wire terminals. Check for poor insulation or accidental ground at end of lead wire (terminal "D").

NOTE

To determine condition of control switch, a new switch may be temporarily installed. However, control switch operation may be checked with a test lamp as follows:

Disconnect lead wires at speedometer adapter (terminal "B") and at solenoid valve (terminal "C"). Turn ignition switch on and alternately connect test lamp leads to disconnected lead wires. Operate control switch and observe test lamp for the following conditions:

When test lamp is connected to speedometer adapter lead wire (terminal "B"), lamp should light in "Low Range" or "down" position of control switch knob. Lamp should go out with control switch knob in "up" position.

When test lamp is connected to solenoid valve, lead wire (terminal "C"), lamp should light in "High Range" or "up" position of control switch knob. Lamp should go out when control switch knob is in the "down" position.

If test lamp indications are correct in the above tests, current supply is correct to speedometer adapter and solenoid valve.

If lamp does not light correctly, trouble may be a short circuit in the wiring harness or control switch, or a wire in the harness may be broken.

Check Solenoid Valve Operation

The solenoid valve must have a good ground connection to vehicle frame to operate satisfactorily. Disconnect lead wire at terminal "C" and air line leading to shift units. Install an air pressure gauge in air line opening in solenoid valve. Apply power supply (vehicle voltage) to solenoid valve terminal and observe pressure gauge reading. Operating pressure should be approximate reservoir pressure. If gauge indicates approximate reservoir pressure, solenoid valve operation is satisfactory. If gauge indicates low or no pressure, solenoid valve is faulty.

Check Air Shift Unit Operation

If electrical system is satisfactory and axle does not shift satisfactorily, the air shift unit may be faulty. Disassemble and repair unit as previously described.

Check Speedometer Adapter Operation

The speedometer adapter is energized in low axle range only. The adapter is grounded through speedometer mounting or speedometer cable and cable housing. Check adapter to see that it is properly grounded. Disconnect lead wire at terminal "B". Connect test lamp to terminal "B" lead and ground on vehicle frame. Turn ignition switch on and observe test lamp reaction.

Test lamp should light in "Low Range" or "down" position of control switch knob. Lamp should go out when control switch knob is placed in "up" position.

If test lamp indications are correct, current supply to adapter is correct. If lamp indications are correct and axle shifts normally but speedometer does not operate properly, replace adapter.

If test lamp indications are not correct, trouble is in wiring harness or control switch.

3-Speed System

If the axle will not shift, test system and components as follows:

Test lamp voltage should be same as system rated voltage. Refer to Fig. 2 for terminal references.

Check Circuit Breaker Operation

Disconnect circuit breaker lead wire (terminal "A"). Connect test lamp across terminal "A" and ground on vehicle frame. Turn on ignition switch (or accessory switch for diesel engines) and observe test lamp operation:

- 1. If lamp lights and stays on continuously, circuit breaker and lead wire are satisfactory.
- 2. If lamp does not light, check for poor electrical connections or broken lead wire. If lead wire and electrical connections are satisfactory, circuit breaker is faulty.
- If lamp does not light immediately, then starts to flash on and off (also a faint clicking of the circuit breaker may be heard), the circuit breaker is faulty.

Check Cab Electric Lockout Switch

Connect test lamp to cab electric lockout switch terminals "B" and "C" and check as follows: With test lamp connected to terminal "B", lamp should light when cab switch is in the "Lockout Disengaged" position. If lamp lights, current supply to control switch is satisfactory. Test lamp should go out when cab switch is in "Lockout Engaged" position.

With test lamp connected to terminal "C", lamp should light when cab switch is in "Lockout Engaged" position. If lamp lights, current supply to the shift unit electric switch is satisfactory. Test lamp should go out with cab switch in "Lockout Disengaged" position. If test indications are as indicated above, cab electric lockout switch operation is satisfactory.

Check Shift Unit Electric Switch

The shift unit electric switch is open in "HI" or "INT" ranges. The switch closes in "LO" range (with axle and shift unit in low range).

To check shift unit electric switch, disconnect lead wire at terminal "D". Connect test lamp to terminal "D" and ground. Place cab electric lockout switch in "Lockout Engaged" position. With axle in "LO" range, lamp should light. Test lamp should not light with axle in "HI" or "INT" ranges. With cab electric switch in "Lockout Disengaged" position, the test lamp should not light regardless of axle range.

Check Control Switch and Wiring Harness

If trouble in control switch or wiring harness is suspected, first check operation of the cab electric lockout switch to make certain current supply to wiring harness is satisfactory. Next, visually check wiring as follows: Check harness for damaged or worn insulation that may cause a ground connection, especially where harness passes through cab floor. Check for short circuits between wire terminals.

If wiring checks out satisfactorily, check control switch. To determine condition of control switch, it is recommended that a new control switch be temporarily installed. However, if desirable, control switch operation may be checked with a test lamp as follows:

NOTE

Under actual installation conditions, lead wires to speedometer adapters could be transposed without affecting operation. However, in the following tests, it is assumed that terminal "E" lead wire is connected to the black wire leading to the rear rear axle solenoid valve, and terminal "F" lead wire is connected to the red wire leading to the forward rear axle solenoid valve.

Disconnect lead wires at speedometer adapters terminals "E" and "F" and at solenoid valves terminals "G" and "H". Turn ignition switch on and alternately connect test lamp leads to disconnected lead wires. Operate control switch and observe test lamp for the following conditions:

When test lamp is connected to speedometer adapter lead wire (terminal "E"), lamp should light in high range or "HI" position of control switch. Lamp should go out with control switch in "INT" (intermediate range) or "LO': ' (low range) position.

When test lamp is connected to speedometer adapter lead wire (terminal "F"), lamp should light in high range or "HI" position and intermediate range or "INT" position. Lamp should go out with control switch in "LO" (low range) position.

When test lamp is connected to solenoid valve lead wire (terminal "G"), lamp should light in intermediate range or "INT" position and high range or "HI" position or control switch. Lamp should go out when control switch is in "LO" position.

When test lamp is connected to solenoid valve lead wire (terminal "H"), lamp should light in high range

or "HI" position of control switch. Lamp should go out when control switch is in "INT" position or "LO" position of control switch.

If test indications are correct in the above tests, current supply is correct to speedometer adapters and solenoid valves.

If lamp does not light correctly, trouble may be a short circuit in wiring harness or control switch, or a wire in a harness may be broken.

Check Solenoid Valve Operation

One solenoid valve is energized to supply. air to shift unit in intermediate ("INT") and high ("HI") range. A second solenoid valve is energized to supply air to shift unit in high ("HI") range only. A third solenoid valve operates lockout on power divider. Each valve must have a good ground connection to vehicle frame to operate satisfactorily. Before condemning solenoid valve operation, make certain that ground connection is satisfactory.

To check solenoid valve operation, disconnect lead wires at terminals "G", "H" and "I" and air lines leading to respective shift unit. Install an air pressure gauge in air line opening in solenoid valve. Apply power supply (vehicle voltage) to solenoid valve terminal and observe pressure gauge reading. Operating pressure should be approximate reservoir pressure. If gauge indicates approximate reservoir pressure, solenoid valve operation is satisfactory. If gauge indicates low or no pressure, solenoid valve is faulty.

Check Air-Torsion Spring Shift Unit Operation

If electrical system is functioning properly but axle does not shift satisfactorily, trouble may be caused by a faulty air-torsion spring shift unit. Disassemble and repair a faulty shift unit as indicated previously.

Check Speedometer Adapter Operation

Two speedometer adapters are mounted together with one adapter being energized in high axle range only, while the other is energized in intermediate axle range and high axle range. The adapters are grounded through speedometer mounting or speedometer cable and cable housing. Before condemning speedometer adapter operation, make certain that ground connection is satisfactory.

To test speedometer adapter circuit with a test lamp, first disconnect lead wire at terminal "E". It is assumed that terminal "E" lead wire connects to the black wire leading to the rear rear axle solenoid valve. Connect test lamp to terminal "E" lead wire and ground on vehicle frame. Turn ignition switch on and

observe test lamp operation. The test lamp should light in high range or "HI" position of control switch. Lamp should go out when control switch is placed in "INT" or "LO" position.

To test other speedometer adapter circuit with a test lamp, disconnect lead wire at terminal "F". It is assumed that terminal "F" lead wire connects to the red wire leading to the forward rear axle solenoid valve. Connect test lamp to terminal "F" lead wire and ground on vehicle frame. Turn ignition switch on and observe test lamp operation. The test lamp should light in

intermediate range or "INT" position and high range or "HI" position of control switch. Lamp should go out when control switch is placed in "LO" position.

If lamp indications are correct, current supply to adapters is correct. If lamp indications are correct and axle shifts normally but speedometer does not operate properly, replace faulty adapter.

If test lamp indications are not correct, trouble is in wiring harness or control switch.

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AXLE REAR LOCKING TYPE DIFFERENTIAL

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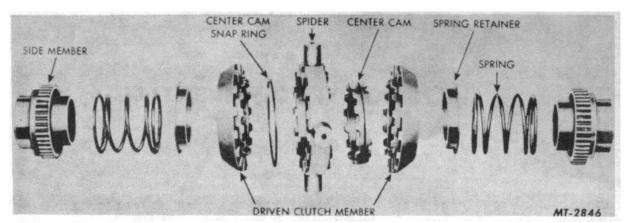


Fig. 1 Internal Spring Design Differential Locking Unit (Exploded View)

DESCRIPTION

The NoSPIN differential (Figs. 1 and 2) provides equal amounts of drive line torque to each rear driving wheel and also permits differential action for turning corners.

This differential also provides greater operating flexibility than a conventional differential, because the locking type differential overcomes wheel spinning when required to operate in mud, sand, snow and on ice or wet roads. The unit is installed in the differential case in place of the conventional gears, pinion and spider.

The action of the unit is the same for both drive and coast loads and forward and reverse driving.

CONSTRUCTION

Two types of NoSPIN differentials have been used on IH vehicles; they are (a) Internal Spring Design, Fig. 1 and (b) External Spring Design, Fig. 2.

The difference in the two units is explained in the text; however, the disassembly will cover the internal design locking unit. The differential locking unit consists of several parts, all assembled around the spider.

Spider and Center Cam Assembly

This assembly consists of the spider, center cam and spider snap ring. The spider has four trunnions projecting radially from a center ring on each side of which are located fixed driving clutch teeth. These teeth vary in number, depending on the size and model of The internal diameter of the spider is differential. uniform. Into it is mounted the center cam. This cam is held in position with a centrally mounted snap ring which permits the center cam to be rotated within the spider but prevents lateral movement. The center cam is symmetric, having the same number of cam lifts on each side as there are clutch teeth on the spider. These lifts or "cams" have uniform contours with rounded surfaces that provide anti-friction ramps for disengaging the driven clutch members.

Driven Clutch Members

Two identical driven clutch members are located on either side of the spider and center cam assembly. Each has a set of clutch teeth

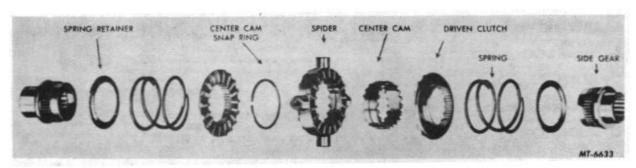


Fig. 2 External Spring Design Differential Locking Unit (Exploded View)

to match the clutch teeth on the spider through which driving torque is transmitted. Radially inward from the driven clutch teeth on models using internal spring are cams which mesh with the cams of the center cam member. These cams have been eliminated on the models using the external spring. The internal diameter of each driven clutch member has splines which engage the external splines of the splined side members. Spring Retainers and Springs

Models with Internal Springs

Spring retainers are inserted into the outer ends of driven clutch member. The bowl side of these retainers is mounted first through the outer side of the driven clutch members. The flanged portion of the spring retainers pass through the internal splines to rest on the mating flanges of the driven clutch members. The springs are mounted in spring retainers after assembly and thrust against their inner cupped ends.

Models with External Springs

Spring retainers fit over the side gear, passing through external splines to seat against the shoulder on the side gear. Springs fit between the driven clutch and outer flanged surface of the spring retainer.

Splined Members

These two splined side members are splined internally to receive the truck axle shafts. The inner hubs of the splined side members are inserted in the outer ends of the springs. The external splines of the splined side members engage the internal splines of driven clutch members on each side of the completed assembly.

OPERATION

Straight Forward Driving

When a vehicle is being driven in a straight forward direction, the clutch teeth on both sides of the spider assembly are fully engaged with the clutch teeth on each driven clutch member. Likewise, the fixed cams of the driven clutch members are fully meshed with the cam surfaces of the floating center cam ring mounted on the inside diameter of the spider, as described previously.

Engagement of the driving and driven clutch teeth is assured by the pressure of the two springs which force the driven clutch members inwardly against the spider and also by the positive locking action developed by the mating undercuts on the driving faces of the clutch teeth.

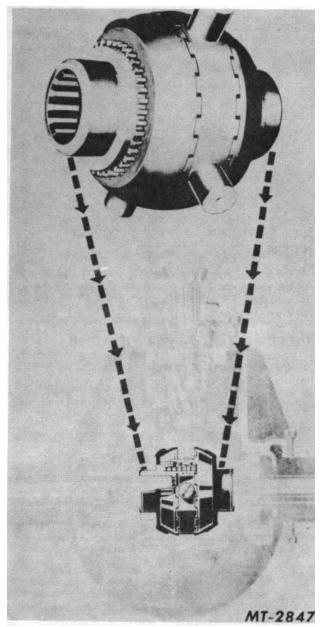


Fig. 3 Typical Installation of NoSPIN Unit (Cross Sectional View)

In this condition, both clutches remain fully engaged so that the assembly operates as a solid unit and each rear wheel is driven forward at ring gear speed.

Straight Rearward Driving

When driving a vehicle in a straight rearward direction, both driven clutch members are held in full engagement with the spider and center cam as described for straight forward driving. However, in this case, the spider rotates in the reverse direction and

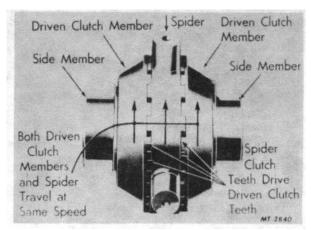


Fig. 4 Straight Forward Driving

shifts the driving force to the opposite set of driving faces on the mating clutch teeth. Again we have the assembly operating as a unit with each wheel being forced to rotate at ring gear speed.

Right Hand Turn - Forward Direction

When making a turn, differential action is required in order to permit the outside wheel to travel a greater distance, and faster, than the inside wheel.

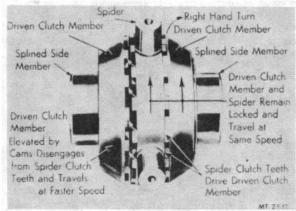


Fig. 5 Right Hand Turn--Forward Direction

A conventional bevel gear type differential permits the outside wheel to turn faster than ring gear speed while the inside wheel turns slower than ring gear speed. The NoSPIN differential allows either wheel to turn faster than the ring gear speed but does not permit either wheel to turn slower than the ring gear speed when power is applied.

When negotiating a right hand turn in a forward direction, the right hand driven clutch member remains fully engaged with the spider clutch teeth and the corresponding cams (see Fig. 5).

The driving clutch teeth of the spider transmit the driving force to the driven clutchmember, which in turn drives the right hand (inside) wheel constantly at ring gear speed, thus propelling the vehicle. The left hand (outside) wheel covers a greater arc than the right hand (inside) wheel and driven by the traction of the road, must turn faster than ring gear speed. Likewise, the left hand driven clutch member must turn faster than the spider. In other words, it permits differences in wheel speeds or differential action. Fig. 6 illustrates how this is accomplished.

The right hand row of came on the center cam member are meshed securely with the cams on the right hand driven clutch member. With the center cam thus locked in this position so that it cannot rotate with respect to the spider, its cams on the left hand side serve as ramps upon which the mating cams on the left hand driven clutch member can rise enabling that driven clutch member to disengage from the spider. The ramps on the center cam are high enough to permit the clutch teeth on the driven clutch member to clear the teeth on the spider and when the crest of the ramp is passed, the teeth of the driven clutch member are forced back by spring pressure into full engagement with the clutch teeth of the spider.

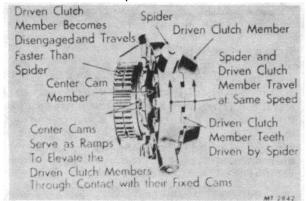


Fig. 6 Forward Right Hand Turn (Cross Sectional View)

This engagement and disengagement or indexing operation continues throughout the turn with a rapidity that is in direct relation to the speed of the overrunning wheel; As the vehicle completes the turn and is again driven in a straight forward direction, differential action no longer being required, both driven clutch members become fully engaged with the clutch teeth of the spider, then the operation, as described in "Straight Forward Driving" is resumed.

Forward Right Hand Turn Braking Condition

In this situation, the vehicle is moving forward, but the direction of torque of the ring gear is reversed because the vehicle is being slowed down by braking action. This reversal of torque is produced by the action of road traction driving the wheels against the torque of the engine. In this condition, when a right hand turn is negotiated, the left hand (outside) wheels rotate at ring gear speed since the left hand driven clutch member remains fully engaged while the right hand (inside) wheels rotate slower than ring gear speed.

The symmetrical design of the differential makes it possible to function in the manner described above which is in effect directly opposite to that described as Right Hand Turns-Forward Direction.

It should be noted that if a turn is negotiated in such a manner that power is first applied and then braking action is encountered before the turn is completed, the differential is designed to function without interruption and will automatically take care of such reversal of torque.

Left Hand Turn Forward Direction

In making a left hand turn with the vehicle driven in a forward direction, the left hand wheel is on the inside of the turn and the power is applied to it so that it must rotate at ring gear speed. The right hand wheel travels through the greater arc, being on the outside of the turn. Its driven clutch member becomes disengaged from the spider clutch teeth, permitting it to be rotated by ground traction faster than the ring gear (See Figs. 7 and 8).

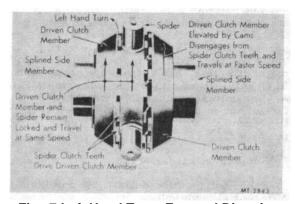


Fig. 7 Left Hand Turn--Forward Direction

The operation of the driven clutch member on the right side of the assembly in the foregoing instance is illustrated above.

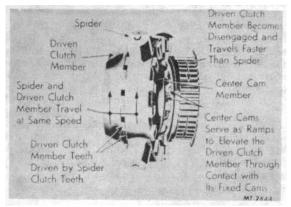


Fig. 8 Forward Left Hand Turn (Cross Sectional View)

Right and Left Hand Turns Rearward Direction

The operation of the NoSPIN differential when required to make turns while traveling in a rearward direction is identical to that when making turns in a forward direction. When moving rearward in a turn under power, the inside wheel is driven at ring gear speed while the outside wheel is driven by the ground faster than ring gear speed. When the rearward turn is nearing completion and the vehicle is slowing down because of application of the brakes, the outside wheel is driven by the ground at ring gear speed, as its driven clutch member is fully engaged and acts to "brake" against the engine torque. The inside wheel is driven by the ground through the smaller arc of travel and since its driven clutch member is disengaged, it will rotate slower than ring gear speed.

Fig. 9 shows the operation of the differential when a right hand turn in a rearward direction is being negotiated.

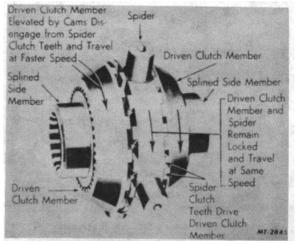


Fig. 9 Right Hand Turn--Rearward Direction

DIFFERENTIAL REMOVAL

The procedure for removing the differential is the same as used for a conventional differential. IMPORTANT PRECAUTION: Before disassembling the differential case, insert a bolt through the center of the NoSPIN unit (axle shaft openings) with a flat washer on each end against the side members (Fig. 10).

Thread a nut on the bolt against the flat washer finger tight. This will prevent possible injury caused by the unit flying apart due to the spring pressure within itself during disassembly of the differential case.

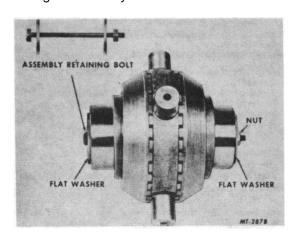


Fig. 10 Inserting Assembly Retaining Bolt

DISASSEMBLY

Remove the bolts from the differential case and lift out the NoSPIN unit. Mount unit in a small press (Fig. 11).

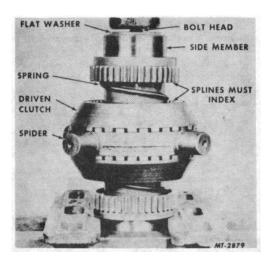


Fig. 11 Release of Spring Pressure

Apply enough pressure on the head of the bolt to release the spring pressure against the nut. Remove the nut and flat washer by reaching underneath the press. Slowly release the press and allow the unit to disassemble itself until the spring pressure is fully released.

Remove unit from press.

Remove side members, springs, spring retainers and driven clutch members. The center cam may be removed from the spider by expanding the snap ring with small screw drivers or wedges.

NOTE: Be careful when removing and reinstalling center cam snap ring to avoid possible injury.

CLEANING, INSPECTION AND REPAIR

Wash all parts thoroughly with a cleaning solvent. Inspect all mating surfaces and teeth for possible wear or damage. Replace all worn or damaged parts before reassembly.

REASSEMBLY

Reassembly is essentially the reverse of disassembly. Lubricate all parts with SAE30 oil during reassembly. Place side member upright and install spring on same. Place spring retainer on spring with flange end toward side member. Install driven clutch member on spring retainer. Place spider on driven clutch member, indexing teeth of same. Install other driven clutch member, spring retainer, spring and side member on spider.

Insert a bolt through the center of the NoSPIN unit with a flat washer against side member. Mount unit in press as shown in Fig. 11. Compress springs by pressing on head of bolt and index splines of side members with those of driven clutch members. NOTE: Keep entire unit aligned in press to prevent it from kicking out while springs are being compressed. Compress unit until side member splines are completely indexed and flush with driven clutch member. Install flat washer on bolt against side member and thread nut on bolt, finger tight, so that it has the appearance of Fig. 10 when removed from the press.

Remove unit from press.

Place unit in differential case and install differential case bolts.

Reassembly from this point is the same as for a conventional differential.

TANDEM LOCK

The NoSPIN locking type differential can also be used in place of the conventional interaxle differential and lock-out control in tandem axles, Fig. 12. In this capacity it operates between the axles in the same manner as between the wheels of a single axle. When the "Tandem Lock" (its name for this application) is used in the power divider unit, the need for manual control of the interaxle differential lockout is completely eliminated.

Operation

Interaxle differential action is required when cornering to permit forward tandem axle to travel farther and faster than rear tandem axle. The tandem lock inter-axle differential, mounted on forward end of thru shaft, allows either drive axle to turn faster than driven speed but does not permit either axle to turn slower than driven speed when power is applied. A right or left turn in a forward direction disengages front driven clutch (b) and side gear (a) from the drive teeth of central driver or spider (c). This results from the wheels on forward tandem axle covering a greater arc than those on rear axle, and driven by traction of road they rotate faster than driven speed. In like manner the rear driven clutch (d) tries to rotate slower than central driver (c), but design prevents this. Torque is then transmitted through rear side gear (e) of tandem lock unit to rear tandem axle at driven speed to propel the vehicle. automatic, full-time power control minimizes tire scuffing and axle shock loads. It also eliminates possible mechanical failure through driver error in the incorrect use of a manual inter-axle lockout.

Maintenance

The disassembly, cleaning, inspection and repair of the tandem lock is the same as covered previously for the single axle unit. For removal and installation of the inter-axle differential, see specific instructions for the conventional unit covered in the Service Manual, Tandem Axle.

IMPORTANT PRECAUTION

If a truck is equipped with a NoSPIN differential, power will be transmitted to the opposite rear wheel or axle if one of the rear wheels or axles slips. Both rear wheels or both rear axles must be raised free of ground if it is necessary to operate one rear wheel with truck stationary; otherwise, the wheel or axle that is not raised will pull truck off its support.

LUBRICATION

The NoSPIN unit is lubricated with the same lube used in conventional differentials. Fill differential carrier through filler hole until oil is level with hole. For tandem axles be sure to pour .47 Liters (one (1) pint) of lube into power divider.

For type of lubricant, refer to Lubrication, CTS-2412.

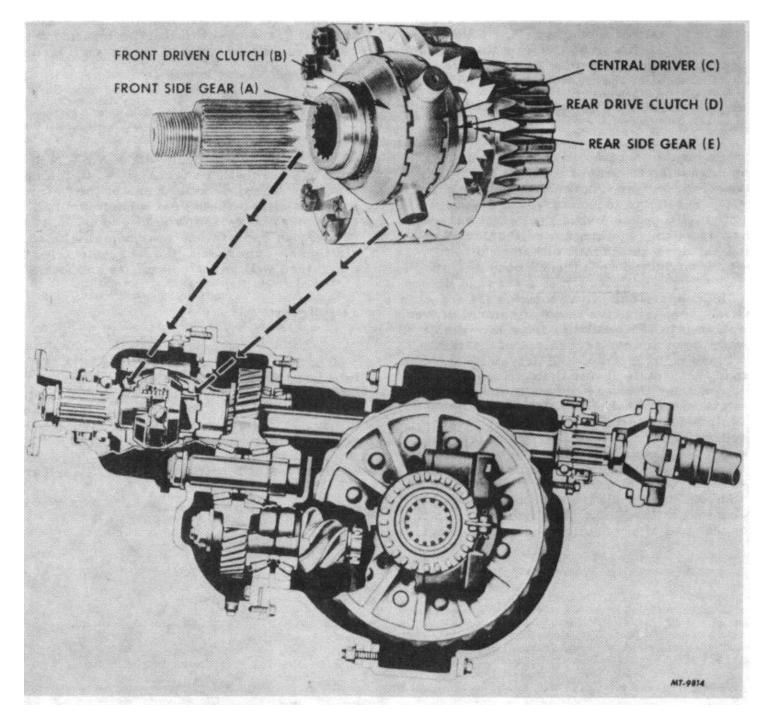


Fig. 12. Cutaway View of Tandem Lock NoSPIN Inter-Axle Differential



REAR AXLE

SELF-CONTAINED TRACTION EQUALIZER

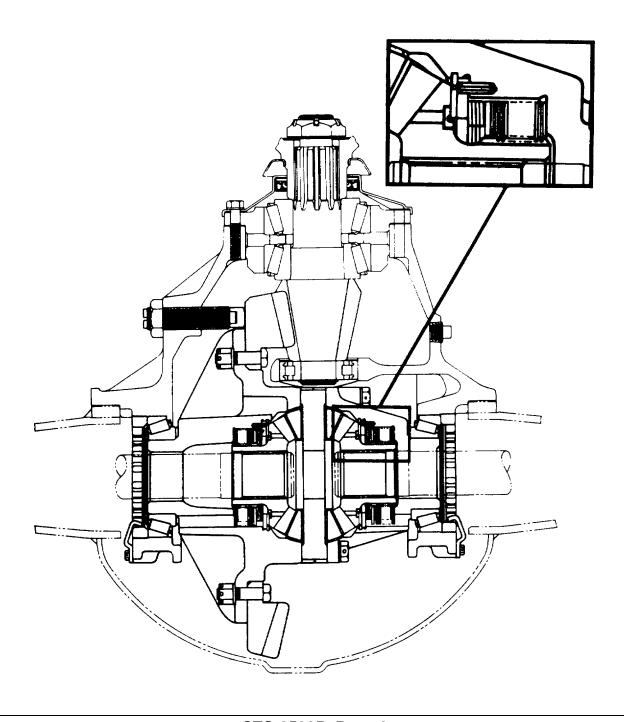
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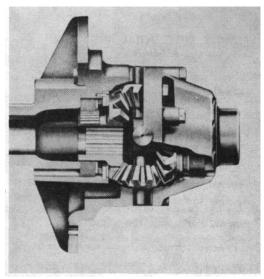
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SINGLE REDUCTION DRIVE UNIT WITH SELF-CONTAINED TRACTION EQUALIZER



SELF-CONTAINED TRACTION EQUALIZER



DESCRIPTION

This manual covers the description and servicing of the self-contained traction equalizer.

An axle equipped with the self-contained traction equalizer delivers an increase in tractive effort to the wheel having the best road adhesion. Besides better enabling the vehicle to propel itself through mud, snow, ice and slush, the traction equalizer makes it easier to control the vehicle on curves, slippery pavement and soft ground. It also eliminates the tendency of vehicle to swerve when one wheel suddenly loses traction because wheel spinning is reduced. The unit is continuously engaged and automatically effective whenever one wheel turns faster than the others.

CONSTRUCTION AND OPERATION

The traction equalizer is basically a springloaded multiple disc clutch unit located entirely within the differential. While most clutches are intended not to slip except when disengaged, the traction equalizer is intended to slip above a certain torque value and not to slip below this torque value. The ability to slip at higher torques enables the vehicle to make turns in a normal manner. The resistance to slip at lower torques enables the vehicle to maintain an appreciable amount of

tractive effort even when one wheel encounters poor traction.

Occasionally it may be found the traction equalizer tends to slip in jerks instead of continuously. Generally this occurs only at slow speeds on sharp turns. When the slip occurs in jerks, it produces a series of fairly loud bangs. What actually happens is that the axle shafts start winding up as vehicle enters the turn. After the windup produces sufficient torque, the traction equalizer slips and the torque drops to a lower value and the slip stops. As the slip suddenly stops, an audible sound is produced. Although the sound is annoying to the driver and bystanders, there is no mechanical damage or harm.

The gear lubricant used is a factor in this slip and stick action. If the static friction coefficient of the lubricant is appreciably higher than the sliding coefficient, the traction equalizer will slip in jerks at slow speed. If the coefficients are equal or reversed, the slip will be smooth and continuous at all speeds. Many gear lubricants are treated for "limited-slip differentials;" one of these should be used to minimize stickslip action and resulting noise.

PERFORMANCE CHECK

The effectiveness of the traction equalizer can be checked by the following method:

- A. Jack up one wheel free of ground.
- B. Block other wheel or otherwise restrain vehicle.
- Put transmission in neutral so propeller shaft is free to rotate.
- D. With long bar and appropriate scale, measure torque to rotate jacked-up wheel.
 Wheel torque = pounds pull x bar length (in feet).
- E. Wheel torque x = 2 = equalizer torque.

The equalizer torque on a new unit will check approximately 4067 N.m (3000 ft.lbs.) or higher. When this torque drops to 2034 N.m (1500 ft.lbs.) or less, the clutch packs should be replaced.



REMOVAL AND INSTALLATION OF SELF-CONTAINED TRACTION EQUALIZER PACK GENERAL DISASSEMBLY

REMOVE DIFFERENTIAL CARRIER FROM HOUSING

- A. Drain lubricant from axle housing.
- B. Remove axle shaft drive stud nuts and lock washers.
- C. Rap axle shafts sharply in center of flange with heavy steel hammer on drift to free dowels. Remove taper dowels and axle shafts.

PRYING THE SHAFTS LOOSE WILL DAMAGE THE HUBS AND OIL SEALS.

- D. Disconnect universal at pinion shaft.
- E. Remove carrier to housing stud nuts and washers. Loosen two top nuts and leave on studs to prevent carrier from falling.
- F. Break carrier loose from axle housing with rawhide mallet.
- G. Remove top nuts and washers and work carrier free. A small pinch bar may be used to straighten the carrier in the housing bore. However, the end must be rounded to prevent indenting the carrier flange. A roller jack may be used to facilitate removal of carrier.
- H. Place carrier in suitable holding fixture.

DISASSEMBLE CARRIER REMOVE DIFFERENTIAL AND GEAR ASSEMBLY

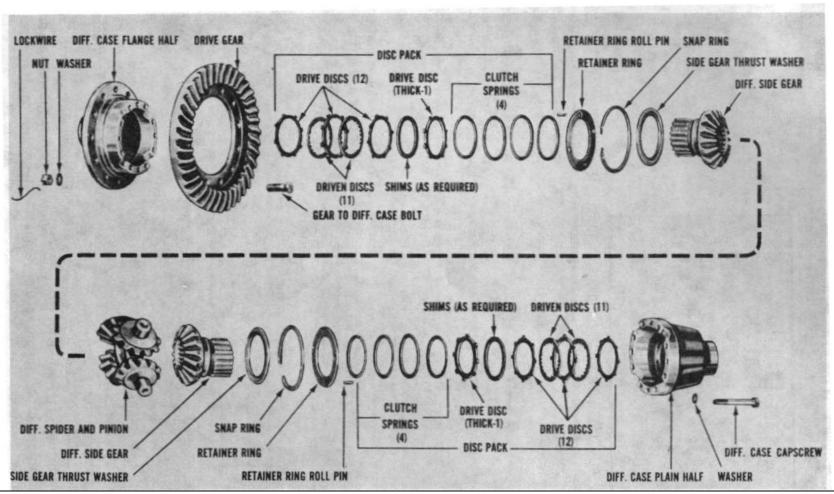
- A. Loosen jam nut and back off thrust block adjusting screw.
- B. Center punch one differential carrier leg and bearing cap to identify for proper reassembly.
- C. Cut lock wire. Remove cap screws and adjusting nut locks.
- D. Remove bearing cap stud nuts or cap screws, bearing caps and adjusting nuts.
- E. Lift out differential and gear assembly.
- F. Remove thrust block from inside of carrier housing.

DISASSEMBLE DIFFERENTIAL CASE AND GEAR ASSEMBLY

- A. If original identification marks are not clear, mark differential case halves with a punch or chisel for correct alignment on reassembling.
- B. Cut lock wire, remove bolts and separate case halves.
- C. Remove spider, pinions, side gears and thrust washers.
- D. If necessary, remove rivets and separate gear and case.
- E. If necessary to replace differential bearings, remove with a suitable puller.



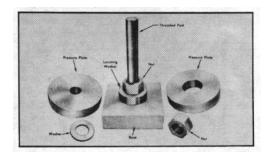
SELF-CONTAINED TRACTION EQUALIZER



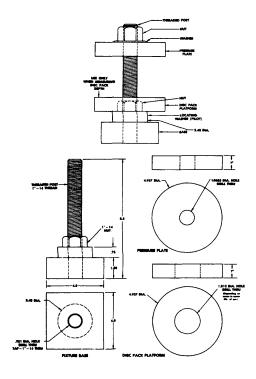
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DIFFERENTIAL CASE HALF FIXTURE

The removal and disassembly procedure for the Traction Equalizer is the same for both differential case halves.



The use of a clamping and alignment fixture will facilitate the disassembly and reassembly of the disc pack.



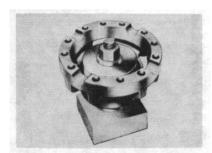
A suitable fixture as shown above can be made from available stock by following dimensions on the above drawing.

REMOVE TRACTION EQUALIZER

A. Remove nut, washer and pressure plate from clamping fixture.



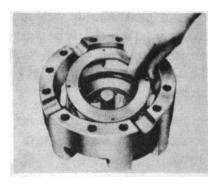
B. Position differential case plain half (bearing end down) over threaded post and locating washer on fixture.



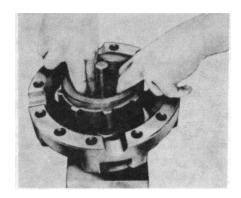
C. Place pressure plate over retaining ring of disc pack and install washer and nut. Clamp base of fixture in vise and tighten nut to 110-120 lb. ft.



- D. Using suitable tool remove internal snap ring from differential case half.
- E. Slowly loosen nut on clamping fixture to release pressure on disc pack. Remove nut, washer and pressure plate from clamping fixture.



F. Remove disc pack retainer ring. Do not remove roll pins from case half unless damaged.



- G. Remove entire disc pack, discard the clutch discs but save the other parts.
- H. Remove empty differential case from fixture.
- I. Repeat procedure for other case half.

PREPARE FOR REASSEMBLY CLEAN, INSPECT AND REPAIR

Parts having ground and polished surfaces such as gears, bearings, bearing journals and differential case halves, should be cleaned in a suitable solvent such as kerosene or diesel fuel oil.

GASOLINE SHOULD BE AVOIDED

DO NOT clean these parts in a hot solution tank or with water and alkaline solutions such as sodium hydroxide, orthosilicates or phosphates.

We do NOT recommend steam cleaning assembled drive units after they have been removed from the housing. This can lead to corrosion (rust) of critical parts of the assembly and the possibility of circulating rust particles in the lubricant. Premature failure of

bearings, gears and other parts can be caused by this practice.

DRYING

Parts should be thoroughly dried immediately after cleaning. Use soft, clean lintless absorbent paper towels or wiping rags free of abrasive material, such as lapping compound, metal fillings or contaminated oil. Bearings should never be dried by spinning with compressed air.

CORROSION PREVENTION

Parts that have been cleaned, dried, inspected and are to be immediately reassembled should be coated with light oil to prevent corrosion. If these parts are to be stored for any length of time, they should be treated with a good RUST PREVENTIVE and wrapped in special paper or other material designed to prevent corrosion.

INSPECT

It is impossible to overstress the importance of careful and thorough inspection of drive unit parts prior to reassembly. Thorough visual inspection for indications of wear or stress, and the replacement of such parts as are necessary will eliminate costly and avoidable drive unit failure.

- A. Inspect all bearings, cups and cones, including those not removed from parts of the drive unit, and replace if rollers or cups are worn, pitted or damaged in any way. Remove parts needing replacement with a suitable puller or in a press with sleeves. Avoid the use of drifts and hammers. They may easily mutilate or distort component parts.
- B. Inspect the differential assembly for the following:
 - Pitted, scored or worn thrust surfaces of differential case halves, thrust washers, spider trunnions and differential gears. Thrust washers must be replaced in sets. The use of a combination of old and new washers will result in premature failure.
 - 2. Wear or damage to the differential pinion and side gear teeth. Always replace differential pinions and side gears in sets.

REPAIR

Use only genuine International Harvester Co. replacement parts for satisfactory service.

- A. Replace all worn or damaged parts. Hex nuts and bolts with rounded corners, all lock washers should be replaced at the time of overhaul.
- B. Remove nicks, mars and burrs from machined or ground surfaces. Threads must be clean and free to obtain accurate adjustment and correct torque. A fine mill file or India stone is suitable for this purpose.
- C. When assembling component parts use a press where possible.
- D. Tighten all the nuts to the specified torque. Use soft iron lock wire to prevent possibility of wire breakage.

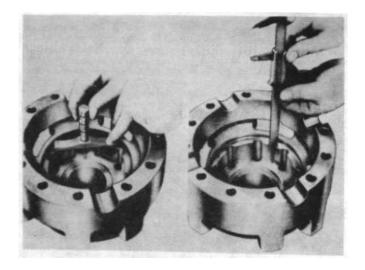
LUBRICATION

For type of lubricant, refer to Lubrication CTS-2412.

REASSEMBLY AND INSTALLATION OF TRACTION EQUALIZER KIT PRELOAD CHECK-CASE HALF

NOTE: Replacement discs are furnished in kits. Each kit contains two sets of discs held together on a mandrel, one set for each case half. These parts have been pre-lubricated and run-in. Each set of parts should be handled as a group to avoid altering the relative position of any of the individual pieces. Leave mandrel in place until assembly into differential case half is completed.

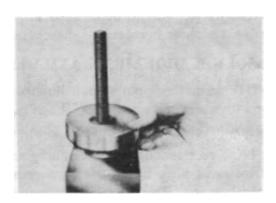
Before assembling disc pack into case half it is necessary to determine the amount of preload shims to be used.



A. Using a depth micrometer or Vernier Gauge, measure the depth of clutch bore in case half as illustrated, make note of measurement.

PRELOAD CHECK -DISC PACK

A. Remove nut, washer and pressure plate from clamping fixture. Clamp base of fixture in vise.



B. Position the 1" thick spacer (Disc Pack Platform) over locating washer of fixture.

CTS-2539P Page 8

DESCRIPTION

The two-speed axles featured in this section provide a correct gear for most load and road conditions. The principles of the single and double reduction axles are incorporated to provide a HIGH and LOW ratio. In HIGH axle ratio the two-speed axle functions as a single reduction unit. When shifted into LOW axle ratio, it functions as a double reduction unit.

OPERATION

To obtain HIGH axle ratio, the sliding clutch (43, Fig. 1) is moved by the shift fork (16) to mesh with the planetary pinion gears (64) and the high speed clutch plate (51). This action causes the planetary pinion gears to be held stationary, and the unit functions as a conventional single reduction axle.

When LOW axle ratio is desired, the sliding clutch (43) is shifted from the position described and becomes meshed with the low speed clutch plate (42) and planetary pinion gears (64). The planetary gears are free to rotate about the sliding clutch gear which is held stationary.

The secondary reduction between the bevel gear (12) and differential assembly is accomplished and the axle becomes a double reduction unit.

DIFFERENTIAL REMOVAL

Removal of the two-speed differential assembly from the axle housing requires the same procedure as removal of a conventional single reduction unit except for disconnecting the shift mechanism.

Remove plug (26), spring (27), and oil distributor tube (28) as shown in Fig. 2. NOTE: All key numbers mentioned in DISASSEMBLY and REASSEMBLY procedures refer to Fig. 1.



Fig. 2 Removal of Plug, Spring and Oil Distributor

Lift shift motor rubber seal (21) from shift fork(16). NOTE: When reassembling, be certain seal is placed with bottom hole over lower stud (see Fig. 3).

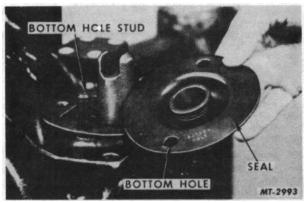
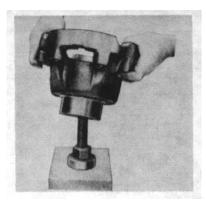
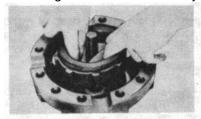


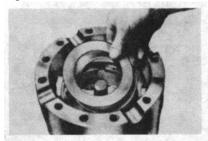
Fig. 3 Lifting Off Shift Motor Seal.



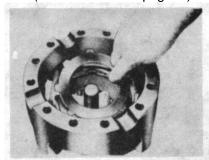
B. Position differential case plain half (bearing end down) over threaded post and locating washer of fixture. (From here on make sure parts are coated with gear oil as the assembly is built up.)



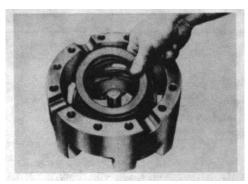
C. Install complete clutch pack as removed from fixture into differential case (with Mandrel still in place). If pack does not require shims go to item "G". If pack requires shims, remove the four (4) Belleville springs, and thick drive disc and go to item "D".



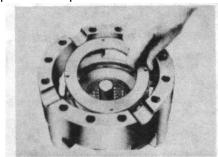
D. Next assemble the proper amount of preload shims. (Refer to item "H" page 9.)



E. Position thick drive disc over shims.



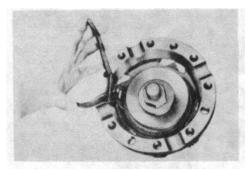
F. Install four (4) Belleville springs, concave side up over disc pack.



- G. Position retainer ring over pack (roll pin hole chamfers down) align holes with roll pins in case half.
- H. Place pressure plate over retainer ring. Install washer and nut onto threaded post of fixture. Tighten nut to 149-163 N.m (110-120 lb. ft.) torque to compress disc pack below snap ring.

CAUTION

As pack is being compressed continue to check alignment of roll pin holes in retainer ring with roll pins in differential case half. If necessary use small blunt drift and hammer to reposition retainer ring.



- J. Using suitable tool install snap ring into differential case half.
- K. Remove nut, washer and pressure plate from fixture. Remove plastic mandrel.

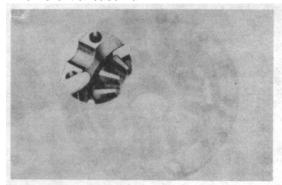
L. Remove differential case plain half from fixture and install flange half.

Note

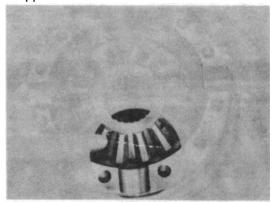
Reassembly procedures of the Traction Equalizer Kit into the flange half is the same as into plain half. Follow pages 8 through 11.

INSTALL SIDE GEARS INTO CASE HALVES 16 TOOTH SIDE GEAR

 A. Place side gear thrust washer in position in one differential case half.



- B. Insert side gear in case half so splines are engaged with clutch discs. Index side gear as required so that teeth on side gear are in line with the spider holes in the case half.
- C. Assemble spider, pinions and pinion thrust washers in this same case half. Check spider legs for proper seating in bores.
- D. Place side gear thrust washer in position in opposite case half.



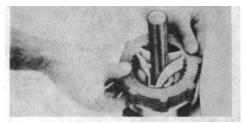
16 TOOTH SIDE GEAR ONLY

- E. Insert side gear in opposite case half. This time, index side gear so that tooth-spaces on side gear are in line with the spider holes in the case half.
- F. Temporarily wire side gear and thrust washer in position in case half.
- G. Invert and place in position on other case half. Be sure to align differential case match marks (already stamped). Case halves should meet within 1.588 mm (1/16 in). If gap is wider recheck for proper indexing of side gears. Remove wire.
- H. Install case capscrews and tighten to 251-278 N.m (185-205 lb. ft.) torque. Lockwire capscrews.
- J. If bearings are to be replaced, install, pressing squarely and firmly onto differential case halves.

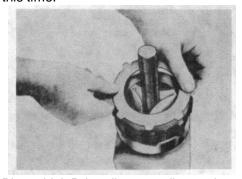
9-14 TOOTH SIDE GEAR

- A. Place differential case halves on bench and observe differential case match marks (already stamped). Rotate case halves until match marks are facing the same direction.
- B. With chalk premark corresponding spider arm bores on both plain and flange case halves.
- C. Install side gear thrust washers.
- D. Insert side gear in one differential case half, engaging splines of side gear with splines of clutch discs. Index gear so a tooth aligns with the premarked spider bore.
- E. With opposite case half align a tooth space with premarked spider bore. continue reassembly by following procedures F through J, page 11.

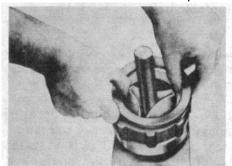
TO INSTALL DIFFERENTIAL CASE ASSEMBLY WITH SELF-CONTAINED TRACTION EQUALIZER IN CARRIER AND HOUSING REVERSE PROCEDURES ON PAGE 4.



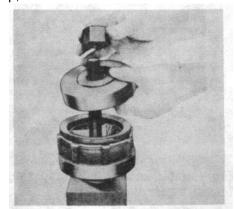
C. Position disc pack on platform. Omit shims at this time.



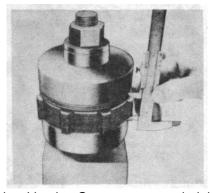
D. Place thick Drive disc over disc pack.



E. Position four (4) Belleville springs, concave side up, over thick disc.



F. Place pressure plate, washer and nut over disc pack and tighten nut to 149-163 N.m (110-120 lb. ft.) torque to compress pack flat.



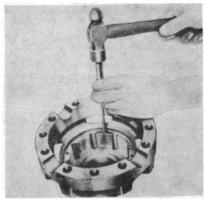
- G. Using Vernier Gauge measure height of pack. Measure between top of disc pack platform (1" thick spacer) and bottom of pressure plate. Make note of measurement.
- H. Subtract pack height Item G from clutch bore depth Item A (Preload Case Half). Select shim pack .004 to .009 less than remainder.

Example: Bore depth Pack height Remainder Shim pack 3.658 cm (1.440 in) 3.581 cm (1.410 in) .076 cm (.030 in) .0534 - .0660 cm (.021 - .026 in)

If desired shim pack exceeds .040, one of the old drive discs may be used as part of the shim pack.

 Remove nut washer and pressure plate from fixture. Remove complete clutch pack and set aside.

KIT INSTALLATION



A. Begin reassembly of the disc pack into differential case plain half by installing roll pins if removed. There are four (4) roll pins per half. Pins must bottom in holes.

AXLE REAR

IH MODEL	IH CODE	IH MODEL	IH CODE	IH MODEL	IH CODE
RA-126	14126	RA-157	14157	RA-197	14197
RA-127	14127	RA-158	14158	RA-199	14199
RA-145	14145	RA-163	14163	RA-246	14246
RA-146	14146	RA-184	14184	RA-252	14252
RA-147	14147	RA-186	14186	RA-286	14286
RA-149	14149	RA-187	14187	RA-292	14292
RA-150	14150	RA-189	14189	RA-298	14298
RA-152	14152	RA-192	14192		
RA-155	14155	RA-196	14196		

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SPECIFICATIONS (TWO SPEED)

IH Model and Code	RA-126 (14126) RA-127 (14127) * RA-187 (14184) * RA-187 (14187)	RA-149 (14149) RA-189 (14189) * RA-199 (14199)	* RA-145 (14145) ** RA-146 (141446) **RA-147 (14147) **RA-150 (14150)	*** RA-152 (14152 ** RA-163 (14163) **RA-186 (14186) ** RA-192 (14192)	* RA-155 (14155) **RA-157 (14157) ***RA-158 (14158)	** RA-196 (14196) **RA 197 (14197)
PINION: Nominal Dimension						
(mm)	92.6	104.76	11 [.]	1.92	121	.44
(in)	3.6244	4.1250	4.4062		4.7812	
SE-10065-9 Disc	E(1) G(1)	I(1) G(1)	M(1) G(1)		I(1) L(1)	
Cage Rotating Torque Scale Reading						
(kg)	2.7-6.8	2.7-6.8	2.7	'-6.8	2.7	-6.8
pounds pull	6-15	6-15	6-15		6-	15
DIFFERENTIAL:						
Bearing Preload			ALL AXLES 2 NO	TCHES R.H. SIDE		
Backlash						
(mm)	.0.15-0.4	0.15-0.4		5-0.4		5-0.4
(in)	.0060016	.006016	.006016			016
SERIAL NUMBER LOCATION		ALL AXLES TOP OF	CARRIER BETWEN	IN OIL SCOOP BOSS	AND FILLER PLUG.	
LUBRICANT CAPACITY						
Liters - Pints	6-45.5	9.5-20	* 9-19			5-24
Liters - Pints	* 11-23	* 13-27.5	** 10.5-22		** 14-29.5	
Liters - Pints			*** 13	.5-28.5	*** 1	6-34

CTS-2097S Page 2



REAR AXLE TORQUE CHART PLANETARY TWO SPPED TYPE

IH MODEL	RA-126 RA-127 RA-184 RA-187	RA-136 RA-149 RA-189 RA-199	RA-145	RA-146 RA-147 RA-163 RA-186	RA-150	RA-152 RA-192	RA-155	RA-157 RA-196 RA-197	RA-158
Pinion End Nut	1-20	1-1/8 - 18	1-1/4 - 12	1-1/4 - 12	1-1/4 - 12	1-1/4 - 12	1-1/4 - 12	1-1/2 - 18	1-3/4 - 12
N.m	310-475	440-610	540-820	540-820	540-820	540-820	540-820	6 80 -950	740-1150
1bf-ft	225-350	325-450	400-600	400-600	400-600	400-600	400-600	500-700	550-850
Pinion Cage-to-Carrier	9/16 - 12	9/16 - 12	9/16 - 12	9/16 - 12	9/16 - 12	9/16 - 12	9/16 - 12	9/16 - 12	5/8 - 11
N.m	155-170	155-170	155-170	155-170	155-170	155-170	155-170	155-170	218-240
1bf-ft	115-125	115-125	115-125	115-125	115-125	115-125	115-125	115-125	160-175
Carrier-to-Axie Housing N.m 1bf-ft	7/16 - 14	1/2 - 13	5/8 - 18	5/8 - 18	5/8 - 18	9 /16 - 18	9 /16 - 11	9 /16 - 18	5/8 - 11
	76-86	132-150	218-240	220-250	300-325	163-190	170-203	162-265	218-240
	56-63	97-110	160-175	165-187	220-240	120-140	125-150	120-195	160-175
N.m 1bf-ft	7/16 - 14 68-95 50-70	7/16 - 14 68-95 50-70	1/2 - 13 108-136 80-100	1/2 - 13 108-136 80-100	1/2 - 13 108-136 80-100	1/2 - 13 108-136 80-100	1/2 - 13 108-136 80-100	1/2 - 13 108-136 80-100	1/2 - 13 108-136 80-100
Drive Gear Support Case N.m 1bf-ft	7/16 - 20	1/2 - 20	9/16 - 18	9/16 - 18	9/16 - 18	9/16 - 18	9/16 - 18	9/ 16 - 18	9/16 - 18
	82-108	122-136	175-203	175-203	175-203	175-203	175-203	175-203	218-260
	60-80	90-100	130-150	130-150	130-150	130-150	130-150	130-150	160-190
Bearing Cap-to-Carrier	5/8 - 11	11/16 - 11	13/16 - 10	13/16 - 10	13/16 - 10	13/16 - 10	13/16 - 10	13/16 - 10	13/16 - 10
N.m	203-230	285-340	475-580	475-580	475-580	475-580	475-580	475-580	475-580
1bf-ft	150-170	210-250	350-425	350-425	350-425	350-425	350-425	350-425	350-425
Cover to Housing N.m 1bf-ft	7/16 - 14 61-69 45-51	7/16 - 14 61-69 45-51	7/16 - 14 47-68 35-50	(Welded)	7/16 - 14 61-75 45-55	(Welded)	7/16 - 14 61-75 45-55	(Welded)	7/16 - 14 61-75 45-55
Axle Flange-to-Wheel Hub	*	5/8 - 18	5/8 - 18	5/8 - 18	3/4 - 16	3/4 - 16	3/4 - 16	3/4 - 16	3/4 - 16
N.m		162-183	203-218	163-183	240-305	295-325	240-305	295-325	240-305
1bf-ft		120-135	150-160	120-135	175-225	217-240	175-225	217-240	175-225
Shift Unit-to-Housing N.m lbf-ft	7/16 - 20	7/16 - 20	7/16 - 20	7/16 - 20	7/16 - 20	7/16 - 20	7/16 - 20	7/16 - 20	7/16 - 20
	47-61	47-61	47-61	47-61	47-61	47-61	47-61	47-61	47-61
	35-45	35-45	35-45	35-45	35-45	35-45	35-45	35-45	35-45

^{*} RA-126: 1/2-20=82-95 N.m (60-70 1bf-ft). RA-127, RA-184, RA-187: 5/8-18=163-185 N.m (120-135 1bf-ft). CTS-2097S Page 3



REAR AXLE

PLANETARY DOUBLE REDUCTION TYPE

SPECIFICATIONS						
	RA-246	RA-252				
IH MODEL	(14246)	(14242)	RA-298			
(IH CODE)	RA-286	RA-292	(14298)			
	(14286)	(14292)				
PINION:						
Nominal Dimension						
(mm)	111.92	111.92	121.44			
(in)	4.4062	4.4062	4.7812			
SE-1065-9-Disc	M(1) G(1)	M(1) G(1)	I(1) L(1)			
Cage Rotating Torque Scale Reading						
(kg)	2.7-6.4	2.7-6.4	2.3-5.4			
(lbs)	6-15	6-15	5-12			
DIFFERENTIAL:						
Bearing Preload	2 Notches	2 Notches	2 Notches			
	RH Side	RH Side	RH Side			
Backlash						
(mm)	0.15-0.4	0.15-0.4	0.15-0.4			
(in)	.006016	.006016	.006016			
HOUSING:	_					
Lube Capacity						
(liter)	13.8	13.8	18.0			
(pints)	29.0	29.0	38.0			
SERIAL NO.						
LOCATION	*	*	*			

			ORQUE CHART
	RA-246	RA-252	
IH MODEL	(14246)	(14252)	RA-298
(IH CODE)	RA-286	RA-292	(14298)
	(14286)	(14292)	
Pinion End Nut	1-1/4-12	1-1/4-12	1-1/2-18
N.m.	540-810	540-810	880-9500
1bf-ft	400-600	400-600	500-700
Pinion Cage to Carrier	9/16-12	9/16-12	9/16-12
N.m.	155-170	155-170	155-170
1bf-ft	115-125	115-125	115-125
Carrier to Axle Housing	5/8-18	9/16-18	9/16-18
N.m.	224-254	162-190	162-190
1bf-ft	165-187	120-140	120-140
Differential Case	1/2-13	1/2-13	1/2-13
N.m.	122-141	122-142	122-142
1bf-ft.	90-105	90-105	90-105
Drive Gear Support Case	9/16-18	9/16-18	9/16-18
N.m.	176-203	176-203	176-203
1bf-ft	130-150	130-150	130-150
Bearing Cap to Carrier	13/16-10	13/16-10	13/16-10
N.m.	475-580	475-580	475-580
1bf-ft	350-425	350-425	350-425
Cover to Housing	(Welded)	(Welded)	(Welded)
Axle Flange to Wheel Hub	5/8-18	3/4-16	3/4-16
N.m.	162-183	290-325	290-325
1bf-ft	120-135	217-240	217-240

^{*} Top of carrier between oil scoop boss and filler plug.

PLANETARY TWO-SPEED

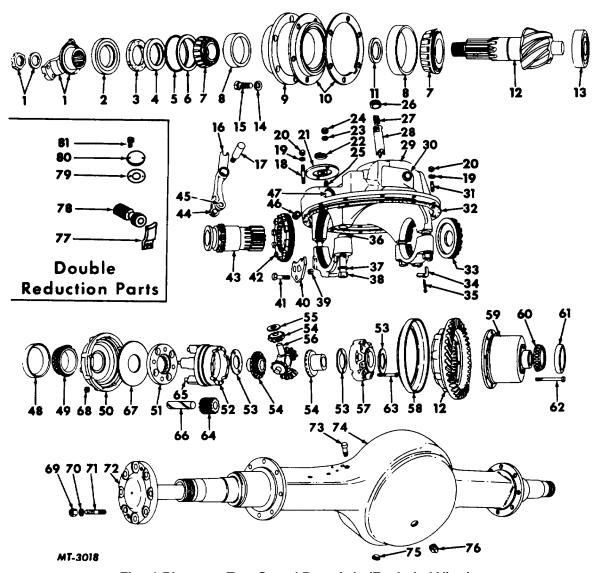


Fig. 1 Planetary Two-Speed Rear Axle (Exploded View) (Double Reduction Similar Except for Stationary Sun Gear)

LEGEND FOR FIG. 1

Key	Description	Key	Description	Key	Description
1.	Flange, comp. asm.	12.	Gear set, ring and pinion	23.	Washer, lock, 7/16
2.	Retainer, pinion oil seal	13.	Bearing, pinion, inner	24.	Nut, hex., 7/16NF
3.	Seal, oil, pinion (felt)	14.	Washer, Lock, 9/16	25.	Stud, shift motor, hsg.
4.	Seal, assembly	15.	Bolt, hex-hd., 9/16NC	26.	Plug, pipe, ctsk.
5.	Seal, oil pinion gear	16.	Fork, sliding clutch shift	27.	Spring, oil dist. tube
6.	Washer, pinion oil seal	17.	Shaft, sliding clutch shift	28.	Tube, oil, distributor
7.	Bearing, cone, pinion	18.	Stud, carrier mounting	29.	Carrier, differential
8.	Bearing, cup, pinion	19.	Washer, Lock, 9/16	30.	Plug, inspection hole, 1"
9.	Cage, pinion bearing	20.	Nut, hex., 9/16NF	31.	Stud, carrier mounting
10.	Shim, pinion brg. cage	21.	Seal, shift motor	32.	Gasket, carrier to hsg.
11.	Spacer. pinion bearing	22.	Spring, shift motor seal	33.	Adjuster. bearing. right

37. Washer, bearing cap bolt 53. Washer, thrust 69. Nut, hex., 3/4NF 38. Bolt, bearing cap 54. Gear, set, pinion & side 70. NOT USED 39. Bushing, dowel brg. 55. Washer, pinion gear 71. Stud, wheel flange 40. Lock, lt. brg. adjuster 56. Spider, differential 72. Shaft, axle 41. Bolt, brg. adjuster 57. Case, differential, right 73. Breather, axle hsg. ver 42. Adjuster, bearing, lt. 58. Drum, case oil collector 74. Housing, axle 43. Clutch, sliding 59. Case, dr. gear support, rt. 75. Plug, drain, 3/4" 44. Pin, shift fork roller 60. Bearing, cone, diff., rt. 76. Plug, pipe, sq-hd. 3/4 45. Roller, clutch shift fork 61. Bearing, cup, diff., rt. 77. Retainer, sun gear 46. Plug, pipe, ctsk. 1/2" 62. Bolt, dr. gear to case 78. Gear, sun Gasket, shift fork cove	Key	Description	Key	Description	Key	Description
49. Bearing, cone, diff. lt. 65. Pin, clutch plate 81. Bolt, shift fork cover	35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47.	Pin, cotter, 3/.16 x 1 Bushing, dowel, brg. Washer, bearing cap bolt Bolt, bearing cap Bushing, dowel brg. Lock, lt. brg. adjuster Bolt, brg. adjuster Adjuster, bearing, lt. Clutch, sliding Pin, shift fork roller Roller, clutch shift fork Plug, pipe, ctsk. 1/2" Plug, expansion, 1-3/8 Bearing, cup diff. lt.	51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64.	Plate, high speed clutch Case, differential Washer, thrust Gear, set, pinion & side Washer, pinion gear Spider, differential Case, differential, right Drum, case oil collector Case, dr. gear support, rt. Bearing, cone, diff., rt. Bearing, cup, diff., rt. Bolt, dr. gear to case Bolt, differential case Gear, planetary pinion	67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79.	Washer, thrust Nut, support, case bolt Nut, hex., 3/4NF NOT USED Stud, wheel flange Shaft, axle Breather, axle hsg. vent Housing, axle Plug, drain, 3/4" Plug, pipe, sq-hd. 3/4" Retainer, sun gear Gear, sun Gasket, shift fork cover Cover, shift fork opening

DESCRIPTION

The two-speedaxles featured in this section provide a correct gear for most load and road conditions. The principles of the single and double reduction axles are incorporated to provide a HIGH and LOW ratio. In HIGH axle ratio the two-speed axle functions as a single reduction unit. When shifted into LOW axle ratio, it functions as a double reduction unit.

OPERATION

To obtain HIGH axle ratio, the sliding clutch (43, Fig. 1) is moved by the shift fork (16) to mesh with the planetary pinion gears (64) and the high speed clutch plate (51). This action causes the planetary pinion gears to be held stationary, and the unit functions as a conventional single reduction axle.

When LOW axle ratio is desired, the sliding clutch (43) is shifted from the position described and becomes meshed with the low speed clutch plate (42) and planetary pinion gears (64). The planetary gears are free to rotate about the sliding clutch gear which is held stationary. The secondary reductionbetween the bevel gear (12) and differential assembly is accomplished and the axle becomes a double reduction unit.

DIFFERENTIAL REMOVAL

Removal of the two-speed differential assembly from the axlehousing requires the same procedure as removal of a conventional single reduction unit except for disconnecting the shift mechanism.

DISASSEMBLY

Remove plug (26), spring (27), and oil distributor tube (28) as shown in Fig. 2. NOTE:

All key numbers mentioned in DISASSEMBLY and REASSEMBLY procedures refer to Fig. 1.

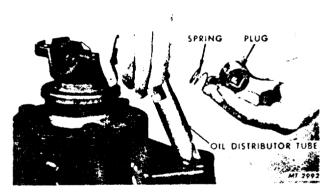


Fig. 2 Removal of Plug, Spring and Gil Distributor Tube,

Lift shift motor rubber seal (21) from shift fork(16). NOTE: When reassembling, be certain seal is placed with bottom hole over lower stud (see Fig. 3).

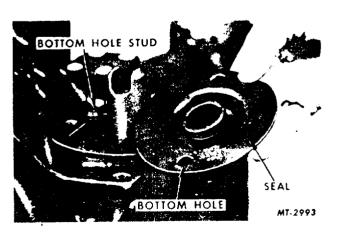


Fig. 3 Lifting Off Shift Motor Seal.

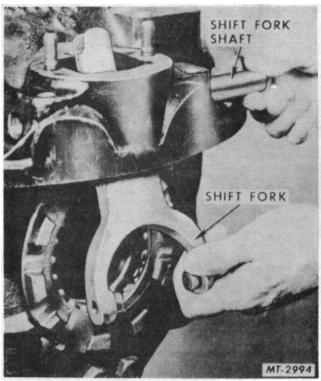


Fig. 4 Removing Sliding Clutch Shift Fork.

Pull out sliding clutch gear (43), see Fig. 5.

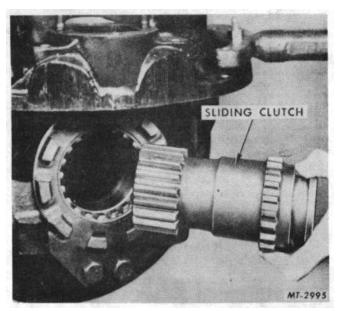


Fig. 5 Removal of Sliding Clutch Gear.

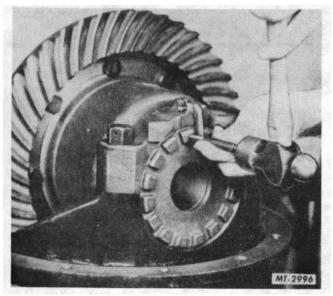


Fig. 6 Marking Differential Bearing Adjuster.

Remove differential carrier bearing cap bolt lockwires on both left and right hand sides. NOTE: DO NOT loosen bearing adjuster lock bolts (41), but loosen only bearing cap bolts (38), Take off right hand bearing adjuster (33), lock (34), and cotter pin (35). See Fig. 7.

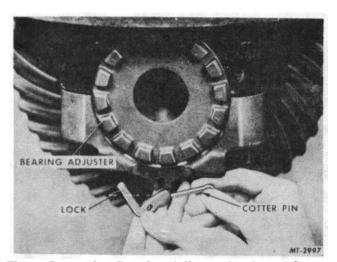


Fig. 7 Removing Bearing Adjuster Lock and Cotter Pin.

Remove left hand differential bearing cap, adjuster (4Z), and lock (40) as an assembly to assure correct positioning of gear during reassembly (see Fig. 8).

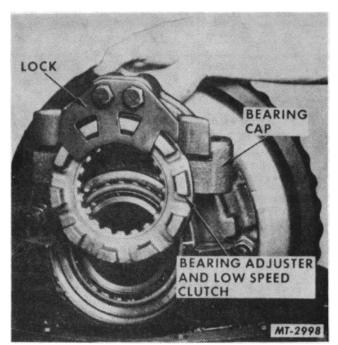


Fig. 8 Removing Bearing Adjuster, Lock, and Cap.

Tip up left hand end of planetary unit so that bevel gear will clear bevel pinion gear (see Fig. 9).

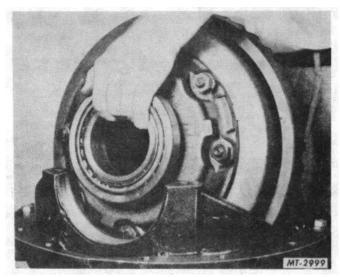


Fig. 9 Tipping Planetary Unit.

Lift out planetary unit with chain hoist (see Fig. 10).

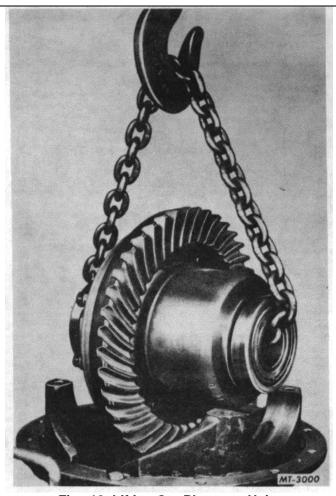


Fig. 10 Lifting Out Planetary Unit.

Take out pinion bearing cage capscrews (15). Use ball-peen hammer to drive out bevel pinion assembly (see Fig. 11).

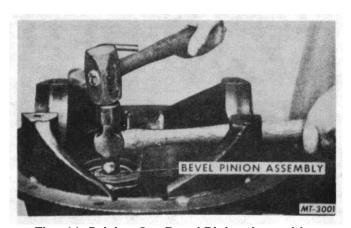


Fig. 11 Driving Out Bevel Pinion Assembly.

After pilot bearing (13) has been freed from carrier pull out bevel pinion assembly. (Note shims (10) behind pinion bearing cage (9). See Fig. 12.

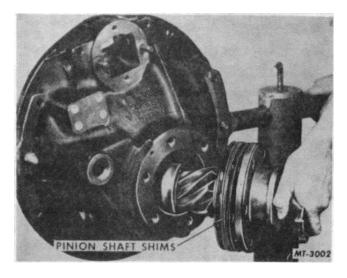


Fig. 12 Removing Bevel Pinion Assembly.

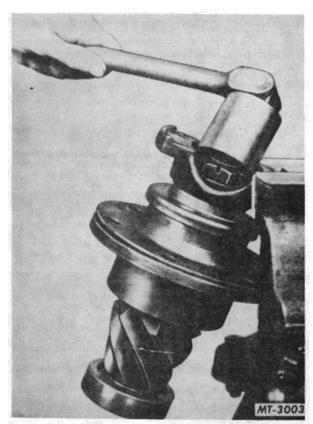


Fig. 13 Removal of Pinion Shaft Nut, Washer, and Flange.

Clamp companion flange (1) of bevel pinion assembly into vise and remove cotter pin, pinion shaft nut and washer (1). Remove assembly from vise and slip off companion flange (see Fig. 13).

Lift off pinion bearing cage (9), bearing (7) and washer (6). Slip off pinion bearing spacer (11). Drive off pinion bearing cone (7) by tapping between teeth of bevel pinion gear, alternately on opposite sides of inner race (see Fig. 14).

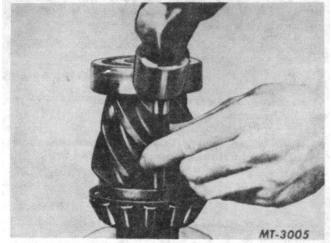


Fig. 14 Removing Pinion Shaft Bearing Cone.

Remove pinion bearing cone (7) and washer (6) from pinion cage assembly (see Fig. 15).

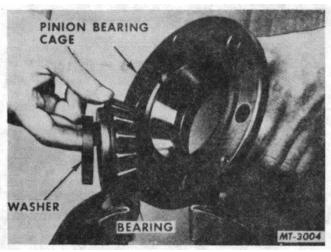


Fig. 15 Removal of Pinion Bearing Cone and Washer.

Take out pinion cage cork seal (5). See Fig. 16. Replace with every repair.

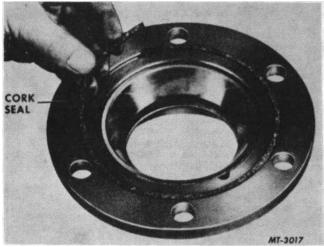


Fig. 16 Removing Pinion Cage Cork Seal.

Remove lockwire from support case bolts (62). Unscrew support case bolt nuts (68) and remove bolts. Tap alternately on opposite sides of bevel gear (12) with rawhide hammer until gear is free of flange on support case (59). See Fig. 17 **NOTE:** When reassembling, use two bolts to assure proper alignment of bolt holes.

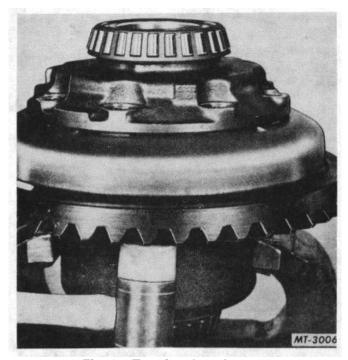


Fig. 17 Tapping Gear Loose.

Lift off left hand support case (50) and oil drum (58). See Fig. 18.



Fig. 18 Removing Support Case and Oil Drum.

Lift off thrust washer (67) and bevel gear (12). See Fig. 19.



Fig. 19 Lifting Off Thrust Washer and Bevel Gear.

Pry off high speed clutch plate (51) and remove idler pinions(64) and pins (66). See Fig. 20.

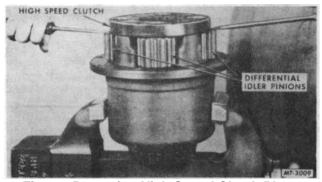


Fig. 20 Removing High Speed Clutch Plate.

Lift out entire differential assembly and remove support case thrust washer (53). See Fig. 21.



Fig. 21 Removal of Differential Assembly and Thrust Washer.

Take out differential case bolt lockwire and remove bolts (63). Note short bolts between spider arms. Lift off right hand differential case half (57). See Fig. 22.

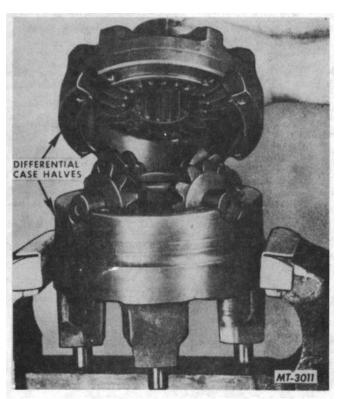


Fig. 22 Removing Differential Case Half.

Remove long hub side gear (54) and thrust washer (53) from right hand differential case half (57). See Fig. 23.

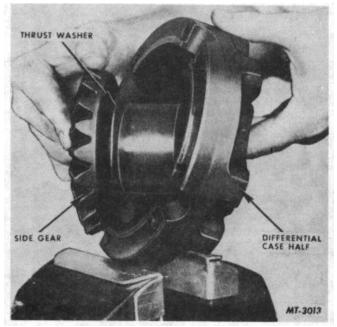


Fig. 23 Removal of Side Gear and Thrust Washer.

Lift out spider (56) and take thrust washers (55) and differential side pinion gears (54) off spider arms (see Fig. 24).

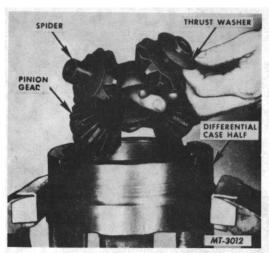


Fig. 24 Removing Spider, Thrust Washers and Side Pinion Gears.

Take out short hub side gear (54) and thrust washer (53) from left hand differential case half (52).

Remove differential bearing cones (49 and 60) by striking inner race on alternate sides through holes provided in support case halves (50 and 59). See Fig. 25.

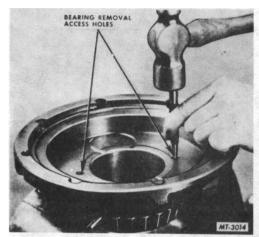


Fig. 25 Removing Differential Support Case Bearing Cones.

CLEANING, INSPECTION AND REPAIR

Clean all parts thoroughly with a cleaning solvent and inspect each for excessive wear or damage. All bearings should be washed in a pressure bearing washer.

Inspect side gear splines. Excessive wear will permit backlash on torque reversal and cause extreme shock to entire assembly. Check companion flange and pinion shaft splines. Also inspect pinion shaft keyway. If excessively worn, key may be sheared in half, allowing drive shaft to rotate freely. Check roller bearings for worn or pitted rolls. Inspect idler pinion pins for being worn undersize or having deep scratches. It is not necessary to replace pins unless worn more than 0.4 mm (1/64") when inserted into high speed clutch plate, differential case or idler pinions, providing all pins in a single unit are worn by approximately the same amount. Examine bevel gears for scoring or pits. CAUTION: DO NOT replace bevel gears and pinions individually, but only as a matched set. Check high speed clutch plate for worn or burred teeth. This condition will cause a rough shift into high range and if worn badly enough will cause axle to slip into low range under high torque loads. Also check outside diameter of clutch plate. Inspect thrust washers for excessive wear. Maximum allowable wear is 0.13 mm (.005") under original size. **NOTE:** Original size may be determined by measuring new thrust washers. Check differential support case bearing hubs for excessive wear due to bearing races turning on them.

Replace all excessively worn parts.

REASSEMBLY

Reassembly is essentially the reversal of disassembly; however, there are some important points to be observed.

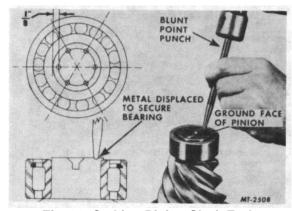


Fig. 26 Staking Pinion Shaft End.

REASSEMBLING INNER PINION WEARING

If pinion shaft inner bearing has been removed, shaft must be staked over in four places after pressing on bearing (see Fig. 26).

REASSEMBLING DIFFERENTIAL UNIT

Lubricate both sides of all thrust washers well. **NOTE:** Chamfered sides of washers must be against back face of side gears. Lubricate spider arms, side pinion bores and side gear hubs. Draw bolts tight and secure with lockwire.

REASSEMBLING PLANETARY UNIT

Before placing thrust washer, lubricate both sides well. Cover idler pinion pins with lubricant. **NOTE:** Chamfered teeth on high speed clutch plate must face pinions. Place notches in oil collector drum between bolt holes in bevel gear. Draw bolts tight and secure with lockwire.

PINION SHAFT BEARING ADJUSTMENT

Pinion bearing cage should be rotated by hand when tightening pinion shaft nut. With shaft held stationary, there should be a noticeable drag when turning the cage. Drag should be 1.7-3.9 N-m (15 to 35-inch pounds) torque. **NOTE**: Reading should be taken with bearings lubricated and cage turning as starting torque will be higher (see Fig. 27).



Fig. 27 Measuring Pinion Bearing Preload.

REASSEMBLING DIFFERENTIAL CARRIER UNIT

Lubricate all bearings as they are reassembled in carrier. **NOTE:** When reassembling bearing adjusters, be certain that threads mesh freely. Start bearing cap bolts before dropping cap and adjuster in place.

BEVEL GEAR DRIVE ADJUSTMENT

Bevel drive pinion is adjusted for tooth contact by means of shims placed between bearing cage flange and carrier. Install pinion and bearing cage assembly using same thickness shims as original setting for first trial. Tighten only two bolts until correct settings are obtained. Reassemble differential and bevel gear unit securing approximately .008 to .015 backlash.

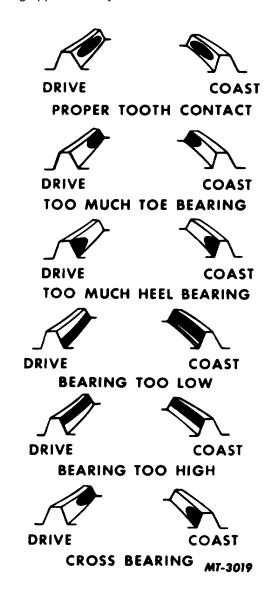


Fig. 28 Location Size and Shape of Correct Tooth Contacts.

Check for proper tooth contact by painting at least ten gear teeth with red lead or prussian blue. Turn gear by hand a few revolutions in both directions to secure tooth contact impressions. This should approximate contact as shown in first illustration of Fig. 28. Obtain proper tooth contact on drive side of teeth and ordinarily coast side will be satisfactory. If contact impression is not correct, compare with illustrations of Fig. 28 and make gear and pinion adjustments as required. NOTE: Gear movements effect lengthwise contact (bearing along the tooth) and pinion movements effect profile contact (bearing up and down on the tooth). Check "Specifications" for bearing preload.

After carrier is assembled in chassis, make final check. Jack up one wheel and paint gear teeth all around. Place axle in HIGH ratio and apply light brake load with engine for a few revolutions with transmission in low and reverse gear. Check tooth contact. The lengthwise bearing can be expected to -lengthen a trifle, particularly towards the heel.

PLANETARY DOUBLE REDUCTION

DESCRIPTION

The planetary double reduction axles are very similar in mechanical design to the two-speed axles. The planetary double reduction axle uses no shift mechanism since the reduction is introduced by locking the differential assembly in low axle ratio. This makes the axle a one-speed unit with the first reduction entering between the bevel drive gear and pinion. The second or double reduction is introduced between the idler pinion gears and axle shafts.

MAINTENANCE

Driver operation of the planetary double reduction axle is the same as that of a conventional single reduction.

Due to the similarity of the double reduction and twospeed axles, the DISASSEMBLY, CLEANING, INSPECTION and REPAIR, REASSEMBLY and LUBRICATION instructions previously mentioned may be used. Likewise, the bevel gear and pinion tooth contact adjustments may be taken from the foregoing.

LUBRICATION

Fill the differential carrier through the filler hole until oil is level with hole. For lubrication intervals refer to Operator's Manual. For types of lubricants recommended, refer to LUBRICATION Section CTS-2412.

TROUBLE SHOOTING

PROBLEM	PROBABLE CAUSE
CONSTANT NOISE	 Lubricant not to specified level. Incorrect kind and weight of lubricant. Wheel bearings out of adjustment or defective. Drive gear and pinion not in adjustment for correct tooth contact. Teeth of drive gear and pinion chipped or worn. Too much or too little pinion to gear backlash. Loose or worn pinion bearings. Loose or worn side bearings.
INTERMITTENT NOISE	 Ring gear does not run true. (a) Uneven pressures on drive gear rivets (or bolts on light duty axles). (b) Warped drive gear. Loose or broken differential bearings.
NOISY ON TURNS ONLY	 Differential pinion gears tight on cross or pinion shaft. Side gears tight in differential case. Differential pinion or side gears defective. Thrust washers worn or damaged. Excessive backlash between side gears and pinions.



PROBLEM	PROBABLE CAUSE
LUBRICANT LEAKS	 Loss through axle shafts. (a)Lubricant above specified level. (b) Incorrect kind and weight of lubricant. (c) Restricted axle housing breather valve. (d) Worn or incorrectly installed axle shaft oil seal. Loss at pinion shaft. (a) Lubricant above specified level. (b) Incorrect kind and weight of Lubricant. (c) Restricted axle housing breather valve. (d) Pinion oil seal worn or incorrectly installed. (e) Lubricant return passage in differential carrier housing restricted. (f) Universal joint companion flange loose on pinion shaft.
REAR WHEELS DO NOT DRIVE (PROPELLER SHAFT ROTAT- ING)	 Broken axle shaft. (a) Loose wheel bearings. (b)Axle shaft too short. (c) Loose flange studs or nuts. (d) Bent housing. Drive gear teeth stripped. Side gear or differential pinion broken. Differential pinion shaft or cross broken. Shift unit binding in neutral (two-speed axles only).

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AXLE REAR

I.H. MODEL	I.H. CODE
RA-15	14015
RA-20 *	14020
RA-25 *	14025
RA-29	14029
RA-30 *	14030
RA-39	14039

^{*} These axles are equipped with NoSPIN differentials; for servicing procedures, refer to Chapter II.

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CHAPTER I

REAR AXLE (SINGLE REDUCTION)

CHAPTER II

LOCKING DIFFERENTIAL



AXLE REAR

CHAPTER I

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DESCRIPTION

The various axles contained in this section are full floating, single reduction units. Fig. 1 illustrates the single reduction differential assembly.

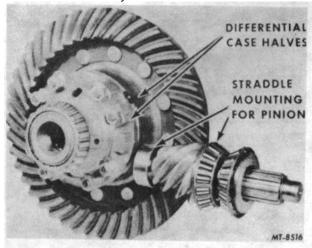


Fig. 1 Differential Assembly

The construction of rear axles may vary as to design, but the fundamental components of the axles perform similarly regardless of the type. The basic parts of the axle with which the serviceman will be concerned are the drive gears, the differential assembly, the axle shafts, and axle housing.

MAINTENANCE

Lubrication

The most important item of axle maintenance about which the truck operator must be concerned is lubrication. For this reason factory recommendations on lubrication intervals, methods of filling, lubricant levels, draining and type of lubricant must be followed to assure long life and satisfactory performance. Inspect the axle frequently for lubricant leakage, especially around housing covers, pinion oil seal retainer and axle shaft flanges. When necessary, change gaskets or seals and keep nuts or bolts tight. See "Lubrication" section in the Operator's Manual provided with each truck.

Axle Housing Breather Valve

To prevent a pressure build-up in the axle housing when the axle becomes warm after a short period of operation, a breather valve, Fig. 2, is provided in rear axles. Without this valve the resulting pressure could force the axle lubricant past the rear wheel oil seals and

damage the brake linings. The valve is so constructed that warm air may pass out of the axle to relieve built-up pressure, yet dirt and moisture are prevented from entering.

The breather valve should be kept open and clean. When the truck is operated off highway on unimproved roads or in ice and snow, dirt may sometimes be forced under the valve cap and cause the valve to become ineffective. Remove valve occasionally and clean thoroughly in a cleaning solution.

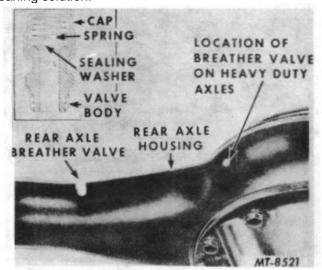


Fig. 2 Location of Breather Valve in Axle Housing

Alignment

The rear axle should also be checked at regular intervals to determine if there is any misalignment of the axle with frame or drive line. Evidence of misalignment may sometimes be noted at the U-bolts. To check for axle misalignment, lay a straightedge across and at right angles to the truck frame. The straightedge should be longer than the axle tread and clamped to the frame a short distance ahead of the rear axle. Measure the distance between the straightedge and identical points at each end of the axle assembly. When distances are not equal, misalignment is indicated, and rear springs and U-bolts must be checked for correct assembly.

Drive Gears

These IH rear axles have the hypoid type of drive as illustrated in Fig. 3.

Because of the offset type of construction,

hypoid rear axles actually have a greater torque capacity than do the spiral bevel type. This is possible because the hypoid pinion is larger in diameter and has gear teeth that are larger than those of the spiral bevel pinion having the same number of teeth and same diameter ring gear. Hypoid pinions also have larger tooth areas and more teeth in longer contact with the ring gear. These design characteristics contribute to greater strength and quieter final drive operation. However, because of this greater tooth contact, more attention is required when securing a correct pinion setting at time of overhaul or when replacing differential bearings. Therefore, every effort must be made to be sure the final setting results in the best possible tooth contact.

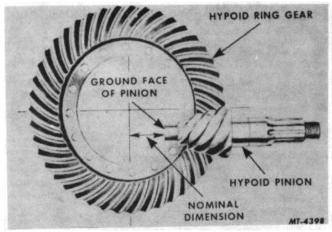


Fig. 3 Hypoid Type Drive

Axle Shafts

Many axle failures can be attributed to the axle shafts; therefore, it is most important that shafts be installed correctly, be of correct size and length for splines to engage fully, have wheel bearings adjusted properly, and be kept free from -runout or bends.

Fig. 4 illustrates the axle shaft and bearing arrangement on a full-floating rear axle.

Axle Housing

In most cases the axle housing used for IH trucks is of one-piece construction with opening in center for mounting the differential and carrier. The outer ends of the axle housing are welded in place to provide mounting for the brake backing plates. A bent axle housing can be the cause of early axle failure, and whenever an axle is rebuilt, this condition should always be checked before going ahead with the assembly. Fig. 5 gives a guick way of checking for a bent housing.

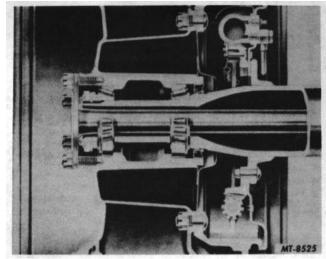


Fig. 4 Cross Section of Full-Floating Rear Axle

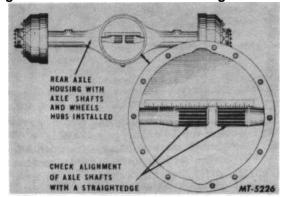


Fig. 5 Method of Checking For Bent Axle Housing

REMOVAL PROCEDURES

Axle Assembly

Whether the complete axle assembly will have to be removed from the truck for overhaul is determined by the extent of the repairs required. For most axle repairs complete removal of the axle will not be necessary; but in the event that it is, removal procedure will be similar to the following:

- 1. Jack up truck until load is removed from springs and place blocks under frame to safety secure truck weight off of rear wheels.
- 2. Drain differential housing.
- 3. Disconnect brake lines and parking brake cables (where used).

- Disconnect propeller shaft at rear axle companion flange.
- 5. Support differential on portable floor jack and take off U-bolts.
- 6. Roll out axle from under truck.

Axle Shaft

The axle shafts can be removed without taking off the wheels. To remove the shafts, first remove the axle shaft nuts from the studs in the wheel hub. Next install puller screws in the two tapped holes provided in the axle shaft flange. As puller screws are turned in, flange of shaft will be forced away from wheel hub and out from axle housing.

Another type of axle shaft removal procedure is required on full-floating axles where the tapered dowel is used in addition to the studs and nuts for securing axle shaft flange to wheel hub. This procedure will be similar to the following:

- 1. Remove flange nuts from studs of wheel hub.
- 2. Using a heavy hammer, strike sharply on the center of the flange of the axle shaft, Fig. 6, This will unseat and loosen the tapered dowels in each stud hole.

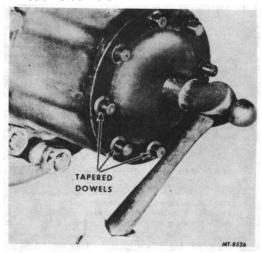


Fig. 6 Loosening Dowels in Axle Shaft

3. Remove the tapered dowels, Fig. 7. NOTE: When dowels are installed, there must be a slight clearance between the lockwasher and axle shaft driving flange. See inset, Fig. 7.

Lack of clearance at this point will cause excessive wear on studs, dowels or holes.

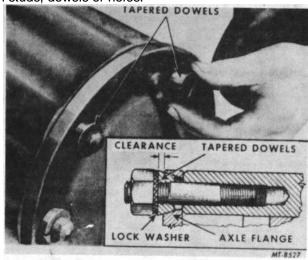


Fig. 7 Details of Taper Dowels

4. After all dowels have been removed, push the axle shaft flange back into position against the wheel hub and again strike a sharp blow in the center of the flange as shown in Fig. 6. This will cause the axle shaft to spring away from the wheel hub and allow removal of the axle shaft without resorting to the use of a pry bar or screwdriver. Any prying between axle shaft flange and wheel hub may damage the seal assembly or machined surfaces of the wheel hub or axle shaft flange.

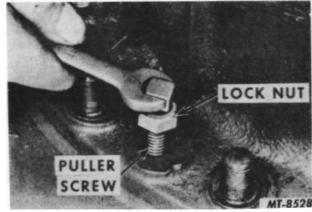


Fig. 8 Puller Screw Installation (Locknut is used if puller screw is to be kept with axle at all times.)

Differential

To remove the differential on some axles, it may be necessary to use the two extra tapped holes found in the differential housing. These are for installing puller screws, Fig. 8. To force carrier from housing, in some



AXLE REAR

instances it may be necessary to break carrier loose from axle housing by striking the carrier with a heavy soft hammer (lead, plastic, rubber or leather). Be sure that the differential is securely supported on a portable floor lift before it is separated from the housing.

DISASSEMBLY

Mount differential assembly in a suitable holding fixture.

Remove Differential and Drive Gear Assembly

1. Remove cotter pins from bearing adjuster locks and remove locks from bearing caps, Fig. 9.

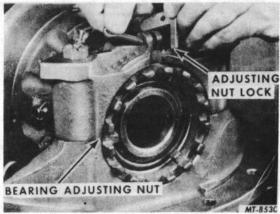


Fig. 9 Adjuster Lock Removal

2. Match mark one differential bearing cap and leg of carrier with punch or chisel, Fig. 10, to identify each for correct reassembly.

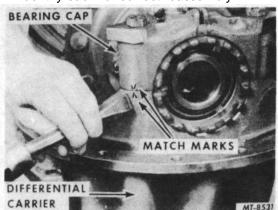


Fig. 10 Marking Bearing Cap for Identity

- Remove bearing cap stud nuts or cap screws and take off the bearing caps and adjusting nuts.
- 4. Tip differential away from pinion and lift assembly out of the differential housing, Fig. 11.

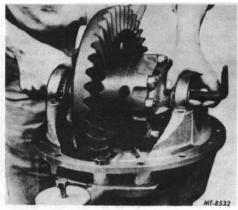


Fig. 11 Lifting out Differential and Gear Assembly

Disassembly Differential Case and Gear Assembly

 Match mark differential case halves, Fig. 12, with a punch for correct alignment on reassembling.

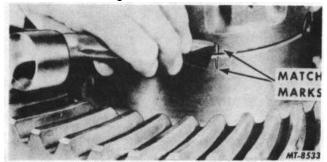


Fig. 12 Marking Differential Case Halves

2. Cut lock wire and remove capscrews or stud nuts to separate case halves, Fig. 13.

NOTE

Some differential assemblies use self-locking capscrews and nuts.

- 3. Remove spider, pinions, side gears and thrust washers, Fig. 14.
- 4. To remove drive gear rivets, carefully center punch each rivet head. Next use a drill .8 mm (1/32") smaller than body of the rivet and drill through rivet head, Fig. 15. Use a

punch to press out remaining portion of the rivet.

NOTE

Never use chisel to cut off rivet heads or damage to differential case might result.



Fig. 13 Separating Differential Case Halves

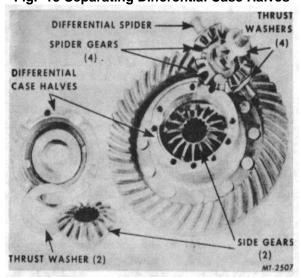


Fig. 14 Component Parts of Differential Case

5. When reinstalling ring gear, it is suggested that Riveting Fixture SE-2222 be used. This special tool is designed for use with either hydraulic or mechanical press equipment. Rivet pressures for ring gear installation should be in accordance with those given in the following chart.

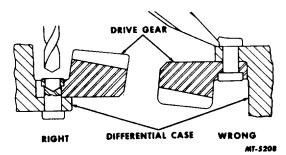


Fig. 15 Drive Gear Rivet Removal

Rivet S	Size	Pressure Per Rivet				
Inch	mm	U.S. Tons/Metric Tons				
7/16	11.1125	18-20	16.3-18.1			
1/2	12.7	20-25	18.1-22.7			
5/8	15.8750	45-50	40.8-45.3			

Remove Pinion and Cage from Differential Housing

There are two methods for removing the pinion and cage assembly and the method to be used will depend on whether puller screw holes have been provided in the pinion cage flange or not. When no puller screw holes are provided, removal is as follows:

- 1. Remove pinion cage capscrews which hold the cage to the differential carrier.
- 2. Remove pinion and cage assembly from the differential carrier, Fig. 16.

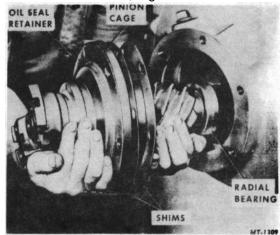


Fig. 16 Removing Pinion and Cage Assembly

- 3. Retain shim pack as an aid to adjustment on reassembly. Do not damage shims.
- 4. If difficulty is encountered in lifting the cage from the carrier, place a brass drift on the inner end of pinion and tap pinion and cage out of differential housing. NOTE: Do not allow pinion and cage assembly to fall or damage may result.

When tapped holes for puller screws are provided, removal of the pinion and cage is as follow s:

- 1. Hold the companion flange or yoke and remove pinion shaft nut and washer.
- 2. Remove flange with a suitable puller.
- 3. Remove pinion cage stud nuts or capscrews.
- 4. Remove bearing cover and oil seal assembly.
- 5. Insert puller screws in the cage flange and remove pinion and cage assembly.

NOTE

Using a drift to drive on inner end of pinion of this type axle will damage the bearing lock ring groove.

6. Retain shim pack as an aid to adjustment on reassembly.

Disassemble Pinion and Cage Assembly

1. If the companion flange or yoke has not previously been removed from pinion, mount the pinion and cage assembly in a vise. Remove the cotter pin and take off pinion and nut as shown in Fig. 17.

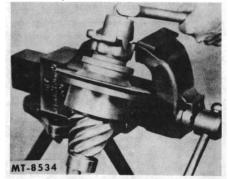


Fig. 17 Pinion and Cage Disassembly

2. Tap or drive the pinion assembly from flange and out of cage using a soft hammer.

- 3. Remove outer bearing from cage.
- 4. Remove spacer or spacer combination from pinion shaft, Fig. 18.
- 5. If it is necessary to remove the rear thrust bearing on the radial bearing, Fig. 18, remove these bearings with a suitable puller

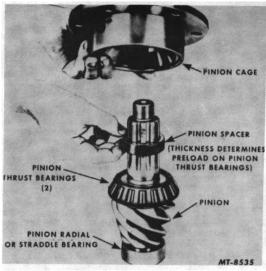


Fig. 18 Removing Pinion Bearing Spacer

 Remove cork seal from pinion cage, Fig. 19. (This seal should be replaced at every disassembly.) If the pinion cage assembly is the type which is removed from the carrier by means of puller screws, remove the oil seal from bearing cover.

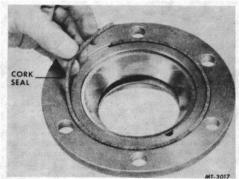


Fig. 19 Removing Pinion Cage Seal

CLEANING

Remove all dirt, old lubricant, and gasket material from components of the rear axle. Immerse in cleaning solvent and use a stiff brush if necessary. Bearings should be cleaned separately in clean solvent and special efforts taken to protect their finely machined surfaces. If compressed air is used for drying, do not spin bearings while drying.

INSPECTION

Examine all <u>bearings</u> for roughness, damage or wear by rotating each bearing slowly in hand. If in doubt as to bearing condition, replace. Ring gear, drive pinion, differential pinions and any other gears should be checked for damaged teeth, worn spots, or distortion. Inspect differential case assembly for cracks, damage or distortion. Make sure splined ends of axle shafts are neither twisted nor cracked. Shim packs should be of uniform thickness. Discard thrust washers and obtain new, even when only slight wear is indicated. Always use new gaskets.

The assembly of the differential carrier is accomplished in the reverse order of the disassembly. There are, however, various adjustments which must be secured as the assembly progresses. In addition to the adjustments there are also a few precautions to be observed. Among these are the following:

- 1. Prelubricate the pinion thrust bearings when reassembling the pinion cage.
- 2. If the ring gear was removed from the differential case half, be sure correct rivet pressures are used in reinstalling gear to case.
- 3. Prelubricate all parts of the differential assembly before bolting case halves together.
- 4. When installing differential bearing caps, make sure they are correctly aligned and that the bearing cups fit properly. If the bearing caps do not seat easily, the adjusting nuts may be cross threaded. Forcing caps into place will cause irreparable damage to the differential carrier or bearing caps.
- 5. Observe torque settings from specifications when tightening any parts.

When making axle repairs such as bearing or drive gear replacement, or when simply making an adjustment, it is most important that the ring gear and pinion be positioned correctly to obtain proper tooth contact. Once the adjustment is obtained, quiet and durable performance from the rear axle is assured.

Fundamentally, the correct tooth contact is obtained by moving the pinion toward or away from the ring gear as necessary, or by moving the ring gear toward or away from the pinion. The actual procedure has been reduced to five principal steps. Each step is vitally important to axle life and satisfactory performance, and for that reason, each step is covered more fully in succeeding paragraphs. The five steps and the order in which they should be performed are as follows:

- 1. **Preload Pinion Bearings** in pinion cage. This is determined by the thickness of spacer between the two pinion thrust bearings, Fig. 18.
- 2. **Establish pinion nominal dimension**, Fig. 1. Use the SE- 1065 Pinion Setting Gauge and add or remove shims to obtain this dimension.
- Set gear lash between ring gear and pinion.
 Do this by moving the ring gear to or from the pinion by means of bearing adjusting nuts, Fig. 9.
- 4. **Preload differential bearings.** This is accomplished by tightening bearing adjusting nuts, Fig. 9.
- 5. Check gear tooth contact. Use the paint impression method for this.

PRELOAD PINION BEARINGS

Before the pinion and drive gear can be adjusted for correct tooth contact, the pinion bearing preload must be set. Preloading the pinion bearings is accomplished by selecting the correct size spacer, Fig. 18, located between the two pinion thrust bearings, and tightening pinion end nut to the specified torque. Temporarily bolt up the pinion, cage and flange assembly, less oil seal and retainer, and clamp the assembly in a vise so as to hold the companion flange, Fig. 17. Pinion end nut should then be drawn tight to the torque shown in specifications. The applying of correct torque to the various pinion end nuts, etc. usually calls for torque limits beyond the capacity of the ordinary torque wrench. Where this is the case, the chart listed below may be used as a guide for obtaining the torque required. Fig. 20 illustrates the length of the wrench handle (A) and the effort that must be applied at (B) when tightening to secure the necessary torque.

The cage should be rotated while tightening the pinion end nut in order to seat and align the bearings. The rotation of the pinion bearings is important; otherwise, a false condition of bearing load could exist. The bearing rollers

must be seated against the face of the bearing cone as shown in Fig. 21. After the pinion bearing load is established, good practice would be to check the ends of the bearing rollere to see whether they are in contact with the face of the bearing cone. Use a feeler gauge ribbon. There must be no clearance at the ends of the rollers.

Torque		Wrench	Effort on Wrench
			Approx.)
Ft Lbs.	N-m	Α	В
200	270	1 foot 30 m	200 lbs. 90kg
		2 feet 81 m	100 IBS. 45kg
250	340	1-1/2 feet 46 m	170 IBS. 77kg
		2 feet 61 m	125 IBS. 57kg
300	410	1-1/2 feet 46m	200 lbs. 90kg
		2 feet 61 m	160 lbs. 68kg
		3 feet 92 m	100 IBS, 45kg
350	475	2 feet 81 m	175 lbs. 80kg
		2-1/2 feet 76 m	140 IBS. 64kg
		3 feet 92 m	118 lbs. 54kg
		3-1/2 feet 1.07m	100 lbs. 45kg
460	605	2-1/2 feet 76m	180 lbs. 82kg
		3 feet 92 m	150 IBS. 88kg
		3-1/2 feet 1.07 m	129 lbs. 58kg
		4 feet 1.21 m	113 lbs. 61kg
500	640	3 feet 92 m	167 lbs. 76kg
		3- 1/2 feet 1.07m	144 lbs. 65kg
		4 feet 1.21 m	125 lbs. 57kg
		4-1/2 feet 1.37m	112 lbs. 50kg
550	675	3-12feet1.07 m	158 lbs. 71kg
		4 feet 1.21 m	137 IBS. 62kg
		4-1/2 feet 1.37m	123 lbs. 56kg
		5 feet 1.53 m	110 lbs. 49kg
B60	820	4 feet 1.21 m	150 lbs. 68kg
		4-1/2 ft 37 m	134 lbs. 61kg
		5 feet 1.53 m	120 lbs. 55kg
		5-½ f 1.88 m	110 lbs. 49kg

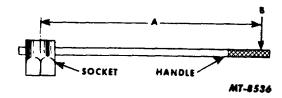


Fig. 20 Wrench Torque Chart and Diagram

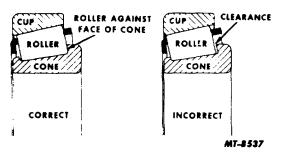


Fig. 21 Roller Bearing When Correct Adjustment is Obtained

The rollers of the bearing must bear against the face of the cone as shown. Rotation of the bearing during adjustment is necessary to obtain this condition.)

To measure the preload, wrap a strong cord or soft wire about the pinion cage and attach end to the spring scale as in Fig. 22. Read scale only while pinion cage is turning. Compare this scale reading or pinion bearing preload with the figure found in the rear axle specifications.



Fig. 22 Measuring Pinion Bearing Preload

When preload reading does not agree with the specifications, the bearing load may be increased by installing a thinner spacer or decreased by using a thicker spacer. Determine spacer thickness with a micrometer, Fig. 23, and make a new selection accordingly. Closer adjustment can be made by working spacer to the desired thickness using emery cloth on a flat surface. Wash spacer clean of emery cuttings before installing on pinion.



Fig. 23 Measuring Spacer Thickness

If the pinion radial or straddle bearing was removed from the end of the pinion during the disassembly, the bearing should be reinstalled at this time. Press the radial bearing onto the end of pinion and stake with a blunt point punch, as shown in Fig. 24, in six equidistant places. It is suggested that for locating punch positions for staking, the end of the pinion be painted with Prussian Blue and a circle be scribed on end of pinion about 3.175 mm (1/8") in from the pinion circumference. When staking the bearing, be careful to make the depth of the indentations or stake points uniform. Otherwise, the bearing might be damaged. Deep punch or stake marks are not necessary. Apply the staking operation at opposite sides of the pinion end until all stake points are obtained. NOTE: Smaller pinions having the straddle bearings are staked in four places only. Where special staking tools are available, they can be used; otherwise, the use of a blunt or round-nose punch is satisfactory.

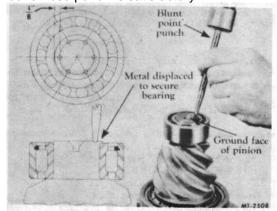


Fig. 24 Staking Pinion Straddle Bearing

ESTABLISH NOMINAL DIMENSION

The pinion setting gauge (SE-1065) is a precision gauge designed for locating the pinion as it meshes with the ring gear to the correct nominal dimension in the shortest possible time.

A step plate and bracket, which are a part of the set, are used whenever hypoid type gears are to be adjusted. Essentially the pinion setting gauge is a direct reading depth micrometer mounted in an arbor. The span of the micrometer is 50-75 mm (2" to 3"), but extensions are provided with the kit to increase the reach. Two sleeves which hold adapter discs slip over the ends of the arbor. Adapter discs are held on the sleeves by knurled nuts. When installed in the differential case, the pinion setting gauge enables the mechanic to measure the distance from the face

or finished end of the installed pinion to the centerline of the ring gear or cross shaft. The measurement which the mechanic reads should agree with the nominal dimension, which can be found in the axle specifications, or which in some

instances is stamped or etched on the pinion itself. Usually there is a plus or minus correction also stamped on the pinion, Fig. 25, and this also must be figured in with the nominal dimension.



Fig. 25 Location of Pinion Setting Markings

The procedure for establishing the correct nominal dimension by means of the pinion setting gauge is as follows:

- Install pinion, cage and bearing assembly in the differential carrier.
- Attach the step plate clamp assembly to the carrier flange and locate step plate clamp screw over the center of the pinion as shown in Fig. 26.

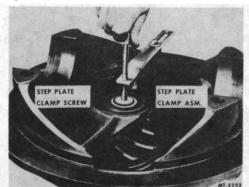


Fig. 26 Locating Step Plate Clamp

3. Install step plate under clamp screw and tighten screw to hold the step plate securely in position as shown in Fig. 27. The step plate is necessary in order to project the face of the pinion to where it can be measured by the gauge which is on the centerline of the ring gear.

NOTE: Be sure lugs on step plate straddle the bearing staking indentations on end of pinion.

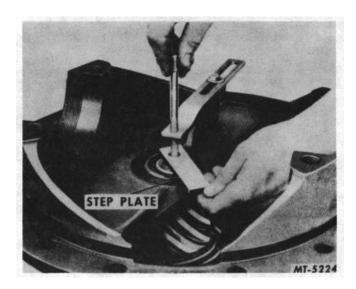


Fig. 27 Installing Step Plate

4. Mount assembled SE-1065 gauge in bearing bores of carrier as shown in Fig. 28. Make certain that bearing bores are clean and free of nicks and burrs. Adjust micrometer so it is directly over end at a 90 degree angle to the step plate. Take micrometer reading. Run the micrometer thimble down to measure the distance between the center of the ring gear and the step plate, or in the event of a spiral bevel type drive, measure the distance to the face of the pinion itself. Make a note of this measurement.

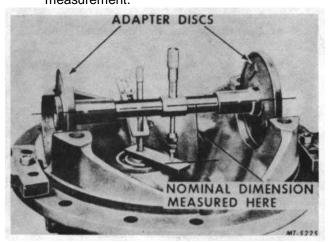


Fig. 28 Assembled Gauge in Position

Locate pinion nominal dimension (cone center specification) for the axle to be adjusted. On some axles this dimension may be shown on the pinion. Where this is not the case, it will be

- listed in the rear axle specifications. Write down this specification.
- 6. Also locate on pinion the etched marking which indicates a variation from zero cone center. If a minus figure, subtract from specified cone center, and if a plus figure, add to specified cone center. NOTE: The plus or minus variation marked on the pinion will not necessarily show small variations such as -5, +3, or +7. On some pinions the variation marking will range to higher figures such as +56, +59 or perhaps higher.

Results of calculation give the corrected cone center or pinion nominal dimension to which the pinion must be set.

- 7. Comparison of corrected cone center (6) with the actual or measured cone center (4) indicates amount of change necessary for pinion position.
- 8. Remove gauge and install ring gear and differential carrier in the differential housing.
- Adjust backlash according to marking on ring gear.

To further clarify the use of the SE1065 pinion setting gauge, the dimensions from the same type of axle as used in the aforementioned disassembly will be used as an example of the calculation involved.

Data:

Rear Axle Model- RA20 Rear Axle Code - 14020 SE- 1065-9 Adapter Disc - N (2) Pinion Nominal Dimension - 2. 9839 Pinion Marked - (-5)

	Pinion warked - (-5)	
Pro	cedure	
(a)	Take micrometer reading with	
	gauge	2.6239
	Add .400 for thickness of step	
	plate	+.4000
	Equals - Measured Nominal	
	Dimension	3.0239
(b)	Record Pinion Nominal Dimen-	
	sion from Specifications or	
	stamped on pinion	2.9839
	Subtract the Pinion Correction	
	(-5)	<u>0050</u>
	Equals - Corrected Nominal	
	Dimension or distance pinion	
	should measure from center	
, ,	of ring gear	2.9789
(C)	Subtract correct Nominal Dimen-	
	sion (b) from actual measure-	
	ment (a)	
	Equals - Amount pinion must be	0.0450
	moved in	0.0450

SET GEAR LASH

A special effort should be made to set the backlash between pinion and ring gear to the same amount as was originally built into them, 0.1-0.15 rnm (.004 to .006) on small gears or 0.15-0.2 mm (.006 to .012) on larger gears. Generally the amount of backlash is stamped or etched on the ring gear, Fig. 25. When installing new gears, backlash is measured with a dial indicator mounted on differential housing, as in Fig. 29. To adjust the backlash, move the ring gear toward or away from the pinion by means of the differential bearing adjusting nuts.

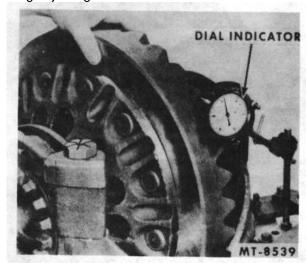


Fig. 29 Using Dial Indicator to Set Correct Backlash

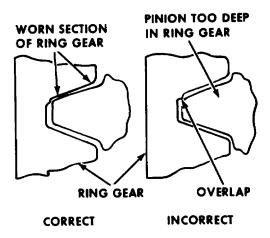


Fig. 30 Right and Wrong Adjustment of Ring Gear

and Pinion When Worn Gears Are Reinstalled

MT-8540

When original gear and pinion sets are being reinstalled, the wear pattern of the gear teeth must be considered in the backlash adjustment. Gears that have been in service for long periods form running contacts which should not be greatly changed. If, in checking backlash, the amount measured is in excess of the amount shown on the ring gear, the lash may be reduced only in the amount that will avoid overlap of the worn tooth section, Fig. 30. A slight overlap at the worn section will cause gear operation to be noisy and rough.

PRMLOAD DIFFERENTIAL BEARINGS

After the ring gear has been adjusted for position, another adjustment, the differential bearing preload, is also accomplished by these same differential bearing adjusting nuts. To set the preload, mount dial indicator at side of ring gear, Fig. 31, and continue the adjustment as follows:

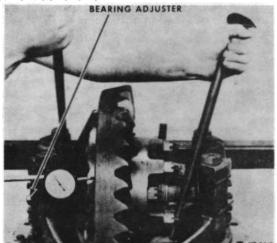


Fig. 31 Adjusting Differential Bearing Preload

- 1. With the side bearing cap capscrews loosened to permit bearing movement, loosen adjusting nuts only enough to notice end play on indicators.
- 2. Tighten adjusting nuts only enough to obtain . 000" end play reading on indicator.

NOTE: While gear is held in ,000" end play and before loading bearings, check gear for runout by revolving ring gear. if runout exceeds 0.2 mm (.008"), remove differential and check for cause.

 Tighten both adjusting nuts from . 000" end play to preload the differential bearings. Tightening nuts one notch each usually gives bearings the correct preload.

- 4. Tighten bearing cap capscrews or stud nuts to specified torque.
- Recheck gear lash to make certain that the lash setting has not been changed during the preloading operation.
- 6. Install adjusting nut locks.

CHECK GEAR TOOTH CONTACT

The following instructions cover the paint impression method of checking tooth contact and are especially for the benefit of those not equipped with an SE1065 pinion setting gauge. The instructions may also be used as a check on the adjustment obtained with the gauge. By this method the mechanic temporarily bolts up the pinion and cage to the differential carrier and coats the drive gear teeth with oiled red lead, as in Fig. 32. When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape, and location of the contacts. If these contacts are not acceptable, shims must be added to or taken from the shim pack located between the pinion cage flange and differential carrier housing. In this manner, a satisfactory adjustment is accomplished. Bear in mind that the accuracy of the adjustment obtained with the paint impression method is dependent upon the skill and experience of the mechanic. It may be necessary to make several trials at the right selection of shims to obtain the correct tooth contact.



Fig. 32 Painting Gear Teeth for Obtaining Tooth Contact Impressions

Sharper tooth contact impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the ring gear teeth. Coast side contact should be automatically correct when drive side contact is correct. As a rule, coating about twelve teeth is sufficient for checking purposes.

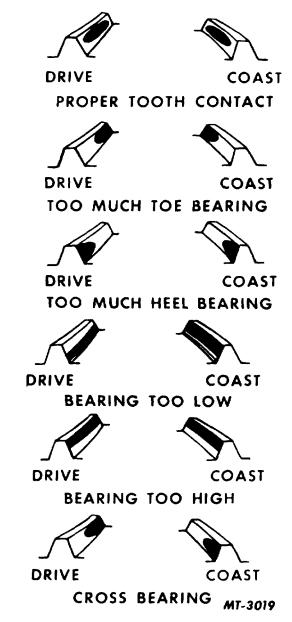


Fig. 33 Location, Size and Shape of Correct Tooth Contacts

With adjustments properly made, a correct tooth contact similar to that shown in Fig. 33 will be secured. The area of contact starts near the toe of the gear and extends about 62-1/2 percent of the tooth length. This adjustment results in a quiet running gear and pinion

set, which, because the load is distributed over the teeth within the proper area, will deliver all the long service built into it.

When checking paint impressions on gear teeth of an axle under heavy load, the impressions usually spread out somewhat longer than the patterns obtained from a bench test. This can be considered as normal. Ring gears, when mounted, should show a bearing toward the toe or small end of the tooth, but never at the heel or large end. The reason is that it is practically impossible to make gears and gear mounting so rigid that no deflection will occur when full torque is applied. This deflection causes the bearing to approach the heel of the tooth. And when gears are adjusted so that the bearing is toward the heel of the tooth, it results in a concentration of load on the top corner of the heel, and breakage will follow.

Loctite Plastic Gasket Material

On those axles which utilize Loctite Plastic Gasket material in place of the more common gasket, the plastic gasket material should be applied as follows:

- 1. Thoroughly clean the mating surface to remove foreign matter.
- 2. Spread a thin, even coating on one surface. On large or rough surface apply to both surfaces.
- 3. Assemble parts. Bolt mating parts together.
- 4. Loctite Plastic Gasket will dry in four to six hours under normal temperatures. If it is not possible to wait the four to six hours, apply Locquic Primer Grade T, which will reduce drying time required to approximately one hour. This primer must be bought locally.

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TROUBLE SHOOTING

Quite often serious trouble in a rear axle can be "headed off" and prevented if sufficient attention is given to the various causes of trouble and the proper remedy is applied. The following list gives most of the common kinds of axle trouble and suggests a possible cause to be corrected.

It should be noted that noises from other units of the truck, such as propeller shafts, universal joints, tires, and even transmissions, are often incorrectly diagnosed as rear axle noise. This possibility should not be disregarded when trouble shooting.

PROBLEM	CAUSE
Constant Noise	 Lubricant not to specified level. Incorrect kind and weight of lubricant. Wheel bearings out of adjustment or defective. Drive gear and pinion not in adjustment for correct tooth contact. Teeth of drive gear and pinion chipped or worn. Too much or too little pinion-to-gear backlash. Loose or worn pinion bearings. Loose or worn side bearings.
Intermittent Noise	 Ring gear does not run true. a. Uneven pressures on drive gear rivets. b. Warped drive gear. Loose or broken differential bearings.
Noisy on Turns Only	 Differential pinion gears tight on cross or pinion shaft. Side gears tight in differential case. Differential pinion or side gears defective. Thrust washers worn or damaged. Excessive backlash between side gears and pinions.
Lubricant Leaks	 Loss through axle shafts. a. Lubricant above specified level. b. Incorrect kind and weight of lubricant. c. Restricted axle housing breather valve. d. Worn or incorrectly installed axle shaft oil seal, Loss at pinion shaft. a. Lubricant above specified level. b. Incorrect kind and weight of lubricant. c. Restricted axle housing breather valve. d. Pinion oil seal worn or incorrectly installed. e. Lubricant return passage in differential carrier housing restricted. f. Universal joint companion flange loose on pinion shaft.
Rear Wheels Do Not Drive (Propeller Shaft Rotating)	 Broken axle shaft. Loose wheel bearings. Axle shaft too short. Loose flange studs or nuts. Bent housing. Drive gear teeth stripped. Side gear or differential pinion broken, Differential pinion shaft or cross broken.



REAR AXLE SPECIFICATIONS									
I.H. MODEL	RA-15	RA-20	RA-25	RA-30	RA-29 RA-39				
I.H. CODE	14015	14020	14025	14030	14029 14039				
PINION									
Nominal Dimension (in.) (mm) SE-1065-9 Disc Cage Rotating Torque Pounds Pull (Kg) DIPPERENTIAL Regarded	2.9830 75.79 N(2) 3-8 1.4-3.6	2.9830 75.79 N(2) 3-8 1.4-3.6	3.2530 82.63 D(2) 3-8 1.4-3.6	3.2530 82.63 D (2) 3-8 1.4-3.6	3.4725 88.20 D(2) 3-8 1.4-3.6				
Bearing Preload	Ea. Side	Ea. Side	Ea. Side	Ea. Side	1 Notch Ea. Side				
HOUSING									
Lub. Capacity (Pints U.S.) (Liters)	6-1/2 3.1	6-1/2 3.1	9-1/2 4.5	18 8.4	23 11				
SERIAL NO. LOCATION	On Bolt	On Bolt	On Bolt	On Bolt	On Bolt				
	Circle of Diff.	Circle of Diff.	Circle of Diff.	Circle of Diff.	Circle of Diff.				

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REAR AXLE TORQUE CHART

IH MODEL	RA-15		RA-20		RA-25		RA-30		RA-Z9, RA	-39
	Ft. Lbs.	N-m	Ft. Lbs.	N-m						
Pinion End Nut	7/8-16		7/8-16		1-1/8-18		1-1/8-18		1-1/8-18	
	250*	340	250*	340	325*	440	325*	440	325*	440
Pinion Cage to Carrier	3/8-16		3/8-16		9/16-12		9/16-12		9/16-12	
	30-40	41-54	30-40	41-54	100-120	135-162	100-120	135-162	100-120	135-162
Carrier to Housing	1/2-20		1/2-20		7/16-20		7/16-20		1/2-20	
	80-90	108-122	80-90	108-122	50-70	68-95	50-70	68-95	80-90	108-122
Differential Case	3/8-24		3/8-24		1/2-20		1/2-20		1/2-20	
	40-50	54-68	40-5Q	54-68	80-90	108-122	80-90	108-122	80-90	108-122
Bearing Cap to Carrier	1/2-20		1/2-20		9/16-18		9/16-18		9/16-18	
	80-90	108-122	80-90	108-122	150-160	200-220	150-160	200-220	150-160	200-220
Drive Flange to Wheel Hub	1/2-20		1/2-20		5/8-11		5/8-11		5/8-11	
	80-90	108-122	80-90	108-122	150-160	200-220	150-160	200-220	150-160	200-220

^{*}Minimum pinion end nut torque with cross type (+) cotter pin holes. Continue to tighten until cotter pin can be inserted. Do not back off pinion end nut to insert cotter pin.

All bolt threads are to be coated with Loctite I.H. No. 576018-C1 before torque is applied.

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AXLE REAR

CHAPTER II

LOCKING TYPE DIFFERENTIAL

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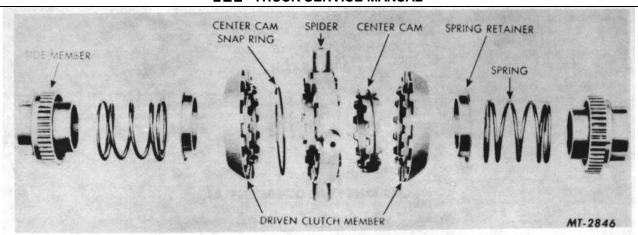


Fig. 34 Internal Spring Design Differential Locking Unit (Exploded View)

DESCRIPTION

The NoSPIN differential (Figs. 34 and 35) provides equal amounts of drive line torque to each rear driving wheel and also permits differential action for turning corners.

This differential also provides greater operating flexibility than a conventional differential, because the locking type differential overcomes wheel spinning when required to operate in mud, sand, snow and on ice or wet roads. The unit is installed in the differential case in place of the conventional gears, pinion and spider.

The action of the unit is the same for both drive and coast loads and forward and reverse' driving.

CONSTRUCTION

Two types of NoSPIN differentials have been used on IH vehicles; they are (a) Internal Spring Design, Fig. 34, and (b) External Spring Design, Fig. 35.

The difference in the two units is explained in the text; however, the di assembly will cover the internal design locking unit.

The differential locking unit consists of several parts, all assembled around the spider.

Spider and Center Cam Assembly

This assembly consists of the spider, center cam and spider snap ring. The spider has four trunnions projecting radically from a center ring on each side of which are located fixed driving clutch teeth. These teeth vary in number, depending on the size and model of The internal diameter of the spider is differential. uniform. Into it is mounted the center cam. This cam is held in position with a centrally mounted snap ring, which permit the center cam to be rotated within the spider but prevents lateral movement. The center cam is symmetric, having the same number of cam lifts on each side as there are clutch teeth on the spider. These lifts or "came" have uniform contours with rounded surfaces that provide anti-friction ramps for disengaging the driven clutch members.

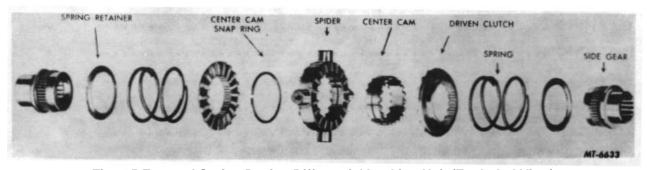


Fig. 35 External Spring Design Differential Locking Unit (Exploded View)

Driven Clutch Members

Two identical driven clutch members are located on either side of the spider and center cam assembly. Each has a set of clutch teeth to match the clutch teeth on the spider through which driving torque is transmitted. Radically inward from the driven clutch teeth on models using internal spring are cams which mesh with the cams of the center cam member. These cams have been eliminated on the models using the external spring. The internal diameter of each driven clutch member has splines which engage the external splines of the splined side members.

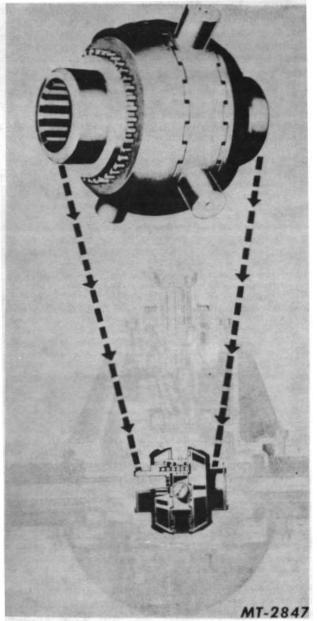


Fig. 36 Typical Installation of NoSPIN Unit (Cross Sectional View)

Spring Retainers and Springs

Models with Internal Springs

Spring retainers are inserted into the outer ends of driven clutch member. The bowl side of these retainers is mounted first through the outer side of the driven clutch members. The flanged portion of the spring retainers pass through the internal splines to rest on the mating flanges of the driven clutch members. The springs are mounted in spring retainers after assembly and thrust against their inner cupped ends.

Models with External Springs

Spring retainers fit over the side gear, passing through external splines to seat against the shoulder on the side gear. Springs fit between the driven clutch and outer flanged surface of the spring retainer.

Splined Members

These two splined side members are splined internally to receive the truck axle shafts. The inner hubs of the splined side members are inserted in the outer ends of the springs. The external splines of the splined side members engage the internal splines of driven clutch members on each side of the completed assembly.

OPERATION

Straight Forward Driving

When a vehicle is being driven in a straight forward direction, the clutch teeth on both sides of the spider assembly are fully engaged with the clutch teeth on each driven clutch member. Likewise, the fixed cams of the driven clutch members are fully meshed with the cam surfaces of the floating center cam ring mounted on the inside diameter of the spider, as described previously.

Engagement of the driving and driven clutch teeth is assured by the pressure of the two springs which force the driven clutch members inwardly against the spider and also by the positive locking action developed by the mating undercuts on the driving faces of the clutch teeth, Fig. 37.

In this condition, both clutches remain fully engaged so that the assembly operates as a solid unit and each rear wheel is driven forward at ring gear speed.

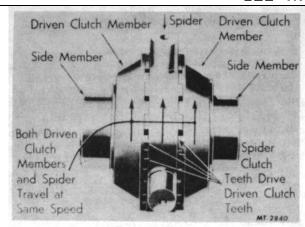


Fig. 37 Straight Forward Driving

Straight Rearward Driving

When driving a vehicle in a straight rearward direction, both driven clutch members are held in full engagement with the spider and center cam as described for straight forward driving. However, in this case, the spider rotates in the reverse direction and shifts the driving force to the opposite set of driving faces on the mating clutch teeth. Again we have the assembly operating as a unit with each wheel being forced to rotate at ring gear speed.

Right-Hand Turn - Forward Direction

When making a turn, differential action is required in order to permit the outside wheel to travel a greater distance, and faster, than the inside wheel.

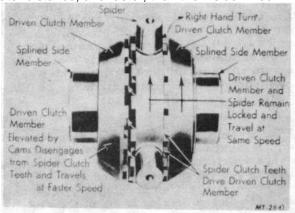


Fig. 38 Right-Hand Turn--Forward Direction

A conventional bevel gear type differential permits the outside wheel to turn faster than

ring gear speed while the inside wheel turns slower than ring gear speed. The NoSPIN differential allows either wheel to turn faster than the ring gear speed but does not permit either wheel to turn slower than the ring gear speed when power is applied.

When negotiating a right-hand turn in a forward direction, the right-hand driven clutch member remains fully engaged with the spider clutch teeth and the corresponding cams, Fig. 38.

The driving clutch teeth of the spider transmit the driving force to the driven clutch member, which in turn drives the right-hand (inside) wheel constantly at right gear speed, thus propelling the vehicle. The left-hand (outside) wheel covers a greater arc than the right-hand (inside) wheel and driven by the traction of the road, must turn faster than ring gear speed. Likewise, the left-hand driven clutch member must turn faster than the spider. In other words, it permits differences in wheel speeds or differential action. Fig. 39 illustrates how this is accomplished.

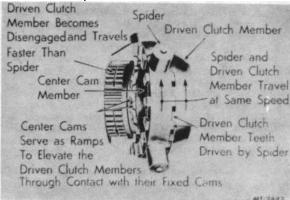


Fig. 39 Forward Right-Hand Turn (Cross Sectional View)

The right-hand row of cams on the center cam member are meshed securely with the cams on the right-hand driven clutch member. With the center cam thus locked in this position so that it cannot rotate with respect to the spider, its cams on the left-hand side serve as ramps upon which the mating cams on the left hand driven clutch member can rise, enabling that driven clutch member to disengage from the spider. The ramps on the center cam are high enough to permit the clutch teeth on the driven clutch member to clear the teeth on the spider and when the crest of the ramp is passed, the teeth of the driven clutch member are forced back by spring pressure into full engagement with the clutch teeth of the spider.

This engagement and disengagement or indexing operation continues throughout the turn with a rapidity that is in direct relation to the speed of the overrunning wheel.

As the vehicle completes the turn and is again driven in a straight forward direction, differential action no longer being required, both driven clutch members become fully engaged with the clutch teeth of the spider; then the operation, as described in "Straight Forward Driving," is resumed.

Forward Right-Hand Turn - Braking Condition

In this situation, the vehicle is moving forward, but the direction of torque of the ring gear is reversed, because the vehicle is being slowed down by braking action. This reversal of torque is produced by the action of road traction driving the wheels against the torque of the engine. In this condition, when a right-hand turn is negotiated, the left-hand (outside) wheels rotate at ring gear speed, since the left-hand driven clutch member remains fully engaged while the right-hand (inside) wheels rotate slower than ring gear speed.

The symmetrical design of the differential makes it possible to function in the manner described above, which is, in effect, directly opposite to that described as "Right-Hand Turn-Forward Direction."

It should be noted that if a turn is negotiated in such a manner that power is first applied and then braking action is encountered before the turn is completed, the differential is designed to function without interruption and will automatically take care of such reversal of torque.

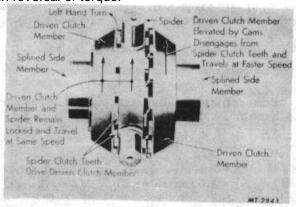


Fig. 40. Left-Hand Turn-Forward Direction Left-Hand Turn - Forward Direction

In making a left-hand turn with the vehicle driven in a forward direction, the left-hand wheel is on the inside of the turn and the power is applied to it so

that it must rotate at ring gear speed. The right-hand wheel travels through the greater arc, being on the outside of the turn. Its driven clutch member becomes disengaged from the spider clutch teeth, permitting it to be rotated by ground traction faster than the ring gear, Figs. 40 and 41.

The operation of the driven clutch member on the right side of the assembly in the foregoing instance is illustrated above.

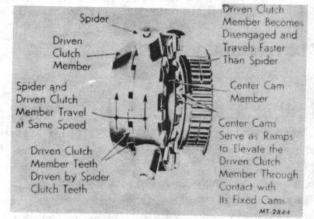


Fig. 41. Forward Left-Hand Turn (Cross Sectional View)

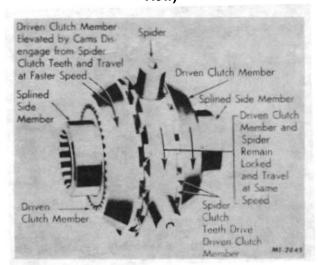


Fig. 42. Right-Hand Turn—Rearward Direction Right- and Left-Hand Turns - Rearward Direction

The operation of the NoSPIN differential when required to make turns while traveling in a rearward direction is identical to that when making turns in a forward direction. When moving rearward in a turn under power, the

inside wheel is driven at ring gear speed while the outside wheel is driven by the ground faster than ring gear speed. When the rearward turn is nearing completion and the vehicle is slowing down because of application of the brakes, the outside wheel is driven by the ground at ring gear speed, as its driven clutch member is fully engaged and acts to "brake" against the engine torque. The inside wheel is driven by the ground through the smaller arc of travel, and since its driven clutch member is disengaged, it will rotate slower than ring gear speed.

Fig. 42 shows the operation of the differential when a right-hand turn in a rearward direction is being negotiated.

DIFFERENTIAL REMOVAL

The procedure for removing the differential is the same as used for a conventional differential. IMPORTANT PRECAUTION: Before disassembling the differential case, insert a bolt through the center of the NoSPIN unit (axle shaft openings) with a flat washer on each end against the side members, Fig. 43.

Thread a nut on the bolt against the flat washer finger tight. This will prevent possible injury caused by the unit flying apart due to the spring pressure within itself during disassembly of the differential case.

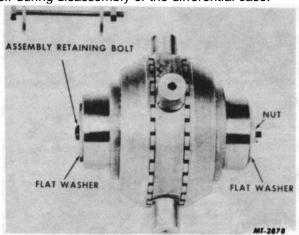


Fig. 43. Inserting Assembly Retaining Bolt DISASSEMBLY

Remove the bolts from the differential case and lift out the NoSPIN unit. Mount unit in a small press, Fig. 44.

Apply enough pressure on the head of the bolt to release the spring pressure against the nut. Remove the nut and flat washer by reaching underneath the press. Slowly release the press and allow the unit to

disassemble itself until the spring pressure is fully released.

Remove unit from press.

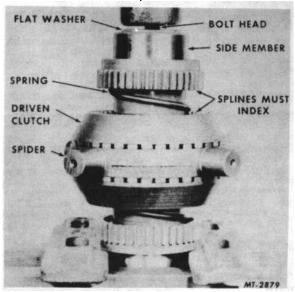


Fig. 44. Release of Spring Pressure

Remove side members, springs, spring retainers and driven clutch members. The center cam may be removed from the spider by expanding the snap ring with small screwdrivers or wedges.

NOTE:

Be careful when removing and reinstalling center cam snap ring to avoid possible injury.

CLEANING, INSPECTION AND REPAIR

Wash all parts thoroughly with a cleaning solvent. Inspect all mating surfaces and teeth for possible wear or damage. Replace all worn or damaged parts before reassembly.

REASSEMBLY

Reassembly is essentially the reverse of disassembly. Lubricate all parts with SAE-30 oil during reassembly. Place side member upright and install spring on same. Place spring retainer on spring with flange end toward side member. Install driven clutch member on spring retainer. Place spider on driven clutch member, indexing teeth of same. Install other driven clutch member, spring retainer, spring and side member on spider.

Insert a bolt through the center of the NoSPIN unit with a flat washer against side

member. Mount unit in press as shown in Fig. 44. Compress springs by pressing on head of bolt and index splines of side members with those of driven clutch members.

NOTE:

Keep entire unit aligned in press to prevent it from kicking out while springs are being compressed. Compress unit until side member splines are completely indexed and flush with driven clutch member. Install flat washer on bolt against side member and thread nut on bolt, finger tight, so that it has the appearance of Fig. 43 when removed from the press.

Remove unit from press.

Place unit in differential case and install differential case bolts.

Reassembly from this point is the same as for a conventional differential.

IMPORTANT PRECAUTION

If a truck is equipped with a NoSPIN differential, power will be transmitted to the opposite rear wheel or axle if one of the rear wheels or axles slips. Both rear wheels or both rear axles must be raised free of ground if it is necessary to operate one rear wheel with truck stationary; otherwise, the wheel or axle that is not raised will pull truck off its support.

LUBRICATION

The NoSPIN unit is lubricated with the same lube used in conventional differentials. Fill differential carrier through filler hole until oil is level with hole.

For type of Lubricant, refer to Lubrication, CTS-2412.

REAR AXLE IH SINGLE REDUCTION (CONE TYPE CARRIER)

IH MODEL	IH CODE
RA-42	14042
RA-44	14044
RA-47	14047
RA-57	14057

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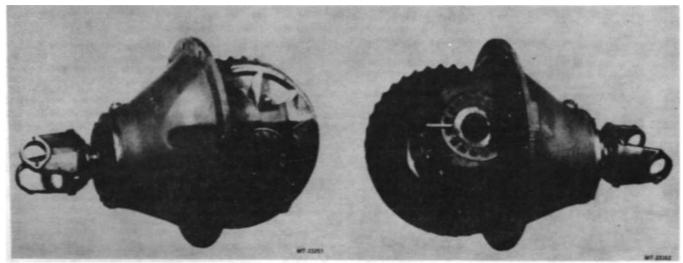


Fig. 1. Differential Carrier Assembly (Left Front)

GENERAL

This service manual covers rebuild procedures and specifications for the IH built Heavy Duty Single Reduction Rear Axle having the cone type differential carrier. These repairs are performed principally on the axle differential after

it is removed from the axle housing.

DESCRIPTION

The IH Heavy Duty Single Reduction Final Drive Unit is a full floating hypoid type assembly mounted in a one piece banjo type axle housing. The hypoid pinion is straddle mounted, having two tapered roller bearings ahead of the pinion teeth for forward and reverse thrust, and also having a third bearing behind the pinion teeth for radial load. The differential itself is of the four pinion and spider type with thrust washer used between pinions and case. Thrust washers are also used between side gears and case.

REMOVAL

The differential carrier assembly (Figs. 1 and 2) can be removed from the axle housing whether the axle is mounted under the truck or removed. The procedure for removing is as follows.

REMOVE AXLE SHAFTS FROM WHEELS AND HOUSING

- 1. Take off all nuts from studs around rear wheel hub.
- 2. To loosen shaft from hub, strike center of axle shaft flange with a 2.3 2.7 kg (5 6 lb.) hammer or sledge.

Fig. 2. Differential Carrier Assembly (Right Rear)

IMPORTANT

Do not use chisels or wedges to loosen shaft. Damage to hub or flange can result from this practice.

REMOVE PROPELLER SHAFT

Separate universal joint from differential companion flange and remove propeller shaft from rear axle.

REMOVE DIFFERENTIAL CARRIER FROM HOUSING

- 1. Remove mounting bolts from carrier to axle housing flange.
- 2. Use puller screws in carrier mounting flange to start carrier from housing.
- 3. Support weight of carrier safely on roller type floor jack or portable floor lift and roll jack and carrier out from under truck.
- 4. Mount differential carrier in rebuild stand.

DISASSEMBLY

DIFFERENTIAL AND DRIVE GEAR FROM CARRIER

- 1. Remove cotter pins from bearing adjuster locks and remove locks from bearing caps.
- 2. Match mark one differential bearing cap and leg of carrier with punch or chisel to identify each for correct reassembly.
- 3. Remove bearing cap bolts and take off the bearing caps and bearing adjusters (Fig. 3).

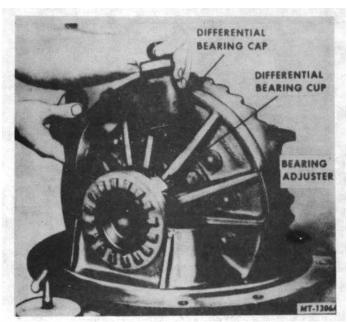


Fig. 3. Removing Differential Bearing Caps

4. Attach chain sling from overhead hoist and lift differential and drive gear assembly from the differential carrier (Fig. 4). Tilt either the carrier or differential assembly to allow drive gear to pass pinion pilot bearing. Place differential assembly on bench.

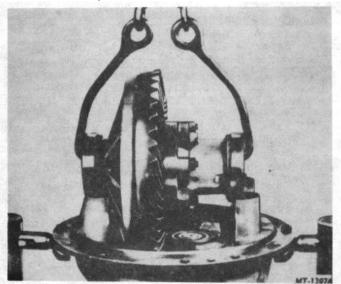


Fig. 4. Lifting Differential from Carrier DIFFERENTIAL AND DRIVE GEAR

 Match mark differential case halves with a punch or chisel to assure correct alignment on reassembly.

- 2. Remove self-locking nuts from differential case bolts and separate the case halves.
- Remove differential spider, spider gears, side gears and thrust washers from differential case halves.
- 4. If necessary to remove drive gear, carefully center punch each rivet head on drive gear side and drill through the rivet head with a drill 0.8 mm (1/32 inch) smaller than rivet body (Fig. 5). Use a punch to press out remaining portion of rivet. Never use chisel to cut off rivet heads or damage to case might result.

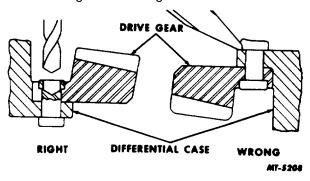


Fig. 5. Drive Gear Rivet Removal PINION AND CAGE FROM CARRIER

- 1. Take out pinion cage bolts which hold the cage to differential carrier.
- 2. Obtain a brass drift and hammer and strike against rear face of pinion shaft (Fig. 6) to start pinion cage out of carrier.



Fig. 6. Loosening Pinion and Cage from Carrier

3. Remove the pinion and cage assembly from the carrier (Fig. 7).

IMPORTANT

Because of the weight of the pinion and cage assembly, make sure that parts are secured safely while removing. Pinion and cage might be damaged if allowed to fall.

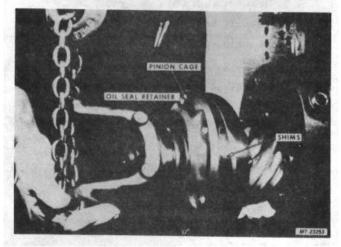


Fig. 7. Removing Pinion and Cage Assembly SEPARATE PINION FROM CAGE

 Mount pinion and cage assembly in a heavy duty vise or holding fixture and remove the pinion end nut as shown in Fig. 8. Use torque multiplier wrench (SE-1933).

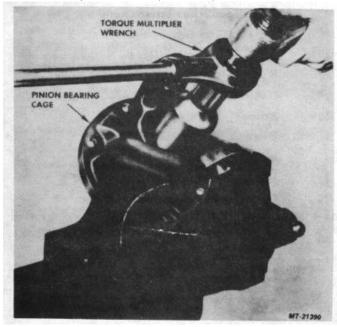


Fig. 8. Removing Pinion End Nut

- 2. Drive the pinion cage assembly from the companion flange with a soft hammer. Do not allow pinion assembly to fall.
- 3. Tap pinion from cage and forward thrust bearing (Fig. 9).
- 4. Remove the thrust bearing spacer from the pinion shaft.
- 5. If it is necessary to remove the rear thrust bearing or the pilot bearing from the pinion shaft, remove these bearings with a suitable puller.

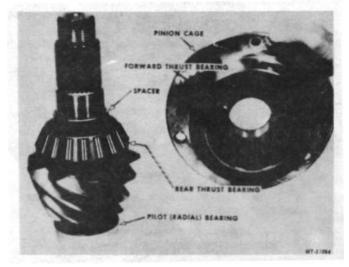


Fig. 9. Pinion Separated From Cage CLEANING, INSPECTION AND REPAIR

Remove all dirt, old lubricant, and gasket material from components of the rear axle. Immerse in cleaning solvent and use a stiff brush if necessary. Bearings should be cleaned separately in clean solvent and special efforts taken to protect their finely machined surfaces. If compressed air is used for drying do not spin bearings while drying.

Examine all <u>bearings</u> for roughness, damage or wear by rotating each bearing slowly in the hand. If in doubt as to bearing condition, replace. Drive gear, drive pinion, differential pinions and any other gears should be checked for damaged teeth, worn spots, or distortion. Inspect differential case assembly for cracks, damage or distortion. Make sure splined ends of axle shafts are neither twisted nor cracked. Shim packs should be of uniform thickness. Discard thrust washers and obtain new even when only slight wear is indicated.

Remove nicks or burrs from machined or ground surfaces. Be sure screw threads are

clean and true to obtain correct adjustments and specified fastening torques. Avoid hammering when assembling components and use a press when necessary.

ADJUSTMENTS

The principal adjustments made on the differential carrier assembly are devised for establishing the proper gear tooth contact and thereby obtaining a long wearing, quiet running rear axle. Fundamentally, there are five adjustments to be covered and these are accomplished as the differential carrier is assembled. To emphasize their importance these five steps or adjustments are listed here as well as in the actual assembly procedure. These adjustments are:

- 1. Preload the pinion bearings.
- 2. Establish the pinion nominal dimension. (Pinion end to axle centerline distance)
- 3. Set gear lash.
- 4. Preload the differential bearings.
- 5. Check the gear tooth contact.

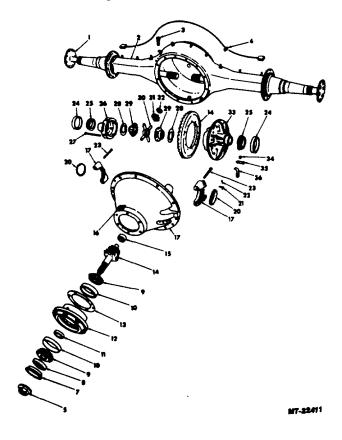


Fig. 10. Exploded View

Legend for Fig. 10

Key Description

- 1 Shaft, Axle
- 2 Housing, Axle Assembly
- 3 Breather, Axle Housing
- 4 Plug, Pipe
- 5 Nut, Companion Flange
- 6 Not Used
- 7 Seal, Pinion Oil
- 8 Spacer, Input Flange
- 9 Bearing, Thrust
- 10 Bearing, Pinion Cup
- 11 Spacer, Pinion Bearing
- 12 Cage, Pinion
- 13 Shim, Pinion Bearing Cage
- 14 Gear Set. Ring and Pinion
- 15 Bearing, Pilot (Radial)
- 16 Plug, Pipe
- 17 Carrier with Caps Assembly
- 18 Not Used
- 19 Not Used
- 20 Adjuster, Differential bearing
- 21 Lock, Bearing Adjuster
- 22 Pin, Cotter
- 23 Bolt, Bearing Cap
- 24 Bearing Differential Cup
- 25 Bearing, Differential Cone
- 26 Case, Differential, Plain Half
- 27 Bolt, Differential Case
- 28 Washer, Side Gear Thrust
- 29 Gear, Differential Side
- 30 Spider, Differential
- 31 Gear, Differential Pinion
- 32 Washer, Pinion Gear Thrust
- 33 Case, Differential Flanged Half
- 34 Nut, Differential Case Bolt
- 35 Rivet, Ring Gear
- 36 Scoop, Oil

REASSEMBLY (Fig. 10)

REBUILD AND INSTALL PINION AND CAGE

- 1. Press rear thrust bearing (9) firmly against shoulder of pinion shaft (14).
- 2. Press pilot bearing (15) on stub end of pinion shaft (14) and against pinion. Stake face of pinion evenly in six places to secure pilot bearing in place (Fig. 11).

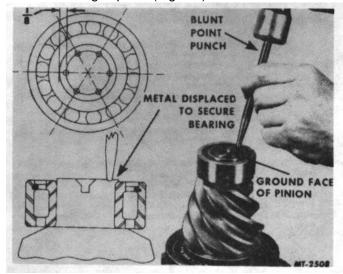


Fig. 11. Staking Pinion Pilot Bearing

It is suggested that for locating punch position for staking, the end of the pinion be painted with Prussian Blue and a circle be scribed on end of pinion about 3 mm (1/8 in.) in from the pinion circumference. When staking the bearings be careful to make the depth of the indentations or stake points uniform, otherwise bearing may be damaged. Deep punch or stake marks are not necessary. Apply the staking operation at opposite sides of the pinion end until all stake points are obtained. Where special staking tools are available they can be used, otherwise the use of a blunt or round nosed punch is satisfactory.

- 3. If bearing cups (10) have been replaced, press new cups firmly against shoulders of pinion cage (12).
- 4. Prelubricate the bearings with gear lubricant.
- 5. Position spacer (11) on pinion shaft and against rear thrust bearing.
- 6. Insert pinion and rear thrust bearing (9) in pinion cage.
- 7. Mount pinion and cage in arbor press and place pre-lubricated front thrust bearing (9) on pinion

shaft. Press bearings firmly and squarely against spacer (11).

Pinion Bearing Preload

Pinion bearing preload is established by selecting the correct size spacer (11) located between the two pinion thrust bearings and tightening pinion end nut to the specified torque (see "Torque Chart").

Temporarily assemble the pinion, cage and flange assembly, less pinion oil seal. Clamp the assembly in a vise so as to hold the companion flange. Tighten end nut to specified torque.

The pinion cage should be rotated while tightening the Dinion so as to seat and align the bearings. Rotation of the pinion is important. Otherwise a false condition of bearing load could exist. The bearing rollers must be seated against the face of the bearing cone (Fig. 12).

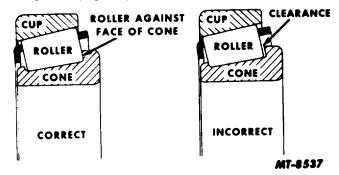


Fig. 12. Pinion Bearing Roller Position

To measure bearing preload, wrap a strong cord or soft wire about the pinion cage and attach end to spring scale (Fig. 13). Read scale only while cage is rotating. Compare this scale reading with the figure shown in "Specifications".

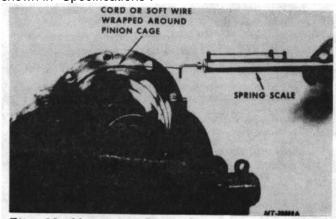


Fig. 13. Measuring Pinion Bearing Preload

When preload does not agree with specifications, bearing load may be increased by installing a thinner spacer or decreased by using a thicker spacer. Determine spacer thickness using a micrometer (Fig. 14) and make a new selection accordingly. Closer adjustment may be obtained by working spacer to desired thickness, using emery cloth on a flat surface. Wash spacer clean of emery cuttings before installing on pinion.

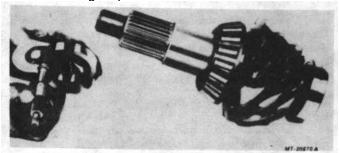


Fig. 14. Measuring Spacer Thickness

After pinion bearing preload is established good practice would be to check bearing roller ends to see whether they are in contact with bearing cone face. Use a feeler gauge ribbon. There must be no clearance at ends of rollers.

When assured that pinion bearing preload is set and bearing roller ends are in contact with bearing cone face, remove pinion end nut and companion flange. Prelubricate pinion bearings with axle lube and install new pinion oil seal to pinion cage (Fig. 15).

Reinstall companion flange and pinion end nut and tighten to specified torque.

Pinion Nominal Dimension

To establish pinion nominal dimension, which is the distance from the face or finished end of the installed pinion to the centerline of the ring gear or cross shaft, proceed as follows:

Install pinion, cage and bearing assembly in differential carrier. Obtain step plate clamp assembly from SE-1065 Pinion Setting Gauge set and attach it to differential carrier flange, locating step plate clamp screw over center of pinion (Fig. 16).

Install step plate under clamp screw and tighten screw to hold step plate securely in position (Fig. 17).

The step plate is necessary to project the face of the pinion where it can be measured by the gauge which is on the centerline of the drive gear.

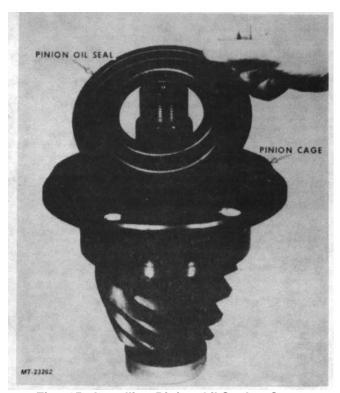


Fig. 15. Installing Pinion Oil Seal to Cage IMPORTANT

Be certain lugs on step plate straddle

the bearing staking indentations on end of pinion.

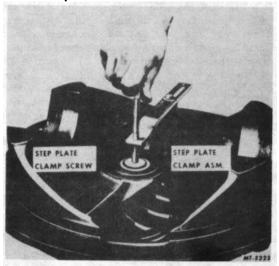


Fig. 16. Locating Step Plate Clamp



Fig. 17 Installing Step Plate

Mount assembled SE-1065 gauge in bearing bores of carrier (Fig. 18). See specifications for correct adapter discs.

Make certain that bearing bores are clean and free of nicks and burrs. Adjust micrometer so it is directly over end at a 90 degree angle to step plate.

Run micrometer thimble down to measure distance between center of drive gear and step plate. Make a note of this reading along with the nominal dimension given in "Specifications". Locate on pinion the etched marking which indicates variation from zero cone setting. If it is a minus figure, subtract it from specified dimension, and if a plus figure, add it to specified dimension. Results of calculation will provide the correct pinion nominal dimension to which pinion must be set. Comparison of corrected nominal dimension indicates amount of change necessary for correct pinion position. It may be necessary to add or remove shims between pinion cage and differential carrier to provide correct pinion nominal dimension.

Remove gauge and prepare to install drive gear and differential carrier in differential housing.

ASSEMBLE DIFFERENTIAL CASE AND DRIVE GEAR

All key numbers used refer to exploded view (Fig. 10).

1. If drive gear (14) was removed from case, rivet gear to case flanged half (33).

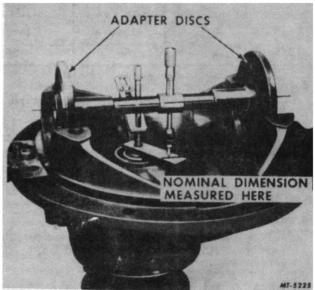


Fig. 18 Assembled Gauge in Position

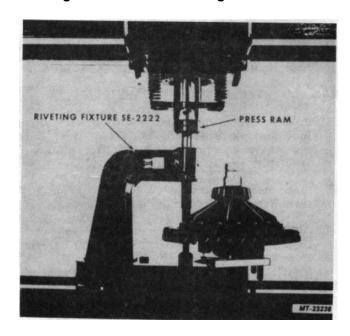


Fig. 19 Method For Installing Drive Gear to Differential Case

When reinstalling drive gear it is suggested that Riveting Fixture SE-2222 be used (Fig. 19). This special tool is designed for use with either hydraulic or mechanical press equipment. Rivet pressures for drive gear installation should be in accordance with those given in the following chart.

Rivet Size	Pressure Per Rivet		
(Inch)	(Tons)		
	Metric	U.S.	
5/8	41-45	45-50	
3/4	45	50	

- Apply axle lubricant to differential case inner walls and all other component parts.
- 3. Place thrust washer (28) and side gear (29) in flanged half of case together with spider (30), gears (31) and thrust washers (32).
- 4. Install opposite side gear and thrust washer in differential case plain half (26).
- 5. Align the match marks and join the two differential case halves. Draw assembly together with four equally spaced bolts (27) and nuts (34).
- Check assembly for free rotation of side gears and pinions and if satisfactory, install remaining differential case bolts. Tighten to torque specified in "Torque Chart",
- 7. Differential bearings (25) are installed by pressing them squarely onto differential case halves.

INSTALL DIFFERENTIAL TO CARRIER

- Prelubricate differential bearings with axle lube and place bearing cups (24) over bearings. Attach chain sling to differential assembly and install in carrier (17).
- 2 Place bearing adjusters (20) in carrier and turn hand tight against bearing cups (24).
- 3. Observe match marks on bearing caps and install caps onto legs of differential carrier.
- Install bearing cap bolts (23) and washers and tighten to specified torque (see "Torque Chart").
- 5. Tighten bearing adjusters (20) alternately until all end play is eliminated. Revolve differential while tightening.

Gear Lash

A special effort should be made to set the backlash between pinion and drive gear to the same amount as was originally built into them 0.2-0.3 mm (.006 - .012 in.). Generally the amount of backlash is stamped or etched on the drive gear. 'When installing

new gears, backlash is measured with a dial indicator mounted on differential housing as in Fig. 20. To adjust the backlash move the drive gear toward or away from the pinion. This is done by backing off one adjusting ring and advancing the opposite ring the same amount.

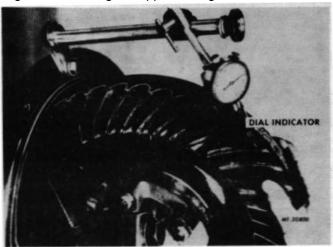
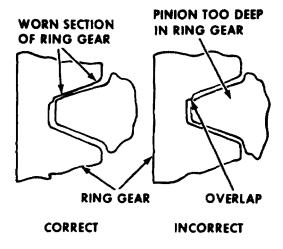


Fig. 20 Setting Correct Backlash

When original gear and pinion sets are being reinstalled, the wear pattern of the gear teeth must be considered in the backlash adjustment. Gears that have been in service for long periods form running contacts which should not be greatly changed. If, in checking backlash, the amount measured is in excess of the amount shown on the drive gear, the lash may be reduced only in the amount that will avoid overlap of the worn section (Fig. 21). A slight overlap at the worn section will cause gear operation to be noisy and rough.



MT-8540

Fig. 21 Correct and Incorrect Lash Adjustment
Where Worn Gears are Reinstalled

Differential Bearing Preload

To set the bearing preload, mount dial indicator at side of drive gear (Fig. 22). With the bearing capscrews loosened to permit bearing movement, loosen adjusting nuts only enough to notice end play on indicator.

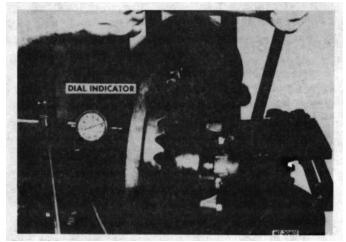


Fig.'22 Adjusting Bearing Preload

IMPORTANT. While gear is held at .000 end play and before loading bearings, check gear for runout by revolving drive gear. If runout exceeds 0.2 mm (.008 in.), remove differential and check for cause.

Also use thread locking compound ("Loctite" or equivalent) on adjusting nut threads before final tightening. Do not allow excess compound to get into bearings.

Tighten both adjusting nuts from .000 end play to preload the differential bearings (see "Specifications").

Tighten bearing cap bolts to specified torque (see "Torque Chart").

Recheck gear lash to make certain lash setting has not been changed.

Install adjusting ring locks and cotter pins.

Gear Tooth Contact

Apply oiled red lead lightly to the hypoid gear teeth (Fig. 23). When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving

bare areas the exact size, shape and location of the contacts (Fig. 24).



Fig. 23 Painting Gear Teeth for Obtaining Tooth Contact Impressions

Sharper impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the gear teeth. Coast side should be correct when drive side is correct. Generally, coating approximately twelve teeth is sufficient for checking purposes.

With adjustments properly made, a correct tooth contact similar to that shown in Fig. 24 will be secured. The area of contact starts near the toe of the gear and extends about 62i per cent of the tooth length. This adjustment results in a quiet running gear and pinion set which, because the load is distributed over the teeth within the proper area, will deliver all the long service built into it.

When checking paint impressions on gear teeth of an axle under heavy load, the impressions usually spread out somewhat longer than the patterns obtained from a bench test. This can be considered as normal. Drive gears when mounted should show a bearing toward the toe or small end of the tooth, but never at the heel or large end. The reason being that it is practically impossible to make gears and gear mounting so rigid that no deflection will occur when full torque is applied. This deflection causes the bearing to approach the heel of the tooth. And when gears are adjusted so that the bearing is toward the heel of the tooth, it results in a concentration of load on the top corner of the heel and breakage will follow.

INSTALL DIFFERENTIAL CARRIER

Using chain sling and overhead hoist, move differential carrier assembly from rebuild stand

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to roller type floor jack. Place a thin even coat of liquid gasket (Loctite #504 or equivalent) on the axle housing flange and roll the differential carrier into position on the axle housing. Install the housing bolts and lockwashers and tighten to specified torque (see "Torque Chart").



Fig. 24 Tooth Contact Impressions

Connect the propeller shaft to companion flange and install the axle shafts. Insert drain plug and fill housing with the prescribed quantity and type of new lubricant. Make sure one pint of lube specified is added to filler hole provided in carrier. Before subjecting rebuilt axle to load, operate truck for a mile or more to circulate lubricant through the differential unit. Do not fail to check lubricant level at recommended intervals.

AXLE SHAFTS

Many axle failures can be attributed to the axle shafts, therefore, it is most important that shafts be installed correctly, be of correct size and length for splines to engage fully and be kept free from runout or bends.

AXLE HOUSING

The axle housing is of one piece construction with an opening in the center for mounting the differential and carrier. A flange is welded to the outer ends of the axle housing for mounting the brake backing plates. A bent axle housing can be the cause of early axle failure and whenever an axle is rebuilt this condition should always be checked before going ahead with the assembly. Fig. 25 gives a quick method of checking for a bent housing.

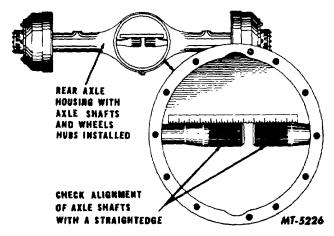


Fig. 25 Method of Checking for Bent Housing

The condition of axle housing cover weld should also be checked. If cover weld is cracked, oil seepage from housing can occur. Rewelding of housing cover is permitted providing special cleaning precautions and recommended welding procedures are observed.

Procedure for repairing cracked weld or leaking housing cover is as follows:

1. Drain differential and remove differential carrier assembly.



- 2. Clean lube from inside of housing and burn remaining lube from inside with torch.
- 3. Clean residual lube with solvent.
- Grind or air arc cracked weld from outside of cover weld to base metal.
- 5. Weld three passes around outside of cover using 1/8" Spec. No. E7016 Weld Rod and supplier's recommended amperage and voltage. Thoroughly clean weld area between passes.
- 6. Weld one pass around cover (360 degree) inside housing using same weld rod as above.
- 7. Remove all weld splatter and slag from inside of housing and return housing to service.

MAINTENANCE

AXLE HOUSING BREATHER VALVE

To prevent a pressure build-up in the axle housing when the axle becomes warm, a breather valve is provided in rear axles. Without this valve the resulting pressure could force the axle lubricant past the rear wheel oil seals and damage the brake linings. The valve is so constructed that warm air may pass out of the axle to relieve built up pressure, yet dirt and moisture are prevented from entering.

The breather valve should be kept open and clean. When the truck is operated off-highways, on unimproved roads or in ice and snow, dirt may sometimes be forced under the valve cap and cause the

valve to become ineffective. Remove valve occasionally and clean thoroughly in cleaning solution.

ALIGNMENT

The rear axle should also be checked at regular intervals to determine if there is any misalignment of the axle with frame or drive line, Evidence of misalignment may sometimes be noted at the U-bolts. To check for axle misalignment lay a straightedge across and at right angles to the truck frame. The straightedge should be longer than the axle tread and clamped to the frame a short distance ahead of the rear axle. Measure the distance between the straightedge and identical points at each end of the axle assembly. When distances are not equal, misalignment is indicated, and rear springs and U-bolts must be checked for correct assembly.

LUBRICATION

One of the most important factors of axle maintenance is lubrication. For this reason factory recommendations on lubrication intervals, lubricant levels, draining and type of lubricant must be followed to assure long life and satisfactory performance. Inspect the axle frequently for lubricant leakage, especially around housing covers, pinion oil seal retainer and axle shaft flanges. When necessary, change seal and keep nuts or bolts tight.

At each chassis lubrication, inspect rear axle for oil level. Fill as necessary.

For types of lube recommended, refer to LUBRICATION, CTS-2412.

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TROUBLE SHOOTING

Serious trouble in a rear axle can be prevented if sufficient attention is given to the various causes of trouble and the proper remedy is applied. The following list gives most of the common kinds of axle trouble and suggests a possible cause to be corrected.

Constant Noise

- 1. Lubricant not to specified level.
- 2. Incorrect kind and weight of lubricant.
- 3. Wheel bearings out of adjustment or defective.
- 4. Drive gear and pinion not in adjustment for correct tooth contact.
- 5. Teeth of drive gear and pinion chipped or worn.
- 6. Too much or too little pinion to gear backlash or overlap of wear pattern.
- 7. Loose or worn pinion bearings.
- 8. Loose or worn side bearings.

Intermittent Noise

- 1. Drive gear does not run true.
 - (a) Uneven pressures on drive gear rivets.
 - (b) Warped drive gear.
- 2. Loose or broken differential bearings.

Noisy on Turns Only

- 1. Differential pinion gears tight on differential spider.
- 2. Side gears tight in differential case.
- 3. Differential pinion or side gears defective.
- 4. Thrust washers worn or damaged.
- 5. Excessive backlash between side gears and pinions.

It should be noted that noises from other units of the truck such as propeller shafts, universal joints, tires and even transmissions are often incorrectly diagnosed as rear axle noise. This possibility should not be overlooked when trouble shooting.

Lubricant Leaks

- 1. Loss through axle shafts.
 - (a) Lubricant above specified level.
 - (b) Incorrect kind and weight of lubricant.
 - (c) Restricted axle housing breather valve.
 - (d) Worn or incorrectly installed axle shaft oil seal.
- 2. Loss at Pinion Shaft.
 - (a) Lubricant above specified level.
 - (b) Incorrect kind and weight of lubricant.
 - (c) Restricted axle housing breather valve.
 - (d) Pinion oil seal worn or incorrectly installed.
- (e) Lubricant return passage in differential carrier housing restricted.
- (f) Universal joint companion flange loose on pinion shaft.
- 3. Loss at Housing Cover.
 - (a) Insufficient seam weld.
 - (b) Cracked seam weld.

Rear Wheels Do Not Drive (Propeller Shaft Rotating)

- 1. Broken axle shaft.
 - (a) Loose wheel bearings.
 - (b) Axle shaft too short.
 - (c) Loose flange studs or nuts.
 - (d) Bent housing.
- 2. Drive gear teeth stripped.
- 3. Side gear or differential pinion broken.
- 4. Differential spider broken.

SPECIFICATIONS

IH MODEL		RA-42	RA-44	RA-47	RA-57
IH CODE		14042	14044	14047	14057
LOAD RATING	(Tons) (Lbs.)	7.9 17500	8.6 19000	9.8 22000	10.4 23000
PINION: Nominal Dimension	(mm) (inch)	95.745 3.7695	95.745 3.7695	95.745 3.7695	108.82 4.2845
SE-1065 Disc		0 (2)	0 (2)	0 (2)	M (2)
Cage Rotating Torque Scale Reading	(kg) (Lbs.)	1.4-3.6 3-8	1.4-3.6 3-8	1.4-3.6 3-8	1.4-3.6 3-8
DIFFERENTIAL: Bearing Preload			1-1/2 to 3 Notche	es (Total both sid	des)
HOUSING:	(Liter)	11.4	11.4	14.9	14.7
Lube Capacity*	(Pint)	24	24	32	31
SERIAL NUMBER LOCATION			On Bolt Circ	cle of Differentia	I

^{*} Add 0.5 Liter (1 Pint) of total at pinion cage plug.

TORQUE CHART

IH MODEL	RA-42		RA-44		RA-47		RA-57	
	N.m	ft.lbs.	N.m	ft lbs.	N.mrn	ft.lbs.	N.m	ft.lbs.
Input Flange-Pinion End Nut	1 3/4-12		1 3/4-12		1 3/4-12		1 3/4-12	
	1220	900	1220	900	1220	900	1220	900
Dinion Cogo to Corrier	9/16-12		9/16-12		9/16-12		5/8-11	
Pinion Cage to Carrier	155-170	115-125	155-170	115-125	155-170	115-125	217-238	160-175
Carrier to Axle Housing	5	/8-11	5/8	-11	5/8	3-11	9/16-	12
	220-240	160-175	220-240	160-175	220-240	160-175	150-162	110-120
Differential Case	9/	16-18	9/16	6-18	9/1	6-18	5/8-1	18
	160-175	120-130	160-175	120-130	160-175	120-130	217-238	160-175
Bearing Cap to Carrier	3	5/4-10	3/4	-10	3/4	I-1 0	3/4-1	10
	370-400	275-300	370-400	275-300	370-400	275-300	370-400	275-300
Drive Flange to Wheel Hub	9/	′16-18	9/16	S-18	3/4	I-16	3/4-1	16
Z o . lango to milosi nab	130-155	95-115	130-155	95-115	290-325	217-240	290-325	217-240



REAR AXLE IH SINGLE REDUCTION TANDEM (CONE TYPE CARRIER)

IH MODEL IH CODE RA-341 14341 RA-351 14351 RA-355 14355

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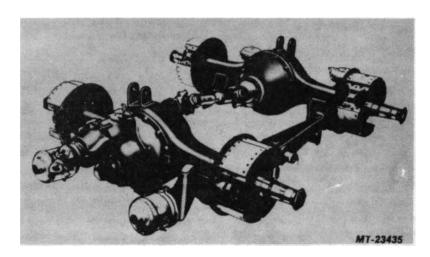


Fig. 1 IH Single Reduction Tandem Rear Axle

GENERAL

This service manual covers rebuild procedures and specifications for the IH built Single Reduction Tandem Axle. Both forward rear and rear rear axles of the models RA-341, 351 and 355 rear axles are included. The repairs are performed principally on the power divider and differential carrier of the forward axle and the differential carrier of the rear rear axle after they are removed from the axle housing.

DESCRIPTION

The IH thru-drive tandem rear axle consists of a heavy-duty single reduction axle with integral power divider and inter-axle differential for the forward rear axle and a conventional heavy-duty single reduction axle for the rear rear axle. Differential parts, ring gear and pinion sets, bearings, and axle shafts are common between the forward and rear axles.

The forward axle has the power divider and inter-axle differential mounted on the forward side of the differential carrier. A thru-shaft carries driving torque through the forward axle housing to the rear rear axle. Driving torque is delivered to the forward rear axle via

the intermediate idler gear and a driven gear mounted on the pinion shaft of the forward axle.

The complete differential carrier and power divider may be removed from the forward axle housing as a unit with the axle mounted in the truck as well as when the axle is removed. Also the power divider may be removed individually without removing the differential carrier. This permits servicing the power divider without disturbing the forward axle differential.

REMOVAL FORWARD REAR AND REAR REAR AXLES Remove Axle Shafts From Wheels and Housings

- 1. Drain lube from both axle housings and the power divider. To drain power divider, remove plug from bottom of intermediate case.
- Take off all nuts from studs around rear wheel hub.
- Loosen shaft from hub by striking center of axle shaft flange with 2.3 2.7 Kg (5-6 lb.) hammer or sledge.
- 4. Pull axle shafts from housing.



Fig. 2 Power Divider And Diff Carrier In Rebuild Stand

Remove Propeller Shafts

- Separate universal joints from companion flanges of input and output shafts of forward rear axle.
- 2. Repeat for input shaft of rear rear axle.

Remove Output Shaft From Forward Rear Axle

- 1. Remove output shaft bearing retainer bolts.
- 2. Use soft hammer and loosen bearing retainer from axle housing.
- 3. Withdraw bearing retainer and output shaft from axle housing.

Remove Diff Carriers From Axle Housings

- Loosen differential carrier-to-axle housing bolts. Remove all bolts except top two. These two bolts will prevent carrier assembly from falling.
- 2. Support carrier assembly on roller jack. Secure as necessary to prevent carrier from falling from jack when removed from housing.
- Remove top two carrier bolts. Loosen locknuts and turn puller screws in to break carrier away from housing. A small pinch bar may be used to straighten carrier assembly in housing, but be careful to avoid damage to carrier flange. Remove carrier assembly from axle housing.
- 4. Roll jack and carrier assembly from under truck. Mount carrier assembly in suitable rebuild stand (Fig. 2).

DISASSEMBLY FORWARD REAR AXLE Disassemble Power Divider From Diff Carrier

1. Remove lockout control assembly (Fig. 3).

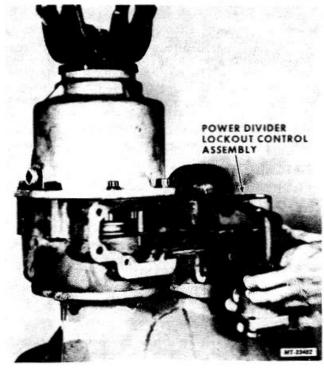


Fig. 3 Removing Power Divider Lockout Control

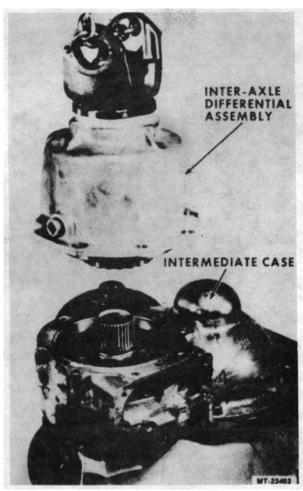


Fig. 4 Removing Inter-Axle Diff

- 2. Remove inter-axle diff cover bolts and lift interaxle diff assembly from power divider intermediate case (Fig. 4).
- 3. Remove intermediate case-to-diff carrier bolts and lift intermediate case from diff carrier (Fig. 5).

Disassemble Inter-Axle Differential

- 1. Secure input (companion) flange with a flange holder tool or by clamping in vise (Fig. 6).
- 2. Use torque multiplier wrench (SE-1933) as shown in Fig. 6 and remove input flange nut.
- Use puller tool (Fig. 7) or press and remove inter-axle diff assembly from cover (nose cone) and input flange.

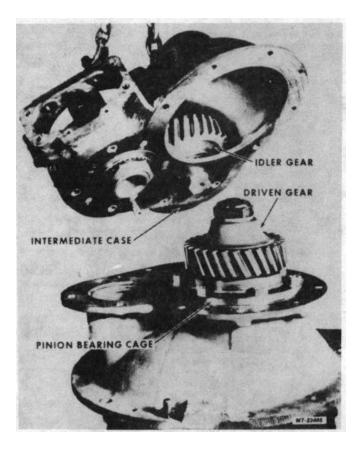


Fig. 5 Removing Power Divider Intermediate Case Assembly

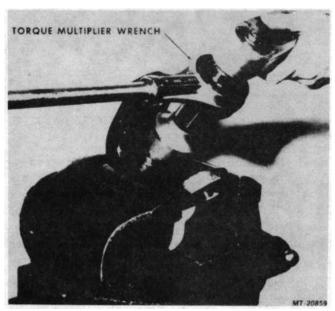


Fig. 6 Removing Input Flange Nut

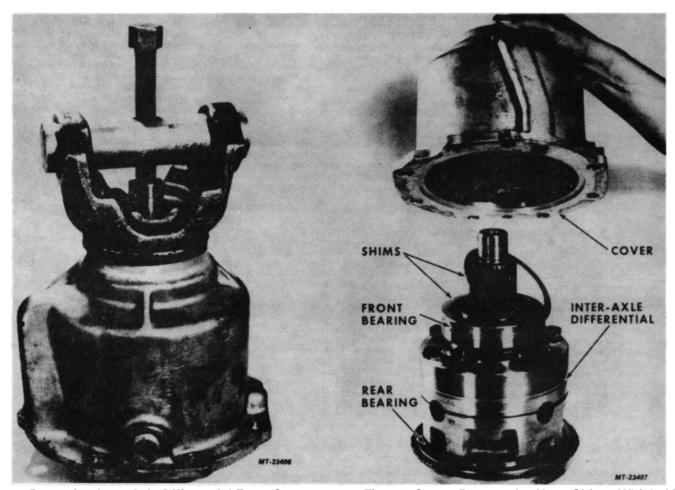


Fig. 7 Removing Inter-Axle Differential From Cover

- 4. Note and retain shims located between front bearing and cover. These shims limit end play of differential assembly in cover (Fig. 8).
- 5. If necessary to remove bearings from diff case, pull bearings using suitable pullers (Fig. 9).
- Match mark diff case halves with a punch or chisel to assure correct alignment upon reassembly.
- 7. Remove diff case bolts and separate case halves.

Fig. 8 Cover Removed. Note Shims Which Limit Diff Case To Cover End Play

- 8. Remove diff spider, spider pinion gears, side gears, and thrust washers (Fig. 10).
- 9. Remove oil seal from inter-axle diff cover.
- If necessary to remove bushing from rear half of diff case, collapse bushing inward by inserting point of chisel between bushing and case at seam of bushing. Avoid damaging case.
- 11. Keep inter-axle diff parts together and protect from damage while removed.

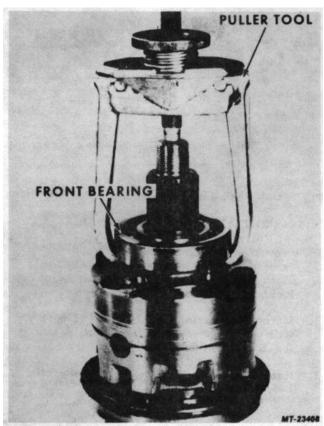


Fig. 9 Removing Front Bearing From Inter-Axle Differential

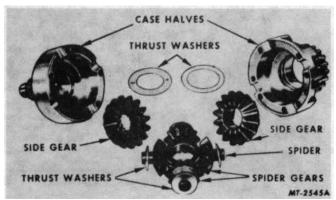


Fig. 10 Components Of Inter-Axle Differential Disassemble Power Divider Intermediate Case

- Lift inter-axle clutch shift collar from input gear (Fig. 11).
- 2. Remove and disassemble input gear.

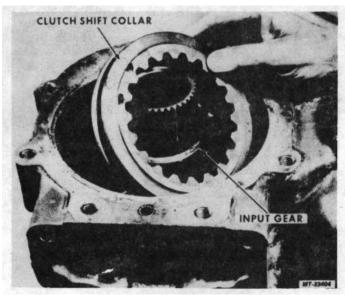


Fig. 11 Removing Clutch Shift Collar

RA-341

- a. Press input gear to rear sufficiently to free bearing snap ring. Remove snap ring.
- b. Remove input gear and bearing by pressing forward to free bearing from bore.
- c. Clamp input gear in soft jawed vise.
- d. Remove bearing retainer nut using bearing nut wrench (SE 2247). See Fig. 12.
- e. Pull bearing from input gear with puller tool.

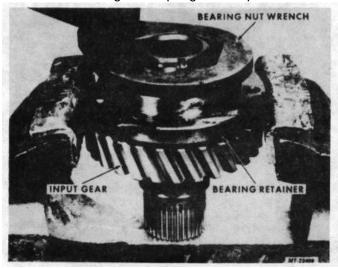


Fig. 12 Removing Input Gear Bearing Retainer Nut (RA-351, 355 Shown RA-341 Similar)

RA-351, 355

- Remove bearing retainer mounting bolts from rear of intermediate case and tap input gear bearings and retainer assembly out toward front.
- Remainder of input gear disassembly is same as for RA-341.

IMPORTANT

Inner bearing is a press fit on gear and will most likely be damaged if removed. Remove only if to replace.

- Loosen idler shaft end nut using torque multiplier wrench. Use flats provided on shaft end to hold shaft from turning while nut is being loosened. Remove nut and washer.
- 4. Support rear face of intermediate case and press idler shaft from case.
- Remove idler shaft gear and bearings from case (Fig. 13 and 14). Separate bearings, bearing races and bearing spacer from idler gear. Note that models RA-351 and 355 use two bearing spacers.

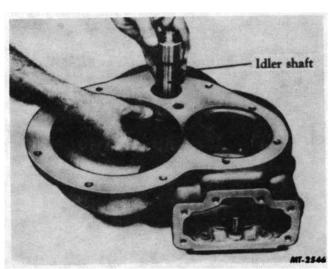


Fig. 13 Removing Idler Shaft and Gear

Disassemble Output Shaft Assembly

- 1. Clamp companion flange of output shaft in vise.
- 2. Remove companion flange nut and flange.
- 3. Remove bearing retainer (with seal).

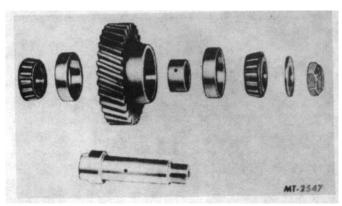


Fig. 14 Idler Gear Components (RA-341 Shown) FORWARD REAR AND REAR REAR AXLES Disassemble Diff Carrier Assembly

- Remove cotter pins from bearing adjuster locks and remove locks.
- Mark one bearing cap and leg of carrier with a punch or chisel to identify each for correct reassembly.
- 3. Remove bearing cap bolts and take off bearing caps and adjusters (Fig. 15).

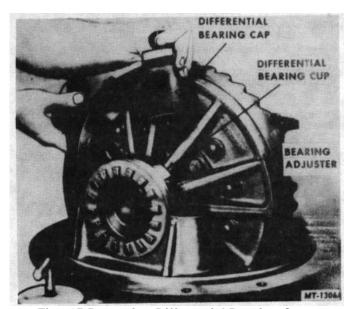


Fig. 15 Removing Differential Bearing Caps

 Lift differential assembly from diff carrier (Fig. 16). Tilt differential assembly to allow ring gear to pass pinion radial bearing. Place differential assembly on bench.

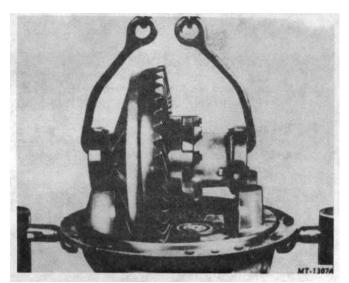


Fig. 16 Lifting Differential From Carrier

Disassemble Differential

- 1. If necessary, remove diff bearings from diff case using suitable puller.
- Match mark diff case halves with a punch or chisel to assure correct alignment upon reassembly.
- 3. Remove self-locking nuts from diff case bolts and separate the diff case halves (Fig. 17).
- 4. Remove diff spider shaft, spider gears, side gears and thrust washers from diff case halves (Fig. 18).



Fig. 17 Separating Diff Case Halves

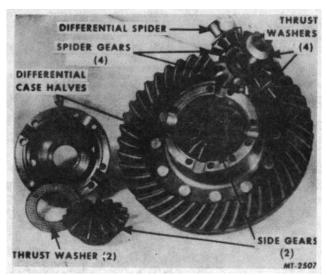


Fig. 18 Differential Component Parts

5. If necessary to remove ring gear from diff case, carefully center punch each rivet head on the ring gear side and drill through the rivet head with a drill 0.8 mm (1/32") smaller than the rivet body (Fig. 19). Use a punch to press out the remaining portion of rivet. Never use a chisel to cut off rivet heads as damage to the diff case might result.

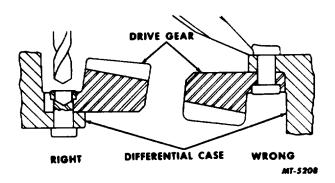


Fig. 19 Drive Gear Rivet Removal Remove Pinion And Cage From Diff Carrier

1. Remove bolts holding pinion cage to diff carrier.

Strike against rear of pinion shaft with a brass drift and hammer to start pinion and cage out of carrier (Fig. 20).

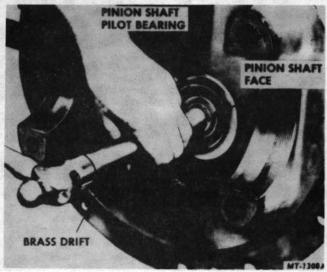


Fig. 20 Starting Pinion And Cage From Carrier

 Remove pinion and cage assembly from carrier (Fig. 21). Temporarily install stud bolts to aid in removal.

CAUTION

Be careful to avoid dropping the pinion and cage assembly. Personal injury od damage to parts may result if assembly is allowed to fall.

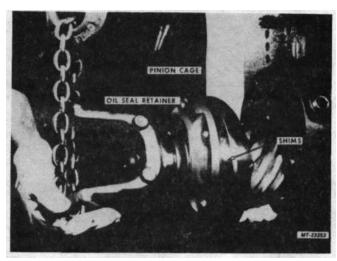


Fig. 21 Removing Pinion And Cage (Rear Rear Shown)

 Return pinion cage shims to aid in readjustment upon reassembly. Do not reuse damaged shims.

Disassemble Pinion And Cage

- 1. Mount pinion and cage assembly in a heavy duty vise or holding tool (Fig. 22).
- Because of the high torque load on pinion end nut, use the torque multiplier wrench (SE-1933) and another long handle wrench to remove nut.



Fig. 22 Removing Pinion End Nut (Rear Rear Shown)

- 3. Pull pinion shaft driven gear or companion flange from pinion.
- 4. Remove spacer from pinion shaft.
- 5. Tap pinion from cage.
- 6. Remove forward pinion bearing from cage.
- 7. Remove bearing spacer from pinion shaft.
- 8. Remove rear pinion bearing and pinion radial bearing from pinion shaft.

IMPORTANT

When axle disassembly is complete, keep parts in order and undamaged. Be especially careful to protect the finely machined surfaces that are now exposed.

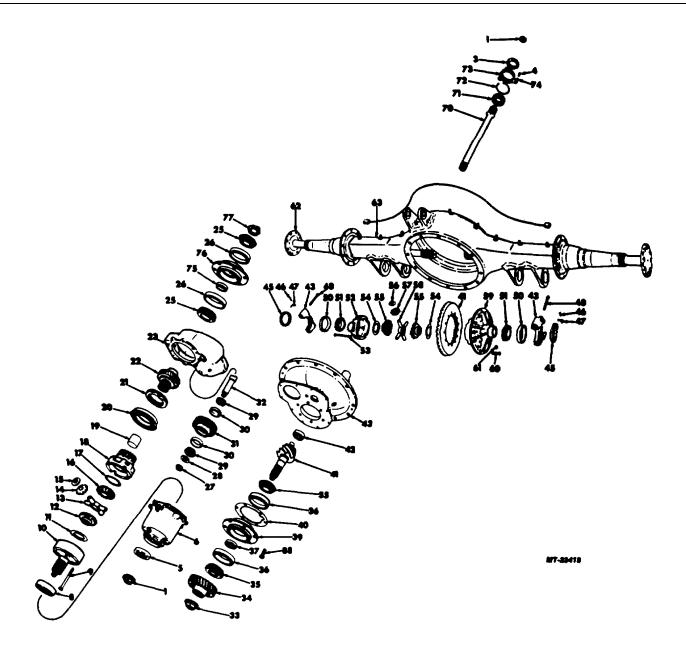


Fig. 23 Forward Rear Axle (Exploded View)

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Legend For Fig. 23

Key.	Description	<u>Key.</u>	Description
1	Nut, Companion Flange	40	Shim
2	Not Used	41	Pinion And Gear Set
3	Seal, Output Shaft Oil	42	Bearing, Pilot (Radial)
4	Bolt, Retainer	43	Carrier Diff, with Caps
5	Seal, Inter-Axle Diff Oil	44	Not Used
6	Cover, Inter-Axle Diff	45	Adjuster, Diff Bearing
7	Not Used	46	Pin Cotter
8	Bearing, Diff .Front	47	Lock, Diff Bearing Adjuster
9	Bolt, Inter-Axle Diff Case	48	Bolt, Diff Bearing Cap
10	Case, Diff, Front Half	49	Not Used
11	Washer, Front Side Gear Thrust	50	Bearing, Diff Cup
12	Gear, Diff, Front Side	51	Bearing, Diff Cone
13	Spider, Diff	52	Case, Diff, Plain Half
14	Gear, Pinion	53	Bolt, Diff Case
15	Washer, Pinion Thrust	54	Washer, Diff Side Gear Thrust
16	Gear, Diff, Rear Side	55	Gear, Diff Side
17	Washer, Rear Side Gear Thrust	56	Washer, Diff Pinion Thrust
18	Case, Diff, Rear Half	57	Gear, Diff Pinion
19	Bushing, Diff Case Rear Half	58	Spider, Diff
20	Bearing Diff Case Rear Half	59	Case, Diff, Flanged Half
21	Collar, Clutch Shift	60	Rivet, Ring Gear To Case
22	Gear, Input Drive	61	Nut, Diff Case Bolt
23	Case, Intermediate	62	Shaft, Axle
24	Not Used	63	Housing, Axle Assembly
25	Bearing, Input Gear, Cone	64	Not Used
26	Bearing, Input Gear, Cup	65	Not Used
27	Nut, Idler Shaft	66	Not Used
28	Washer, Idler Shaft	67	Not Used
29	Bearing, Idler Gear, Cone	68	Not Used
30	Bearing, Idler Gear, Cup	69	Not Used
31	Gear, Idler	70	Shaft, Output
32	Shaft, Idler Gear	71	Bearing, Output Shaft
33	Nut, Pinion End	72	Ring, Snap, Bearing Retainer
34	Gear, Pinion Shaft Driven	73	Retainer, Output Shaft Bearing
35	Bearing, Pinion Cone	74	Washer, Flat
36	Bearing, Pinion Cup	75 70	Not Used
37	Spacer, Pinion Bearing	76 77	Retainer Input Gear Bearing
38	Bolt, Pinion Bearing Cage	77	Nut, Input Gear Bearing Retainer
39	Cage, Pinion Bearing		

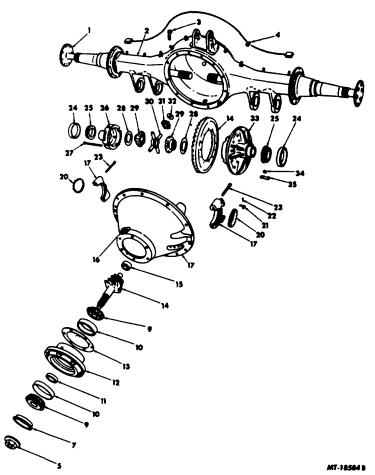


Fig. 24 Rear Rear Axle (Exploded View)

Legend for Figure 24

Key.	<u>Description</u>	<u>Key.</u>	Description
1	Shaft, Axle	19	Not Used
2	Housing, Axle, Assembly	20	Adjuster, Diff Bearing
3	Breather	21	Lock, Adjuster
4	Plug, Filler	22	Pin, Cotter
5	Nut, Companion Flange	23	Bolt, Bearing Cap
6	Not Used	24	Bearing, Diff Cup
7	Seal	25	Bearing, Diff Cone
8	Not Used	26	Case, Diff, Plain Half
9	Bearing, Pinion Cone	27	Bolt, Diff Case
10	Bearing Pinion Cup	28	Washer, Thrust
11	Spacer	29	Gear, Diff Side
12	Cage, Pinion Bearing	30	Spider, Diff
13	Shim	31	Gear, Diff Pinion
14	Pinion And Gear Set	32	Washer, Thrust
15	Bearing, Pilot (Radial)	33	Case, Diff, Flanged Half
16	Plug, Filler	34	Nut, Diff Case Bolt
17	Carrier, Diff with Caps	35	Rivet
18	Not Used		

CLEANING, INSPECTION AND REPAIR

Remove all dirt, old lubricant, and liquid gasket material from components of the rear axle. Immerse in cleaning solvent and use a stiff brush if necessary. Bearings should be cleaned separately in clean solvent and special efforts taken to protect their finely machined surfaces. If compressed air is used for drying, do not spin bearings while drying.

Examine all <u>bearings</u> for roughness, damage or wear by rotating each bearing slowly in the hand. If in doubt as to bearing condition, replace. Ring gear, drive pinion, differential pinions and any other gears should be checked for damaged teeth, worn spots, or distortion.

Inspect diff case assembly for cracks, damage or distortion. Make sure splined ends of axle shafts are neither twisted nor cracked. Shim packs should be uniform thickness. Discard thrust washers and obtain new even when only slight wear is indicated.

ADJUSTMENTS

The principal adjustments made on the diff carrier assembly are devised for establishing the proper gear tooth contact and thereby obtaining a long wearing, quiet running rear axle. Fundamentally, there are five adjustments to be covered and these are accomplished as the diff carrier assembly is assembled. To emphasize their importance, these five steps or adjustments are listed here as well as in the actual assembly procedure. These adjustments are:

- 1. Preload the pinion bearings.
- 2. Set pinion nominal dimension.
- 3. Set gear lash.
- 4. Preload the diff bearings.
- 5. Check gear tooth contact.

REASSEMBLY

When reassembling the rear axles, see also the exploded views (Figs. 23 and 24) for correct installation of parts.

FORWARD REAR AND REAR REAR AXLES

Assemble Pinion And Cage

- 1. Place rear pinion bearing on pinion shaft and press into place against pinion.
- 2. Place pilot bearing on stud end of pinion shaft and press firmly against shoulder of pinion. Stake face of pinion shaft in six (6) evenly spaced places to secure pilot bearing in place (Fig. 25).

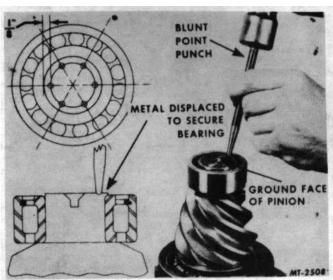


Fig. 25 Staking Pinion Pilot Bearing

- Pre-lubricate the bearings with rear axle gear lubricant.
- 4. Place bearing spacer on pinion shaft and press against rear pinion bearing.

IMPORTANT

The bearing spacer is furnished in various thicknesses in graduations of .025 mm (.001") to permit changing of spacer thickness to obtain correct pinion bearing preload.

- 5. Insert pinion (with rear pinion bearing and spacer) into pinion cage.
- 6. Mount pinion and cage in arbor press. Place prelubricated front pinion bearing on pinion.
- 7. Press bearing into place firmly against bearing preload spacer.
- Revolve pinion cage around pinion several times to s seat bearings correctly.
- 9. Remove pinion and cage from press.

Preload Pinion Bearing

Pinion bearing preload is established by selecting the correct size spacer located between the two pinion thrust bearings and tightening pinion end nut to the specified torque (see "Torque Chart").

1. Temporarily install companion flange on end of pinion shaft.

IMPORTANT

When preloading pinion bearings of forward rear axle, obtain a spare companion flange and non-locking end nut in lieu of driven gear and flange nut for temporary installation on pinion.

Do not use flange type lock nut during bearing preload procedure.

- 2. Clamp pinion assembly in a vise so as to hold companion flange.
- Rotate pinion cage while tightening end nut to specified torque (see "Torque Chart"). Rotation of cage is important so as to seat and align bearings, otherwise, a false condition of bearing load could exist. Bearing rollers must be seated against face of bearing cone (Fig. 26).

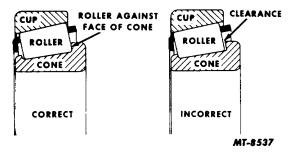


Fig. 26 Pinion Bearing Roller Position



Fig. 27 Measuring Pinion Bearing Preload

4. Measure bearing preload by wrapping a strong cord or soft wire about the pinion cage and attach end to spring scale (Fig. 27). Read scale only while cage is rotating. Compare this scale reading with the figure shown in "Specifications". When preload does not agree with Specifications bearing load may be increased by installing a thinner spacer or decreased by using a thicker spacer. Determine spacer thickness using a micrometer (Fig. 28) and make a new selection accordingly. Closer adjustment may be obtained by working spacer to desired thickness, using emery cloth on a flat surface.

5. Wash spacer clean of emery cuttings before installing on pinion.

After pinion bearing preload is established, good practice would be to check bearing roller ends to see whether they are in contact with bearing cone face. Use a feeler gauge ribbon. There must be no clearance at ends of rollers (Fig. 26).

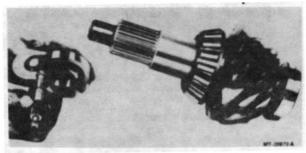


Fig. 28 Measuring Spacer Thickness

- 6. Remove end nut and companion flange.
- 7. FORWARD AXLE: Install pinion shaft driven gear and flange nut. Clamp pinion shaft driven gear in fixture or jaws of vise using jaw shields or other soft material to avoid damage to gear. REAR REAR AXLE: Install seal in pinion cage and place companion flange and flange nut on pinion shaft.
- 8. Tighten pinion flange nut to specified torque (see "Torque Chart").
- 9. Recheck pinion bearing preload.

Assemble Pinion and Cage to Differential Carrier

 Place original shim pack on pinion cage and mount cage in diff carrier. Tap cage into place with a soft hammer. 2. Install pinion cage bolts and tighten to specified torque (see "Torque Chart").

Set Pinion Nominal Dimension

To establish pinion nominal dimension, which is the distance from the face or finished end of the installed pinion to the centerline of the ring gear or cross shaft, proceed as follows:

> Obtain step plate and clamp assembly from SE-1065 Pinion Setting Gauge set and attach it to diff carrier flange, locating step plate clamp screw over center of pinion (Fig. 29).

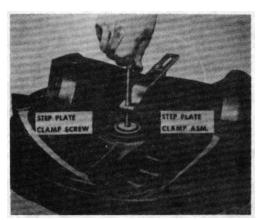


Fig. 29 Locating Step Plate Clamp

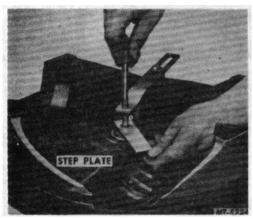


Fig. 30 Installing Step Plate

Install step plate under clamp screw and tighten screw to hold step plate securely in position (Fig. 30).

The step plate is necessary to project the face of the pinion where it can be measured by the gauge which is on the centerline of the drive gear.

IMPORTANT

Be certain lugs on step plate straddle the bearing staking indentations on end of pinion.

Mount assembled SE-1065 gauge in bearing bores of carrier (Fig. 31). See "Specifications" for correct disc size.

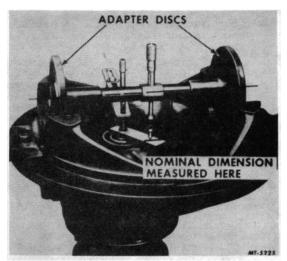


Fig. 31 Assembled Gauge In Position

Make certain that bearing bores are clean and free of nicks and burrs. Adjust micrometer so it is directly over end at a 90 deg. angle to step plate.

Run micrometer thimble down to measure distance between center of ring gear and step plate. Make a note of this reading along with the nominal dimension given in "Specifications". Locate on pinion the etched marking which indicates variation from zero cone setting. If it is a minus figure, subtract it from specified dimension, and if a plus figure, add it to specified dimension. Results of calculation will provide the corrected pinion nominal dimension to which pinion must be set. Comparison of corrected nominal dimension with the actual or measured dimension indicates amount of change necessary for correct pinion position. It may be necessary to add or remove shims between pinion cage and diff carrier to provide correct pinion nominal dimension.

Remove gauge and prepare to install ring gear and differential to diff carrier.

Assemble Differential

 If ring gear was removed from diff case, rivet gear to diff case flange. Use riveting fixture SE-2222 with hydraulic press (Fig. 32). Rivet pressures (tons) should be within the range given in "Specifications."

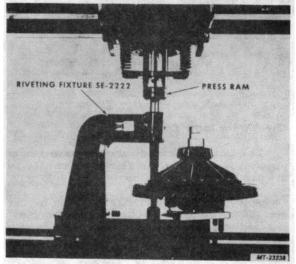


Fig. 32 Installing Drive Gear To Diff Case

- Apply rear axle lubricant to the inner walls of the diff case halves and to all differential component parts.
- Place side gear thrust washer and side gear in flanged half of diff case and assemble spider, spider gears and spider gear thrust washers to side gear.
- Place opposite side gear and thrust washer in other half of diff case.
- Align the match marks and assemble the diff case. Draw assembly together with four equally spaced bolts and nuts. Make sure side gears and spider gears mesh correctly.
- Check for free rotation of side gears and spider gears. If satisfactory, install remaining diff case bolts and nuts.
- 7. Tighten diff case bolt nuts to specified torque (see "Torque Chart").
- 8. Install diff bearings by pressing them squarely onto diff case.

Install Differential On Diff Carrier

- 1. Pre-lubricate diff bearings with rear axle lubricant and place bearing cups over bearings.
- Lift differential assembly and place into position in diff carrier. Tilt differential assembly to allow ring gear to pass pinion pilot bearing.
- 3. Place bearing adjusters in carrier and turn hand tight against bearing cups.
- 4. Assemble bearing caps to carrier. Align identifying marks on bearing cap and carrier leg.
- 5. Install bearing cap bolts and washers. Tighten to specified torque (see "Torque Chart") .
- 6. Tighten bearing adjusters alternately until all end play is eliminated. Revolve differential while tightening bearing adjusters to correctly seat bearings.

Set Gear Lash

A special effort should be made to set the backlash between pinion and ring gear to the same amount as was originally built into them (.15-.3 mm or .006-.012"). Generally the amount of backlash is stamped or etched on the ring gear. When installing new gears, backlash is measured with a dial indicator mounted on differential housing (Fig. 33). To adjust the backlash move the ring gear toward or away from the pinion. This is done by backing off one adjusting ring and advancing the opposite ring the same amount.

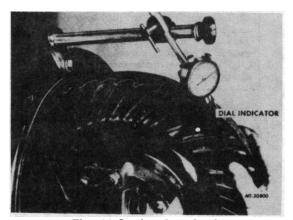
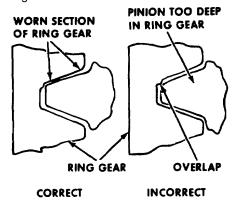


Fig. 33 Setting Gear Lash

When original gear and pinion sets are being reinstalled the wear pattern of the gear teeth must be considered in the backlash adjustment. Gears that have been in service for long periods form running contracts which should not be greatly changed. If, in checking backlash, the amount measured is in excess of the amount shown on the ring gear, the lash may be reduced only in the amount that will avoid overlap of the worn tooth section (Fig. 34). A slight overlap at the worn section will cause gear operation to be noisy and rough.



MT-8540

Fig. 34 Examples of Lash Adjustment Where Worn Gears Are Reinstalled

Preload Diff Bearings

To set the bearing preload, mount dial indicator at side of ring gear (Fig. 35). With the bearing capscrews loosened to permit bearing movement, loosen adjusting nuts only enough to notice end play on indicator.

IMPORTANT

While gear is held in .000 end play and before loading bearings, check gear for runout by revolving ring gear. If runout exceeds .2 mm (.08"), remove differential and check for cause.

Tighten both adjusting nuts from .000 end play to preload the differential bearings (see "Specifications").

Tighten bearing cap bolts to specified torque (see "Torque Chart"). $\begin{tabular}{ll} \hline \end{tabular}$

Recheck gear lash to make certain that the lash setting has not been changed.

Install adjusting ring locks and cotter pins.

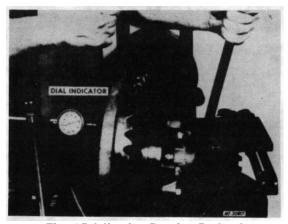


Fig. 35 Adjusting Bearing Preload

Check Gear Tooth Contact

The final check of differential assembly adjustment is checking the gear tooth contact by the paint impression method.

Apply oiled red lead lightly to the hypoid gear teeth. When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts (Fig. 36).

Sharper impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the gear teeth. Coast side should be correct when drive side is correct. Generally, coating approximately twelve teeth is sufficient for checking purposes.

With adjustments properly made, a correct tooth contact similar to that shown in Fig. 36 will be secured. The area of contact starts near the toe of the gear and extends about 621 percent of the tooth length. This adjustment results in a quiet running gear and pinion set which, because the load is distributed over the teeth within the proper area, will deliver all the long service built into it.

When checking paint impressions on gear teeth of an axle under heavy load, the impressions usually spread out somewhat longer than the patterns obtained from a bench test. This can be considered as normal. Ring gears when mounted should show a bearing toward the toe or small end of the tooth, but never at the heel or large end. The reason being that it is practically impossible to make gears and gear mounting so rigid that no deflection will occur when full torque is applied.

This deflection causes the bearing to approach the heel of the tooth. And when gears are adjusted so that the bearing is toward the heel of the tooth, it results in a concentration of load on the top corner of the heel and breakage will follow.

COAST DRIVE PROPER TOOTH CONTACT COAST DRIVE TOO MUCH TOE BEARING COAST DRIVE TOO MUCH HEEL BEARING COAST DRIVE BEARING TOO LOW COAST DRIVE BEARING TOO HIGH COAST DRIVE CROSS BEARING MT-3019

Fig. 36 Tooth Contact Impressions

FORWARD REAR AXLE

Assemble Inter-Axle Differential

 If removed, apply a coating of rear axle lubricant to bushing and install in rear half of diff case using installer tool (SE-2024) and proper disc from (SE-1905) set to support diff case half. (Fig. 37).

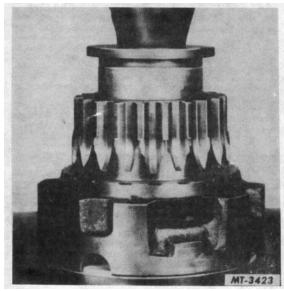


Fig. 37 Installing Bushing In Rear Half of Diff Case

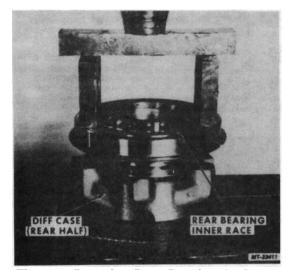


Fig. 38 Pressing Rear Bearing On Inter-Axle Diff Case - Rear Half

 Press front and rear bearings onto case halves using suitable adapters and support blocks for inner bearing races (Figs. 38 and 39). When pressing front bearing on to case be certain large radius on inner race of bearing is next to case.

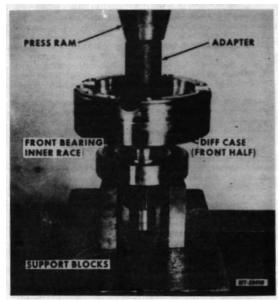


Fig. 39 Pressing Front Bearing On Inter-Axle Diff Case Front Half.

- Apply rear axle lubricant to diff case halves and to all differential component parts.
- Position thrust washer and rear side gear in rear half of diff case.
- 5. Place spider, spider pinion gears and pinion gear thrust washers in position in rear half of diff case.
- Position thrust washer and front side gear in front half of diff case.
- Align the notch marks and assemble the diff case. Draw assembly together with four equally spaced bolts. Make sure side gears and spider pinion gears mesh correctly.
- Check for free rotation of gears. If satisfactory, install remaining diff case bolts.
- Tighten case bolts to specified torque (see "Torque Chart").

Establish Inter-Axle Diff-To-Cover (Nose Cone) End Play

Diff case-to-cover (nose cone) end play is controlled by shims placed between the front bearing and the diff cover, as shown in Fig, 40). The instructions below tell how to determine the thickness of shims required to keep end play within specified limits.

The following instructions show the intermediate case removed from the diff carrier; however, a similar procedure can be followed to determine the shim thickness while the intermediate case is mounted on the diff carrier. Be careful to prevent differential from falling to avoid personal injury or damage to parts.

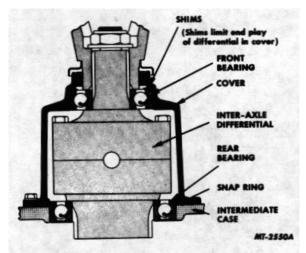


Fig. 40 Cross-Section Showing Shims Used To Control Inter-Axle Diff End Play

- Position diff case in intermediate case by inserting rear bearing into bearing bore of intermediate case.
 Tap on end of input shaft with a fiber or plastic hammer (do not use soft metal hammer) to seat rear bearing snap ring firmly against intermediate case.
- Assemble diff cover to diff case. Do not include shims, diff cover gasket, or diff cover oil seal. Tap cover with a soft hammer to seat cover firmly against intermediate case.
- Using a feeler gauge, measure clearance between front bearing and cover. This clearance represents the total amount of case-to-cover end play. Note and record this amount.

4. To determine the thickness of shims required to obtain the specified end play, subtract the amount of permissible end play .00-.12 mm (.000-.005") from the total end play found in step 3 above. For Example:

Total End Play (per step 3) . 70 mm (.028")

Minus Specified End Play . 000-.12 mm (.000-.005")

Leaves Required Shim .58-.70 mm

Thickness Range of . . . (.023-.028")

Shims are furnished in thicknesses of .13 to .25 mm (.005 and .010"). Select a shim pack with a total thickness within the range of required thickness found above.

Thus:

Total End Play (per step 3) .70 mm (.028")

Minus Thickness of Shim

Pack <u>.63 mm (.025")</u>

Leaves Final End Play of .07 mm (.003"). and is within the specified limits of .000-.12 mm (.000-.005")07 mm (.003")

- 5. Remove the differential cover from intermediate case and position shim pack (as determined above) between front bearing and cover (Fig. 41).
- Replace cover on intermediate case making sure shims are centered on bearing race to avoid pinching shims between cover and O.D. of bearing. Tap cover with a soft hammer to seat cover firmly against intermediate case.
- Check end play by measuring clearance between the shims and the cover. Clearance (end play) should be within specified limits.

While .000 end play is permissible, it is important that the bearings not be loaded with side thrust. Therefore, end play between specified limits is desired.

8. After determining amount of shims required to obtain correct end play, remove diff cover and remove the

inter-axle differential (with bearings) from the intermediate case.

 Press oil seal into diff cover (see Fig. 42). Press oil seal into cover until outer face of seal is flush with end of cover.

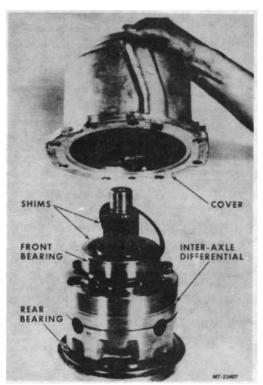


Fig. 41 Shims For Limiting Differential Case-To-Cover (Nose Cone) End Play



Fig. 42 Installing Inter-Axle Diff Cover Oil Seal



- 10. With shim pack in position on bearing, install diff cover (with oil seal) on diff case.
- 11. Install input flange, washer and end nut.
- 12. Using suitable flange holder tool or by clamping assembly in vise (Fig. 43), tighten end nut to specified torque. (see "Torque Chart")



Fig. 43 Tightening Companion Flange Nut

Assemble Power Divider Intermediate Case

- Assemble idler shaft bearings, bearing races and bearing spacer to idler gear. On models RA-351 and 355, position the bearing spacers correctly to index oil groove in rear spacer with oil passage in idler shaft (see Fig. 44).
- 2. Position idler shaft in intermediate case so flats on rear of shaft will index with flats in differential carrier.
- 3. Support front face of intermediate case and press idler shaft into position.
- Install idler shaft end nut and washer. Tighten nut to specified torque. Use flats on end of shaft to hold shaft from turning while tightening nut
- 5. Using a dial indicator, check end play of idler gear. End play should be within specified limits. (See "Specifications.")
- 6. If end play is not within specified limits, remove idler shaft and idler gear and change the bearing spacer. End play can be reduced by installing a thinner spacer or increased by installing a thicker spacer. Determine spacer thickness with micrometer and make new selection accordingly.

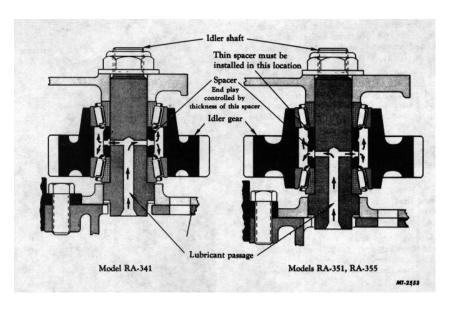


Fig. 44 Cross Section Of Idler Shaft Installation

While .000 end play for idler shaft is permissible, it is important that bearings not be loaded with side thrust. Therefore, end play between specified limits is desired.

7. Assemble and install input gear.

RA-341:

- a. Press bearing on input gear.
- Install bearing retaining nut. Clamp gear in vise and tighten retainer nut using SE-2247 wrench (Fig. 45). Tighten to specified torque. Use punch to stake nut to gear end.
- c. Check input gear bearing end play with a dial indicator .025-.076 mm (.001.003").
 Use bearing spacers as required to obtain correct end play.
- d. When end play is correct and retainer nut is final torqued, stake retainer nut at milled slot in input gear.
- e. Position gear and bearing assembly in intermediate case. Support rear face of case and press bearing into case bearing bore. Press bearing to rear sufficiently to install bearing snap ring.
- f. Install snap ring on bearing and press bearing and gear forward until snap ring seats firmly against shoulder of case.

RA-351 and 355:

- Using bearing spacer previously removed for a trial assembly, install bearings and cage on input gear and clamp assembly in vise.
- Install bearing retaining nut and, using SE-2247 bearing nut wrench, tighten to specified torque (Fig. 45). Use punch to stake nut to gear end.
- Install input gear bearings and bearing retainer into intermediate case. Secure cage with six hex bolts. (See "Torque Chart").

Assemble Output Shaft

- 1. Support output shaft bearing and press output shaft into bearing.
- 2. Tap bearing case of retainer over bearing and secure with snap ring.
- 3. Install seal in bearing case.
- 4. Install flange and end nut.
- 5. Clamp flange in vise or use flange holder tool and tighten output shaft end nut to specified torque. (See "Torque Chart".)

Assemble Inter-Axle Differential To Intermediate Case

 Position diff lock clutch shift collar on input gear (Fig. 46).

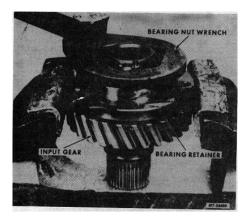


Fig. 45 Tightening Input Gear Bearing Retaining Nut (RA 351, 355 Shown RA-341 Similar)

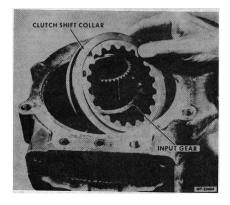


Fig. 46 Installing Clutch Shift Collar

- Apply a 3 mm (1/8") bead of gasket sealant on intermediate case.
- Position inter-axle differential assembly on intermediate case (Fig. 47). Make sure teeth on rear of differential mesh with clutch shift collar previously installed.

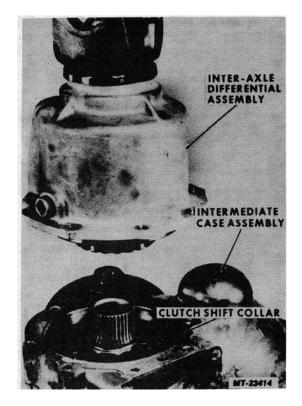


Fig. 47 Installing Inter-Axle Differential

 Install diff cover bolts. Tighten to specified torque. (See "Torque Chart".)

Install Intermediate Case And Inter-Axle Differential To Diff Carrier

- Apply a 3 mm (1/8") bead of gasket sealant on intermediate case.
- Position intermediate case assembly on diff carrier (Fig. 48). Make sure flats on end of idler shaft index with flats in carrier.
- 3. Install intermediate case bolts. Tighten evenly to specified torque. (See "Torque Chart" .)

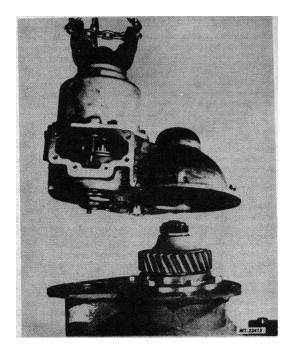


Fig. 48 Installing Intermediate Case To Diff Carrier
Install Power Divider Lockout Control Assembly

1. Apply 3 mm (1/8") bead of gasket sealant on intermediate case opening and install lockout control housing assembly (Fig. 49).

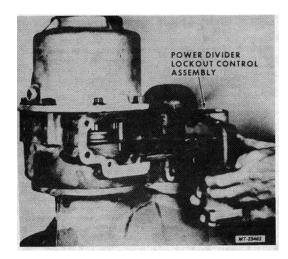


Fig. 49 Installing Lockout Control Assembly

 Install lockout control housing mounting bolts. Tighten to specified torque (See "Torque Chart").

Assemble Power Divider And Diff Carrier To Axle Housing

- Support carrier assembly on roller jack. Secure as necessary to prevent carrier assembly from falling from jack.
- 2. Apply 3 mm (1/8") bead of gasket sealant on axle housing.
- Align carrier assembly with axle housing and roll into position. A small pinch bar may be used to straighten carrier in housing but be careful to avoid damage to carrier or axle housing.
- Install carrier mounting stud nuts and tighten evenly to specified torque. (See "Torque Chart".)
- 5. Place liquid gasket on axle housing mounting face and insert output shaft into position. Rotate output shaft slightly to mesh shaft splines with inter-axle differential side gear.
- 6. Install bearing retainer bolts. Tighten to specified torque 41-52 N-m (30-38 ft. lbs.)
- 7. Install axle shafts. Tighten axle flange bolts to 295-326 N-m (217-240 ft. lbs.)
- 8. Connect propeller shaft to output shaft.

IMPORTANT

When installing propeller shaft connecting forward and rear rear axles of the tandem, the slip yoke splines of shaft must be toward front.

9. Connect power divider lockout control. Refill axle with lubricant (See Lubrication) .

REAR REAR AXLE

Install Diff Carrier To Axle Housing

- 1. Using chain sling and hoist, move diff carrier from rebuild stand to roller type floor jack.
- 2. Apply liquid gasket to carrier flange and roll the carrier into position on axle housing.
- 3. Install housing bolts and tighten to specified torque 217-240 N-m (160-175 ft. lbs.).

- Connect propeller shaft to companion flange and install axle shafts.
- 5. Insert drain plugs and fill housing with prescribed quantity and type of new lubricant.

POWER DIVIDER LOCK

OPERATION

During normal operation the power divider lock is kept in the disengaged position. In this position the inter-axle differential of the power divider allows both axles of the tandem to differentiate or drive independent of each other.

When maximum traction is required such as for pulling through deep sand, mud or snow, the lockout control on dash is operated to engage the power divider lock. This activates the shift fork shaft and fork in power divider to lock up the inter-axle differential and provide positive drive to both forward and rear axle units.

The lockout mechanism must be engaged only when the truck is standing still. It should be kept engaged only as long as positive traction is required. Continuous unnecessary engagement will result in excessive tire wear and may damage the axles.

The power divider lockout is controlled by either a valve or switch on the vehicle instrument panel. A "tell-tale" warning light is also provided on instrument panel to indicate when power divider lock is engaged.

Three different kinds of power shift systems are used to actuate the power divider lock. These systems are covered in paragraphs which follow.

ELECTRIC SHIFT SYSTEM

The electric shift system consists of an electric powered motor unit mounted on the forward rear axle with a control switch on dash.

For complete information on the electric shift system (Maintenance, Trouble Shooting, Rebuild, etc. See REAR AXLES CTS-2774 in the Service Manual).

VACUUM SHIFT SYSTEM

The vacuum shift system consists of a vacuum power unit mounted on the forward

rear axle with a control valve located on the instrument panel. The power source for the vacuum shift system is vacuum from the engine intake manifold for gasoline engines or a vacuum pump for diesel engines. If either the vacuum power unit or vacuum control valve are defective they must be replaced.

AIR SHIFT SYSTEM

The air shift system consists of an air power cylinder mounted on the forward rear axle with an air control valve on the instrument panel. The power divider lock is disengaged by air pressure and spring controlled for engagement ("lock in").

When the PDL (Power Divider Lock) control is placed in the "lock" position air in the system is exhausted and the PDL will shift to the "lock" mode.

When the PDL control is placed in the "unlock" position, air pressure will hold the PDL in the disengaged mode.

The air control valve, control cylinder, hoses and pipe connections of air control systems should be inspected periodically for leakage and other repairs. At time of axle overhaul, control cylinder and control valve should be inspected carefully and worn or damaged parts replaced.

MAINTENANCE

AXLE SHAFTS

Axle failure can also be attributed to the axle shaft. For this reason it is most important that shafts be installed properly, be of correct size and lengths for splines to engage fully and be kept free from runout or bends.

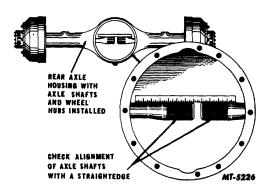


Fig. 50. Method of Checking For Bent Housing

AXLE HOUSING

The axle housing is of one piece construction with an opening in the center for mounting the diff carrier. A flange is welded to the outer ends of the axle housing for mounting the brake backing plates. A bent axle housing can be the cause of early axle failure and whenever an axle is rebuilt this condition should always be checked before going ahead with the assembly. Fig. 50 gives a quick method of checking for a bent housing,.

The condition of axle housing cover weld should also be checked. If cover weld is cracked, oil seepage from housing can occur. Rewelding of housing cover is permitted providing special cleaning precautions and recommended welding procedures are observed.

Procedure for repairing cracked weld or leaking housing cover is as follows:

- 1. Drain differential and remove diff carrier assembly.
- 2. Clean lube from inside of housing and burn remaining lube from inside with torch.
- 3. Clean residual lube from housing with solvent.
- Grind or air arc cracked weld from outside of cover weld to base metal.
- Weld three passes around outside of cover using 1/8" Spec. No. E7016 Weld Rod and supplier's recommended amperage and voltage. Thoroughly clean weld area between passes.
- 6. Weld one pass around cover (360 degree) inside housing using same weld rod as above.
- 7. Remove all weld splatter and slag from inside of housing and return housing to service.

LUBRICATION Draining And Refilling Instructions

To drain axle lubricant from forward axle and power divider, remove drain plugs from bottom of axle housing and bottom of the power divider intermediate case.

To drain the rear rear axle, remove the drain plug from the axle housing.

To fill the forward rear axle, make sure all drain plugs are tight. Pour 0.5 liter (1 pint) of

lubricant into the power divider at plug on top of inter-axle diff cover. Fill axle housing to the level of filler hole.

To fill rear rear axle, make sure all drain plugs are tight. Fill to level of filler hole. On initial lubrication of new or rebuilt axles, pour 0.5 liter (1 pint) of lubricant into pinion bearing cage at filler plug provided in differential carrer.

To assure initial lubrication of rebuilt axle assemblies, it is recommended that the axles be "run-in" to distribute the lubricant.

This is accomplished by raising and securely blocking all rear wheels off the floor and operating the axles at medium speed for approximately two to three minutes. After running in axles, recheck lubricant level.

Slip Joints

The propeller shaft slip joint splines must be free to slip as required to compensate for articulation of the axles. Keep slip joints lubricated. When operating under dusty, wet or muddy conditions, more frequent lubrication of the propeller shaft may be required. Inspect slip yoke dust seals and replace worn or damaged seals to prevent entry of dirt or moisture which might cause binding or seizing of slip joint splines.

SPECIAL TOOLS				
SE-1065-A	Pinion Gauge			
SE-1065-64	Pinion Gauge Discs			
SE-1905	Remove and Installer Set			
SE-1933	Torque Multiplier Wrench			
SE-2024	Installer Tool			
SE-2222	Riveting Fixture			
SE-2247	Bearing Nut Wrench			

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TROUBLE SHOOTING

Serious trouble in a rear axle can be prevented if sufficient attention is given to the various causes of trouble and the proper remedy is applied. The following list gives most of the common kinds of axle trouble and suggests a possible cause to be corrected.

Constant Noise

- 1. Lubricant not to specified level.
- 2. Incorrect kind and weight of lubricant.
- 3. Wheel bearings out of adjustment or defective.
- 4. Drive gear and pinion not in adjustment for correct tooth contact.
- 5. Teeth of drive gear and pinion chipped or worn.
- 6. Too much or too little pinion to gear backlash or overlap of wear pattern.
- 7. Loose or worn pinion bearings.
- 8. Loose or worn side bearings.

Intermittent Noise

- 1. Drive gear does not run true.
 - (a) Uneven pressure on drive gear rivets.
 - (b) Warped drive gear.
- Loose or broken differential bearings in either axle or in inter-axle differential.

Noisy On Turns Only

- Differential pinion gears tight on differential spider.
- 2. Side gears tight in differential case.
- 3. Differential pinion or side gears defective.
- 4. Thrust washers worn or damaged.
- 5. Excessive backlash between side gears and pinions.

It should be noted that noises from other units of the truck such as propeller shafts, universal joints, tires and even transmissions are often incorrectly diagnosed as rear axle noise. This possibility should not be disregarded when trouble shooting.

Lubricant Leaks

- 1. Loss through axle shafts.
 - (a) Lubricant above specified level.
 - (b) Incorrect kind and weight of lubricant.
 - (c) Restricted axle housing breather valve.
 - (d) Worn or incorrectly installed axle shaft oil seal.
- 2. Loss at pinion shaft.
 - (a) Lubricant above specified level.
 - (b) Incorrect kind and weight of lubricant.
 - (c) Restricted axle housing breather valve.
 - (d) Pinion oil seal worn or incorrectly installed.
 - (e) Lubricant return passage in diff carrier housing restricted.
 - (f) Universal joints companion flange loose on pinion shaft.
- 3. Loss at axle housing cover.
 - (a) Insufficient or defective seam weld.
 - (b) Cracked seam weld.

Rear Wheels Do Not Drive (Propeller Shaft Rotating)

- 1. Broken axle shaft.
 - (a) Loose wheel bearings.
 - (b) Axle shaft too short.
 - (c) Loose flange studs or nuts.
 - (d) Bent housing.
- 2. Drive gear teeth stripped.
- 3. Side gear or differential pinion broken in either axle or in inter-axle differential.
- 4. Differential spider broken in either axle or in inter-axle differential.

SPECIFICATIONS

IH MODEL		RA-341	RA-351	RA-355
IH CODE		14341	14351	14355
LOAD RATING:	Metric Ton	13.5	15.2	17.3
	lbs	30000	34000	38000
PINION:				
Nominal Dimension	mm	88.20	95.75	
	in	3.4725	3.769	5
SE-1065 Disc (Pinion Setting Gauge)		D(2)		0(2)
Pinion Bearing Preload			l	- ()
(Cage Rotating Torque)	Kgs		1.35-3.6	
(1131 1111 3 1111)	lbs		3-8	
DIFFERENTIAL:				
Bearing Preload (Notches)		1 Ea. Side	1 1/2 Total	Roth Sides
Dearing Freioad (Notches)		I La. Side	1 1/2 10(a)	Dotti Gides
Drive Gear To Pinion Backlash	mm	.20	.25	
	in	.008	.010	0
Drive Gear Rivet Pressures	Metric Ton		40.8-45.3	
	U.S. Ton		45-50	
POWER DIVIDER:				
Idler Gear Bearing End Play	mm		.0007	
,	in		.000003	
Inter-Axle Diff End Play	mm		.000012	
·	in		.000005	
Input Gear Bearing End Play	mm		.0308	
	in		.001003	
AXLE HOUSING:				
Lubricant Capacity				
Forward Rear Axle*	liters	11.4		10.4
	pints	24		22
Rear Rear Axle*	liters	12.3		11.4
	pints	26		24
SERIAL NUMBER LOCATION		On Bolt Circle	of Diff Carrier	

^{*} Pour 0.5 Liter (1 pint) of total through filler hole in top of nose cone on forward axle or top of pinion on rear rear axle.



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IH MODEL	RA-	341		<u>351</u>	<u>RA-355</u>		
	<u>N-m</u>	Ft lbs	<u>N-m</u>	Ft lbs	<u>N-m</u>	Ft lbs	
Input Shaft End Nut	1 1/4 510-575	4-12 375-425	1 1/- 510-575	4-12 375-425	1 1/ 510-575	/4-12 375-425	
Inter-Axle Diff Case Bolts		-13 75-85	1/2 102-115		1/2 102-115	2-13 75-85	
Inter-Axle Diff Cover Bolts	1/2 [.] 96-115	-13 70-85	1/2 96-115		1/2 96-115		
Idler Shaft Nut	1 1/8 339-407			250-300	1 1 <i>/</i> 339-407	/8-12 250-300	
P.D. Case to Diff Carr. Bolts	1/2 [.] 96-115	-13 70-85	1/2 96-115	-13 70-85	1/2 96-115	2-13 70-85	
P.D. Input Gear Brg. Ret. Nut	2 1/2 540(min)	2-16 400(min)	2 1/2 540(min)	2-16 400(min)	2 1/ 540(min)	/2-16 400(min)	
Pinion End Nut		3-18 325(min)	1 3/- 1225-1675		1 3/ 1225-1675		
Pinion Cage to Carrier Bolts		6-12 115-125	9/16 155-170	6-12 115-125	9/1 155-170	6-12 115-125	
Diff Carrier to Housing Bolts	5/8 [.] 217-240	-11 160-175		-11 160-175	5/8 217-240	3-11 160-175	
Diff Case Bolts		6-18 120-130	9/16 162-176	6-18 120-130	9/1 162-176	6-18 120-130	
Diff Brg. Cap to Carrier Bolts		-10 275-300		-10 275-300	3/4 370-405	1-10 275-300	
Axle Flange to Wheel Stud Nuts		-18 125-145		-18 125-145	3/ ² 236-290	1-16 175-215	
Inter Axle Lockout Cyl.Mtg.Bolts	3/8 [.] 41-51	-16 30-38	3/8 41-51	-16 30-38	3/8 41-51	3-16 30-38	
Output Shaft Brg Retainer Bolts	3/8 [.] 41-51	-16 30-38	3/8 41-51	-16 30-38	3/8 41-51	3-16 30-38	
Output Shaft End Nut	1 1/4 510-575	4-12 375-425	1 1/- 510-575	4-12 375-425	1 1, 510-575	/4-12 375-425	
Lockout Cylinder Piston Bolt	3/8- 21-27	-24 15-20	3/8 21-27	-24 15-20	3/8 21-27	3-24 15-20	
Lockout Cylinder Cover Bolt	1/4 9.5-12	-20 7-9	1/4 10-12	-20 7-9	1/4 10-12	1-20 7-9	



REAR AXLE

SINGLE REDUCTION TANDEM

IH CODE

IH MODEL

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			SPECIFICATIONS				
IH Model		RA-341	RA-351	RA-355	RA-386	RA-387	
IH C	ode		14341	14351	14355	14386	14387
Pinic	on: Nominal Dimension	mm inch	88.20 3.4725		95. 3.76		
SE-1	065 Disc Pinion Setting Gauge		D-2	0(2)			
	Pinion Bearing Preload (Pinion Cage Rotating Torque Scale Reading)	Kgs lbs.	1.35-3.6 3-8		1.35 3-		
Diffe	rential: Differential Bearing Preload (Notch/s)		1 Each Side		1 1/2 - 3 T	otal Both Si	des
	Ring Gear to Pinion Gear Backlash	mm inch	.20 .008			25)10	
	Ring Gear Rivet Pressures (Tons)	US Metric	45-50 40.8-45.3			5-50 3-45.3	
Powe	er Divider: Idler Gear Bearing End Play	mm inch	000 07 000003)07)003	
	Inter-Axle Differential End Play	mm inch	000013 000005)013)005	
	Input Gear Bearing End Play	mm inch,				07 1003	
Hous	Lubricant Capacity: *Forward Rear Axle		25 pints 11.8 liters		10.	pints 9 liters	
	Rear Rear Axle		26 pints 12.3 liters			pints 4 liters	

^{**} Unit Serial Number Location
* Pour one pint of total through hole in top of inter-axle differential cover.

^{**} On bolt circle of differential carrier.

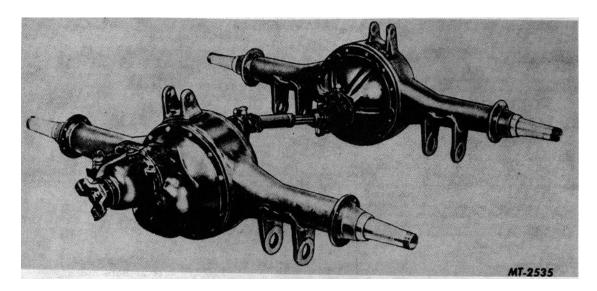


Fig. 1. IH Thru-Drive Tandem Rear Axle.

DESCRIPTION

The IH thru-drive tandem rear axle consists of a heavy-duty single reduction axle with integral power divider and inter-axle differential for the forward rear axle and a conventional heavy-duty single reduction axle for the rear rear axle. Differential parts, ring gear and pinion set s, bearings, and axle shafts are common between the forward and rear axles.

The forward axle has the power divider and interaxle differential mounted on the forward side of the differential carrier. A thru-shaft carries driving torque through the forward axle housing to the rear rear axle. Driving torque is delivered to the forward rear axle via the intermediate idler gear and a driven gear mounted on the pinion shaft of the forward axle.

The complete differential carrier and power divider may be removed from the forward axle housing as a unit with the axle mounted in the truck as well as when the axle is removed. Also the power divider may be removed individually without removing the differential carrier. This permits servicing the power divider without disturbing the forward axle differential.

GENERAL

This section covers service procedures for both forward and rear rear axles. Specifications and torque values given are also for both axles.

Cleanliness is important during the overhaul procedure. Entry of dirt into the unit could result in damage and early failure of component parts. The unit should be thoroughly cleaned externally before disassembly. After disassembly, all parts should be thoroughly washed in clean solvent.

All parts should be inspected carefully for wear, damage, or other indications of short service life to determine what repairs are needed and what corrective measures should be taken to prevent recurrence of difficulties. Any questionable parts should be replaced. Reference to "TROUBLE SHOOTING" given in this section will aid in analyzing difficult ties as well as provide corrective suggestion s.

Particular attention must be given to assure correct reassembly of parts. The

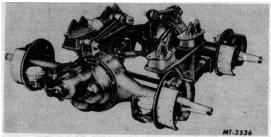


Fig. 2 Tandem Axle Suspension System (Rubber Load Cushion Type).

unit is designed to operate efficiently only when parts are assembled and adjusted properly.

When reassembling the unit, all gears, bearings and other moving or contacting parts should be prelubricated with clean axle lubricant.

DISASSEMBLY

FORWARD REAR AXLE:

Removal of Power Divider and Differential Carrier Assembly from Axle Housing.

 Drain lubricant from axle housing and power divider. To drain power divider, remove plugs from bottom of inter-axle differential cover and bottom of power divider intermediate case. See Fig. 47.

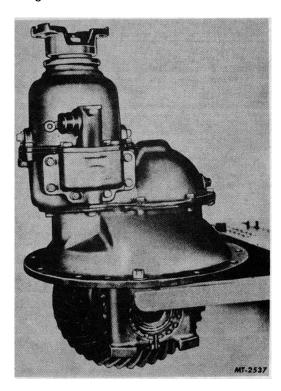


Fig. 3 Power Divider and Differential Carrier Assembly Mounted In Rebuild Stand.

- 2. Remove axle shafts. After removing axle flange stud nuts, install puller screws in tapped holes in axle flanges. Turn puller screws in to force axle shafts outward.
- Disconnect inter-axle lock control linkage from lever at lock control housing. On trucks with air or vacuum lock controls, disconnect air or vacuum pipe at cylinder.
- 4. Disconnect propeller shafts from input and thrushaft flanges.
- Remove thru-shaft bearing retainer bolts. Use a soft hammer to loosen bearing retainer from axle housing. Withdraw bearing cage and thrushaft from axle housing.
- Loosen differential carrier-to-axle housing stud nuts. Remove all nuts and lock washers except top two. These two nuts will prevent carrier assembly from falling.
- 7. Support carrier assembly on roller jack. Secure as necessary to prevent carrier from falling from jack when removed from housing.
- 8. Remove top two carrier stud nuts. Loosen locknuts and turn puller screws in to break carrier away from housing. A small pinch bar may be used to straighten carrier assembly in housing, but be careful to avoid damage to carrier flange. Remove carrier assembly from axle housing.
- Roll jack and carrier assembly from under truck. Mount carrier assembly in suitable rebuild stand. See Fig. 3.

Removal of Power Divider Assembly from Differential Carrier.

- Remove bolts from inter-axle lock control housing and remove lock control housing, see Fig. 4.
- 2. Remove inter-axle differential cover bolts and lift inter-axle differential assembly from power divider intermediate case, see Fig. 5.
- 3. Remove intermediate case-to-differential carrier bolts and lift intermediate case from differential carrier, see Fig. 6.



Fig. 4. Removing Inter-Axle Lock Control Assembly.

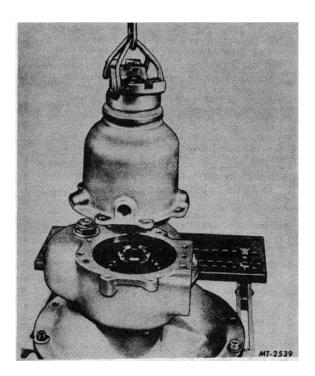


Fig. 5. Removing Inter-Axle Differential.

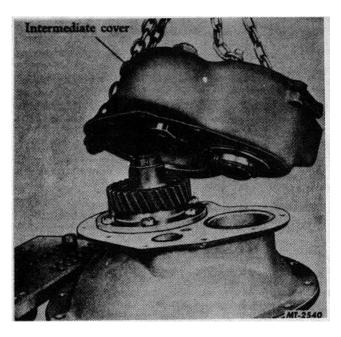


Fig. 6 Removing Power Divider Intermediate Case Assembly.

Disassembly of Inter-Axle Differential.

1. Remove input flange nut. Secure flange with suitable flange holder tool or by clamping in vise, see Fig. 7.

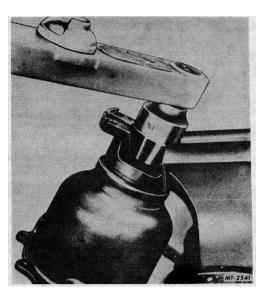


Fig. 7 Removing Input Flange Nut.

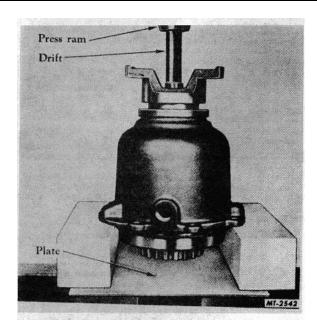


Fig. 8 Pressing Inter-Axle Differential From Cover.

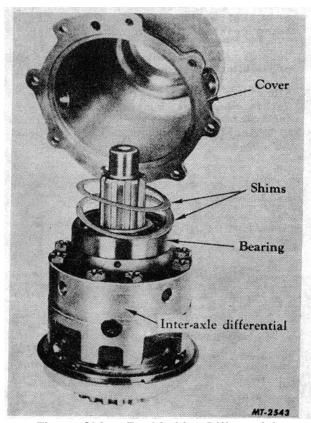


Fig. 9 Shims For Limiting Differential Case-To-Cover End Play.

2. Press inter-axle differential assembly from cover and flange, see Fig. 8.

Use a plate under support blocks to prevent differential assembly from falling to floor when bearing clears cover.

- 3. Note and retain shims located between front bearing and cover. These shims limit end play of differential assembly in cover, see Fig. 9.
- 4. If necessary to remove bearings from differential case, pull bearings using suitable pullers, see Fig. 10.
- 5. Match mark differential case halves with a punch or chisel to assure correct alignment upon reassembly.
- 6. Remove differential case bolts and separate case halves.
- 7. Remove differential spider, spider pinion gears, side gears, and thrust washers, see Fig. 11.
- 8. Remove oil seal from inter-axle differential cover.
- 9. If necessary to remove bushing from rear half of differential case, collapse bushing inward by inserting point of chisel between bushing and case at seam of bushing. Avoid damaging case.

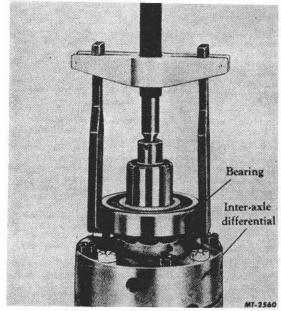


Fig. 10 Removing Front Bearing From Inter-Axle Differential.

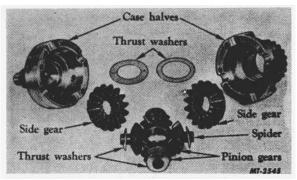


Fig. 11 Components of Inter-Axle Differential

Disassemble Power Divider Intermediate Case

- 1. Lift inter-axle lock clutch ring from power divider input gear.
- 2. Remove and disassemble input gear. RA341:
- a. Press input gear to rear sufficiently to free bearing snap ring. Remove snap ring.
- b. Remove input gear and bearing by pressing forward to free bearing from bore.
 - c. Clamp input gear in soft-jawed vise.
- d. Remove bearing retainer nut using SE1996 wrench and SE1933 multiplier wrench, Fig. 12.
 - e. Pull bearing from input gear with puller tool.

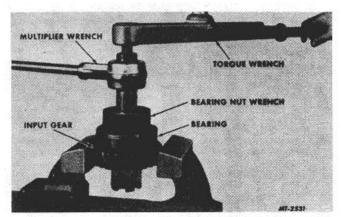


Fig. 12 Removing or Tightening Input Gear Bearing Retainer Nut (RA-341)

RA-351, 355, 386 and 387:

a. Remove bearing retainer mounting bolts from rear of intermediate case and tap input gear, bearings and retainer assembly out toward front.

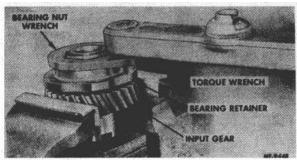


Fig. 13 Removing or Tightening Input Gear Bearing Retainer Nut (RA-351, 355, 386 and 387)

- b. Clamp input gear in soft-jawed vise.
- c. Remove bearing retainer nut using SE2247 bearing nut wrench, Fig. 13.
- d. Disassemble retainer and bearings from input gear.

Inner bearing is a press fit on gear and will most likely be damaged if removed. It should be removed only if replaced.

- 3. Loosen idler shaft end nut using torque multiplier wrench. Use flats provided on shaft end to hold shaft from turning while nut is being loosened. Remove nut and washer.
- 4. Support rear face of intermediate cover and press idler shaft out of case (see Fig. 14).
- 5. Slide idler gear and bearings from cover. Separate bearings, bearing races and bearing spacer from idler gear. Note that models RA-351, 355, 386 and 387 use two bearing spacers.

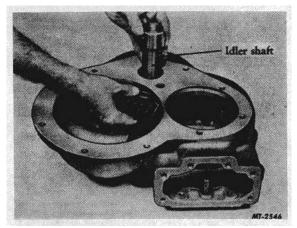


Fig. 14 Removing Idler Shaft

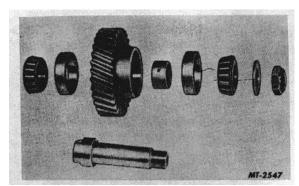


Fig. 15 Exploded View Of Idler Gear Components (Model RA-341 Shown).

Disassembly of Thru-Shaft Assembly.

- 1. Mount thru-shaft in vise by clamping flange in jaws of vise.
- 2. Loosen end nut and remove nut, washer, and flange.
- 3. Remove bearing retainer with seal and snap ring.
- 4. Use snap ring tool to remove snap ring from bearing retainer. Drive or press oil seal from bearing retainer.
- 5. Using a suitable sleeve to support bearing inner race, press bearing from shaft.

REAR REAR AXLE:

Removal of Differential Carrier from Axle Housing.

- 1. Drain lubricant from axle housing,
- 2. Take off all nuts from studs around rear wheel hub.
- 3. Install puller screws in the two tapped holes provided in axle shaft flange.
- 4. As puller screws are turned in, axle shaft flange will be forced away from hub and out of housing.
- 5. Remove mounting nuts from carrier to axle housing flange.
- 6. Use puller screws provided in carrier mounting flange to start carrier from housing.
- 7. Support weight of carrier safely on roller type floor jack or portable floor lift and roll jack and carrier out from under truck.

8. Mount differential carrier in rebuild stand.

FORWARD AND REAR REAR AXLES:

Disassembly of Differential Carrier Assembly.

- 1. Remove cotter pins from bearing adjuster locks and remove locks.
- 2. Mark one bearing cap and leg of carrier with a punch or chisel to identify each for correct reassembly.

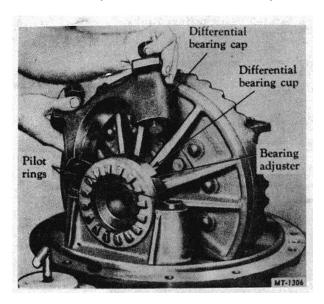


Fig. 16 Removing Differential Bearing Cap.

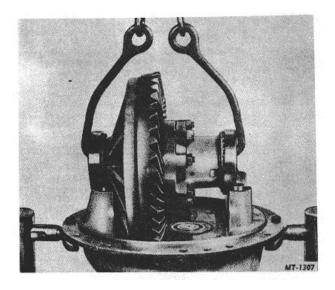


Fig. 17 Lifting Differential From Carrier.

- 3. Remove bearing cap bolts and take off the bearing caps and bearing adjusters. Note and retain the four bearing cap pilot rings, see Fig. 16.
- 4. Lift differential assembly from differential carrier, see Fig. 17. Tilt differential assembly to allow ring gear to pass pinion radial bearing. Place differential assembly on bench.

Disassembly of Differential.

- 1. Remove differential bearings from differential case using suitable puller.
- 2. Match mark differential case halves with a punch or chisel to assure correct alignment upon reassembly.
- 3. Remove self-locking nuts from differential case bolts and separate the differential case halves, see Fig. 18.

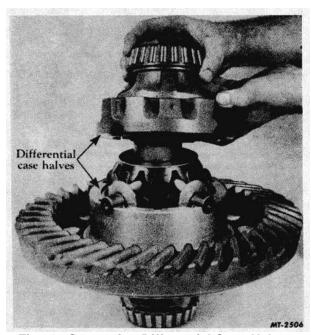


Fig. 18 Separating Differential Case Halves.

- 4. Remove differential spider, spider pinion gears, side gears, and thrust washers from differential case halves.
- 5. If necessary to remove ring gear from differential case, carefully center punch each rivet head on the ring gear side and drill through the rivet head with a drill .8 mm (1/32") smaller than the rivet body, see Fig. 20. Use a punch to press out the remaining portion of rivet. Never use a chisel to cut off rivet heads as damage to the differential case might result.

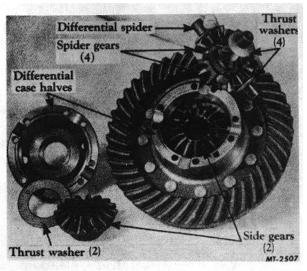


Fig. 19 Component Parts of Differential.

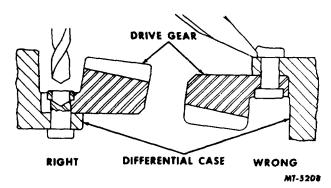


Fig. 20 Drive Gear Rivet Removal.

Removal of Pinion and Cage Assembly from Differential Carrier.

- 1. Remove bolts holding pinion cage to differential carrier.
- 2. Strike against rear of pinion shaft with a brass drift and hammer to start pinion and cage out of carrier, see Fig. 21.
- 3. Remove pinion and cage assembly from carrier, see Fig. 22.

WARNING: Be careful to avoid dropping the pinion and cage assembly. Personal injury or damage to parts may result if assembly is allowed to fall.

4. Retain pinion cage shims to aid in readjustment upon reassembly. Do not damage shims.

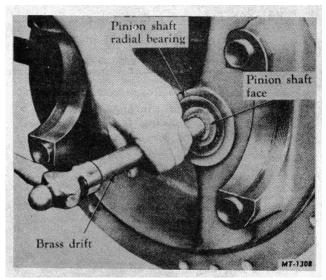


Fig. 21 Starting Pinion and Cage Assembly from Carrier.

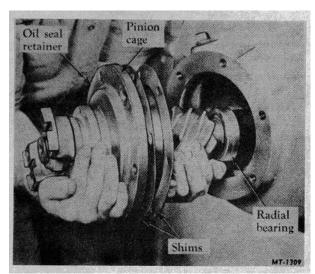


Fig. 22 Removing Pinion and Cage Assembly (rear rear axle shown).

Disassembly of Pinion and Cage.

- 1. Mount pinion and cage assembly in a heavy duty vise. Clamp pinion shaft driven gear (forward rear axle) or companion flange (rear rear axle) in vise (Fig. 23). Use jaw shields to avoid damage to driven gear.
- 2. Remove the pinion end nut. A torque multiplier wrench (SE-1933) is recommended for this operation together with another wrench having a handle 762.0 mm (30") long.

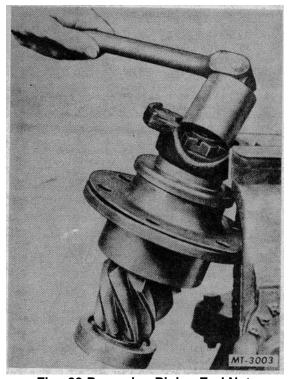


Fig. 23 Removing Pinion End Nut (rear rear axle shown).

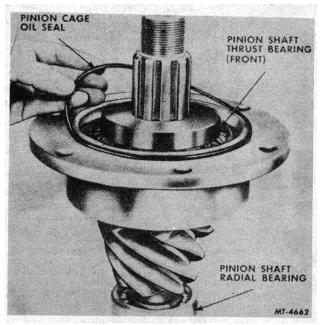


Fig. 24 Removing Pinion Cage Oil Seal (rear rear axle only).



- 3. Pull pinion shaft driven gear or companion flange from pinion.
- 4. Remove spacer from pinion shaft (RA-351, 355, 386 and 387 rear rear axle only).
- 5. Tap pinion from cage.
- 6. Remove pinion cage "'O" ring type seal, Fig. 24 (rear rear axle only).

- 7. Remove forward pinion bearing from cage.
- 8. Remove bearing spacer from pinion shaft.
- 9. Remove the rear pinion bearing and pinion radial bearing from the pinion shaft.

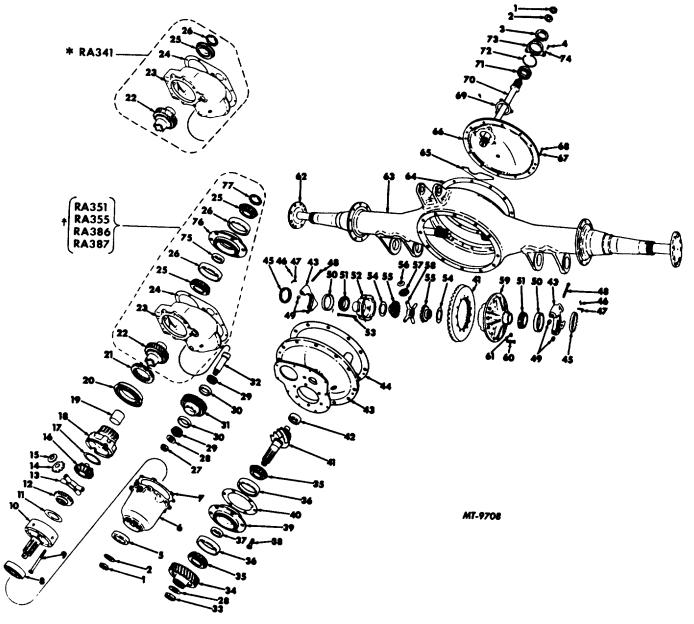


Fig. 25 Forward Rear Axle (Exploded View)

		Legend for Fig. 25	
Key	<u>Description</u>	<u>Key</u>	<u>Description</u>
1	NUT, companion flange	39	CAGE w/CUPS
2	WASHER, companion flange	40	SHIM, pinion bearing cage upper
3	SEA L, output shaft oil	41	GEAR SET, ring and pinion
4	BOLT, bearing retainer	42	BEARING, pinion pilot
5	SEAL, oil	43	CARRIER W/CAPS
6	COVER. intermediate differential	44	GASKET, differential carrier to housing
7	GASKET	45	ADJUSTER
8	BEARING, input shaft front	46	PIN, cotter
9	BOLT, intermediate diff. spider case	47	LOCK, differential bearing adjuster
10	CASE, intermediate diff front half	48	BOLT, differential bearing cap
11	WASHER, side gear front thrust	49	DOWEL, differential bearing cap
12	GEAR, intermediate diff. front side	50	BEARING, differential cup
13	SPIDER, intermediate differential	51	BEARING, differential cone
14	GEAR, intermediate differential pinion	52	CASE, differential (plain half)
15	WASHER, pinion gear front thrust	53	BOLT, differential case
16	GEAR, intermediate diff. rear side	54	WASHER, differential side gear thrust
17	WASHER, rear side gear thrust	55	GEAR, differential side
18	CASE w/BUSHING (rear half)	56	WASHER, differential pinion thrust
19	BUSHING, intermediate diff. side gear	57	GEAR, differential pinion
20	BEARING, case rear half	58	SPIDER, differential
21	RING, differential clutch	59	CASE, differential (flange half)
22	GEAR, differential input	60	RIVET, ring gear to differential case
23	CASE, adapter intermediate differential	61	NUT, differential case bolt
24	GASKET, intermediate differential case	62	SHAFT, axle
25	BEARING, complete*	63	HOUSING, axle
25	BEARING, cone †	64	GASKET, axle housing cover
26	NUT, input shaft bearing retainer*	65	NOT USED
26	BEARING, cup †	66	COVER, axle housing rear
27	NUT, idler shaft	67	BOLT, hex head
28	WASHER, idler shaft	68	WASHER, lock
29	BEARING, idler gear cone	69	GASKET, output shaft bearing retainer
30	BEARING, idler gear cup	70	SHAFT, output
31	GEAR w/BEARING	71	BEARING, output shaft
32	SHAFT, idler gear	72	RING, output shaft bearing snap
33	NUT, pinion shaft	73	RETAINER, output shaft bearing
34	GEAR, pinion shaft	74	WASHER, lock
35	BEARING, pinion cone	75	WASHER, rear input gear bearing †
36	BEARING, pinion cup	76	RETAINER, rear input gear bearing †
37	SPACER, pinion bearing	77	NUT, input gear bearing retainer †
38	BOLT, hex head lock		

*RA-341 Only † RA-351, RA-355, RA-386 and RA-387 Legend for Fig. 26

<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
4	NUT against the sec	40	OLUM airies bession essential
1	NUT, companion flange	13	SHIM, pinion bearing cage upper
2	WASHER, companion flange nut	14	GEAR SET, ring and pinion
3	FLANGE	15	BEARING, pinion pilot
4	S LINGER	16	PLUG, pipe, sq. hd.
5	RETAINER w/SEAL	17	CARRIER w/CAPS
6	SPACER, pinion bearing	18	GASKET, carrier to housing
7	SEA L, oil	19	DOWEL, differential bearing cap
8	BEARING, outer pinion cone	20	ADJUSTER, differential bearing
9	BEARING, outer pinion cup	21	LOCK, differential bearing adjuster
10	SPACER, outer pinion bearing	22	PIN, cotter
11	"O" RING, oil seal retainer	23	BOLT, differential bearing cap
12	CAGE w/CUPS	24	BEARING, differential cup



Legend for Fig. 26 (Continued)

<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
25	BEARING, differential cone.	32	WASHER, pinion thrust.
26	CASE, differential (plain half).	33	CASE, differential (flanged half)
27	BOLT, differential case.	34	NUT, differential case bolt.
28	WASHER, side gear thrust.	35	RIVET, ring gear to differential case.
29	GEAR, differential side.	36	NOT USED
30	SPIDER, differential.	37	SHAFT, axle.
31	GEAR, differential pinion.	38	HOUSING, axle.

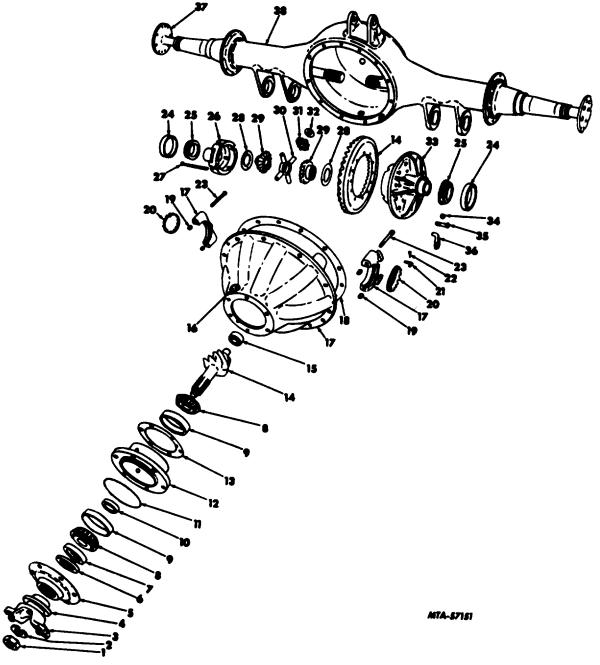


Fig. 26 Rear Rear Axle (Exploded View).

CLEANING, INSPECTION AND REPAIR

Remove all dirt, old lubricant, and gasket material from components of the rear axle. Immerse in cleaning solvent and use a stiff brush if necessary. Bearings should be cleaned separately in clean solvent and special efforts taken to protect their finely machined surfaces. If compressed air is used for drying, do not spin bearings while drying.

Examine all <u>bearings</u> for roughness, damage or wear by rotating each bearing slowly in the hand. If in doubt as to bearing condition, replace. Ring gear, drive pinion, differential pinions and any other gears should be checked for damaged teeth, worn spots, or distortion. Inspect differential case assembly for cracks, damage or distortion. Make sure splined ends of axle shafts are neither twisted or cracked. Shim packs should be of uniform thickness. Discard thrust washers and obtain new even when only slight wear is indicated.

REASSEMBLY

FORWARD AND REAR REAR AXLES:

Reassembly of Pinion and Cage.

- 1. Place rear pinion bearing on pinion shaft and press into place against pinion.
- 2. Place radial bearing on stub end of pinion shaft and press firmly against shoulder of pinion. Stake face of pinion shaft in six (6) evenly spaced places to secure radial bearing in place, see Fig. 27.

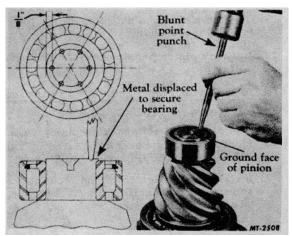


Fig. 27 Staking Pinion Radial Bearing.

3. Pre-lubricate the bearings with rear axle gear lubricant.

4. Place bearing spacer on pinion shaft and press against rear pinion bearing.

The bearing spacer is furnished in various thicknesses (in graduation of .025 mm (.001") to permit changing of spacer thickness to obtain correct Dinion bearing preload.

- 5. Insert pinion (with rear pinion bearing and spacer) into pinion cage.
- 6. Mount pinion and cage in arbor press. Place prelubricated from pinion bearing on pinion.
- 7. Press bearing into place firmly against bearing preload.
- 8. Revolve pinion cage around pinion several times to seat bearings correctly.
- 9. Remove pinion and cage from press.

ADJUSTMENT

The principal adjustments made on the differential carrier assembly are devised for establishing the proper gear tooth contact and thereby obtaining a long wearing, quiet running rear axle. Fundamentally, there are five adjustments to be covered and these are accomplished as the differential carrier assembly is assembled. To emphasize their importance these five steps or adjustments are listed here as well as in the actual assembly procedure. These adjustments are:

- 1. Preload the pinion bearings.
- 2. Establish the pinion nominal dimension.
- 3. Set gear lash.
- 4. Preload the differential bearings.
- 5. Check the gear tooth contact.

Pinion Bearing Preload.

Pinion bearing preload is established by selecting the correct size spacer located between the two pinion thrust bearings and tightening pinion end nut to the specified torque (see "Torque Chart").

1. Temporarily install companion flange nut and washer on end of pinion shaft.

For ease of handling, it is advisable to obtain a spare companion flange for temporary installation on pinion in lien of driven gear when preloading forward

rear axle pinion.

- 2. Clamp pinion assembly in a vise so as to hold companion flange.
- 3. Rotate pinion cage while tightening end nut to specified torque (see "Torque Chart"). Rotation of cage is important so as to seat and align bearings, otherwise, a false condition of bearing load could exist. Bearing rollers must be seated against face of bearing cone, see Fig. 28.

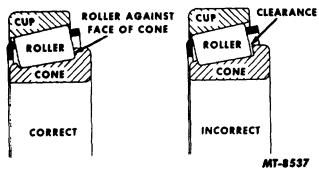


Fig. 28 Pinion Bearing Roller Position.

4. Measure bearing preload by wraping a strong cord or soft wire about the pinion cage and attach end to spring scale (Fig. 29). Read scale only while cage is rotating. Compare this scale reading with the figure shown in "Specifications".

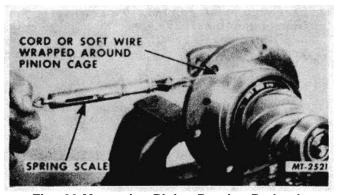


Fig. 29 Measuring Pinion Bearing Preload.

When preload does not agree with "Specifications bearing load may be increased by installing a thinner spacer or decreased by using a thicker spacer. Determine spacer thickness using a micrometer (Fig. 30) and make a new selection accordingly. Closer adjustment may be obtained by working spacer to desired thickness, using emery cloth on a flat surface.

5. Wash spacer clean of emery cuttings before installing on pinion.

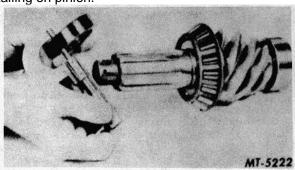


Fig. 30 Measuring Spacer Thickness.

After pinion bearing preload is established good practice would be to check bearing roller ends to see whether they are in contact with bearing cone face. Use a feeler gauge ribbon. There must be no clearance at ends of rollers, Fig. 28.

- 6. Remove end nut, washer and companion flange.
- 7. Forward rear axles only: Install pinion shaft driven gear, nut and washer. Clamp pinion shaft driven gear in jaws of vise using jaw shields or other soft material to avoid damage to gear.
- 8. Rear rear axle only: Install "O" ring type oil seal in pinion cage. Place spacer on end of pinion shaft.

RA-341 rear rear axle has no spacer.

Install retainer with seal, companion flange nut and washer on end of pinion shaft.

- 9. Tighten pinion end nut to specified torque (see "Torque Chart").
- 10. Recheck pinion bearing preload and install cotter pin.

Reassembly of Pinion and Cage to Differential Carrier.

- 1. Place original shimpack on pinion cage and mount cage in differential carrier. Tap cage into place with a soft hammer.
- 2. Install pinion cage bolts and lockwahsers and tighten to specified torque. (See "Torque Chart").

Pinion Nominal Dimension.

To establish pinion nominal dimension which is the distance from the face or finish-

ed end of the installed pinion to the centerline of the ring gear or cross shaft, proceed as follows:

Obtain step plate and clamp assembly from SE-1065 Pinion Setting Gauge set and attach it to differential carrier flange, locating step plate clamp screw over center of pinion, see Fig. 31.

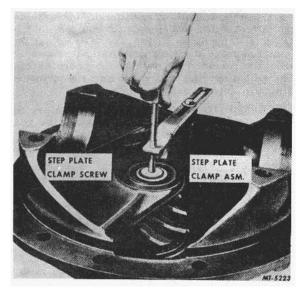


Fig. 31 Locating Step Plate Clamp.

Install step plate under clamp screw and tighten screw to hold step plate securely in position, see Fig. 32.

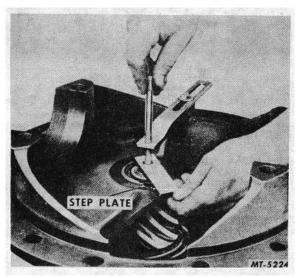


Fig. 32 Installing Step Plate.

The step plate is necessary to project the face of the pinion where it can be measured by the gauge which is on the centerline of the drive gear.

Be certain lugs on step plate straddle the bearing staking indentations on end of pinion.

Mount assembled SE-1065 gauge in bearing bores of carrier (Fig. 33). See "Specifications" for correct disc

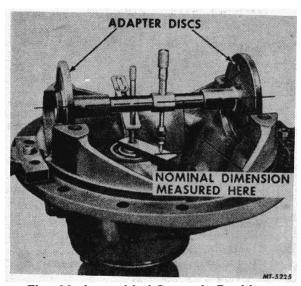


Fig. 33 Assembled Gauge In Position.

Make certain that bearing bores are clean and free of nicks and burrs. Adjust micrometer so it is directly over end at a 90° angle to step plate.

Run micrometer thimble down to measure distance between center of ring gear and step plate. Make a note of this reading along with the nominal dimension given in "Specifications". Locate on pinion the etched marking which indicates variation from zero cone setting. If it is a minus figure, subtract if from specified dimension, and if a plus figure, add it to specified dimension. Results of calculation will provide the corrected pinion nominal dimension to which pinion must be set. Comparison of corrected nominal dimension with the actual or measured dimension indicates amount of change necessary for correct pinion position. It may be necessary to add or remove shims between pinion cage and differential carrier to provide correct pinion nominal dimension.

Remove gauge and prepare to install ring gear and differential carrier in differential housing.

Reassembly of Differential.

- If ring gear was removed from differential case, rivet gear to differential case flange. Use riveting fixture SE-2222 with hydraulic press. Rivet pressures (tons) should be within the range given in "Specifications".
- Apply rear axle lubricant to the inner walls of the differential case halves and to all differential component parts.
- Place side gear thrust washer and side gear in flanged half of differential case and assemble spider, spider pinion gears, and spider gear thrust washers to side gear.
- 4. Place opposite side gear and thrust washer in other half of differential case.
- Align the match marks and assemble the differential case. Draw assembly together with four equally spaced bolts and nuts. Make sure side gears and spider pinion gears mesh correctly.
- Check for free rotation of side gears and spider pinion gears. If satisfactory, install remaining differential case bolts and nuts.
- 7. Tighten differential case bolt nuts to specified torque. (See "Torque Chart").
- 8. Install differential bearing by pressing them squarely onto differential case.

Installing Differential on Differential Carrier.

- 1. Pre-lubricate differential bearings with rear axle lubricant and place bearing cups over bearings.
- Lift differential assembly and place into position in differential carrier. Tilt differential assembly to allow ring gear to pass pinion radial bearing.
- Place bearing adjusters in carrier and turn hand tight against bearing cups.
- Assemble bearing caps to carrier. Align identifying marks on bearing cap and carrier leg. Make sure that pilot rings are in place between caps and carrier.
- 5. Install bearing cap bolts and washers. Tighten to specified torque. (See "Torque Chart").
- 6. Tighten bearing adjusters alternately until all end play is eliminated. Revolve differential

while tightening bearing adjusters to correctly seat bearings.

Gear Backlash.

A special effort should be made to set the backlash between pinion and ring gear to the same amount as was originally built into them .15-.30 mm (.006-.012"). Generally the amount of backlash is stamped or etched on the ring gear. When installing new gears, backlash is measured with a dial indicator mounted on differential housing as in Fig. 34. To adjust the backlash move the ring gear toward or away from the pinion. This is done by backing off one adjusting ring and advancing the opposite ring the same amount.

When original gear and pinion sets are being reinstalled the wear pattern of the gear

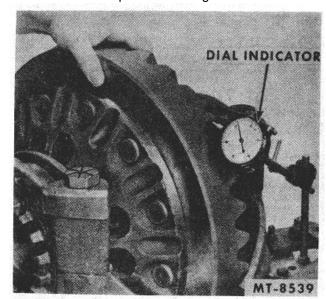
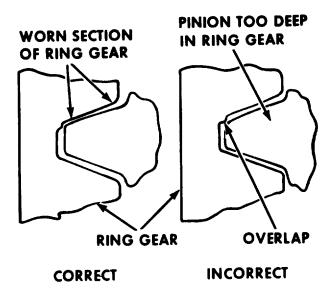


Fig. 34 Setting Correct Backlash.

teeth must be considered in the backlash adjustment. Gears that have been in service for long periods form running contacts which should not be greatly changed. If, in checking backlash, the amount measured is in excess of the amount shown on the ring gear, the lash may be reduced only in the amount that will avoid overlap of the worn tooth section (Fig. 35). A slight overlap at the worn section will cause gear operation to be noisy and rough.



MT-8540

Fig. 35 Correct and Incorrect Lash Adjustment where Worn Gears are Reinstalled.

Differential Bearing Preload.

To set the bearing preload, mount dial indicator at side of ring gear (Fig. 36). With the bearing capscrews loosened to permit bearing movement, loosen adjusting nuts only enough to notice end play on indicator.

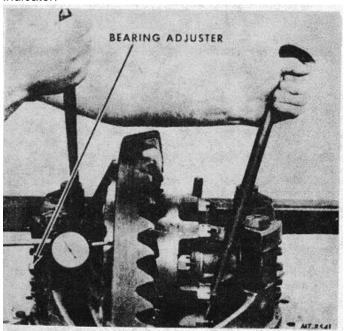


Fig. 36 Adjusting Bearing Preload.

While gear is held in .000 mm (.000") end play and before loading bearings, check gear for runout by revolving ring gear. If runout exceeds .20 mm (.008"), remove differential and check for cause.

Tighten both adjusting nuts from .000 mm (.000") end play to preload the differential bearings (see "Specifications").

Recheck gear lash to make certain that the lash setting has not been damaged.

Install adjusting ring locks and cotter pins.

Gear Tooth Contact.

The final check of differential assembly adjustment is checking the gear tooth contact by the paint impression method.



Fig. 37 Painting Gear Teeth for Obtaining Tooth Contact Impressions.

Apply oiled red lead lightly to the hypoid gear teeth (Fig. 37). When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts (Fig. 38).

Sharper impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the gear teeth.

Coast side should be correct when drive side is correct. Generally, coating approximately twelve teeth is sufficient for checking purposes.

With adjustments properly made, a correct tooth contact similar to that shown in (Fig. 38), will be secured. The area of contact starts near the toe of the gear and

extends about 62-1/2 per cent of the tooth length. This adjustment results in a quiet running gear and pinion set which, because the load is distributed over the teeth within the proper area, will deliver all the long service built into it.



Fig. 38 Tooth Contact Impressions.

When checking paint impressions on gear teeth of an axle under heavy load, the impressions usually spread out somewhat longer than the patterns obtained from a bench test. This can be considered as normal. Ring gears when mounted should show a bearing toward the toe or small end of the tooth, but never at the heel or large end. The reason being that it is practically impossible to make gears and gear mounting so rigid that no deflection will occur when full torque is applied. This deflection causes the bearing to approach the heel of the tooth. And when gears are adjusted so that the bearing is toward the heel of the tooth, it results in a concentration of load on the top corner of the heel and breakage will follow.

FORWARD REAR AXLE:

Reassembly of Inter-Axle Differential.

 If removed, apply a coating of rear axle lubricant to bushing and install in rear half of differential case using installer tool (SE-2024) and proper disc from (SE1905) set to support differential case half.

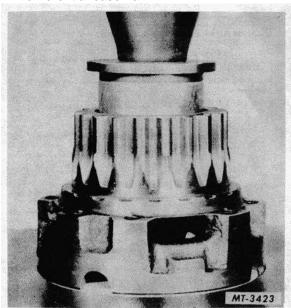


Fig. 39 Installing Bushing in Rear Half of Differential Case.

- 2. Apply rear axle lubricant to differential case halves and to all differential component parts.
- 3. Position thrust washer and rear side gear in rear half of differential case.

- Place spider, spider pinion gears and pinion gear thrust washers in position in rear half of differential case.
- Position thrust washer and front side gear in front half of differential case.
- 6. Align the notch marks and assemble the differential case. Draw assembly together with four equally spaced bolts. Make sure side gears and spider pinion gears mesh correctly.
- 7. Check for free rotation of gears. If satisfactory, install remaining differential case bolts.
- 8. Tighten case bolts to specified torque (see "Torque Chart).
- 9. Press front and rear bearings onto case, using suitable adapters to press against inner bearing race, see Figures 40 and 41.

When pressing front bearing on to case, be certain that large radius on inner race of bearing is next to case.

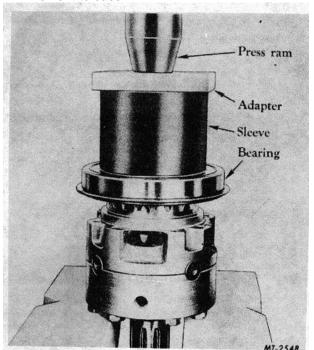


Fig. 40 Pressing Rear Bearing Onto Inter-Axle Differential Case.

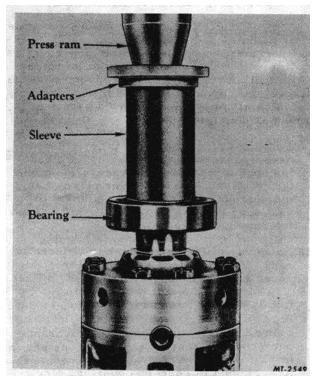


Fig. 41 Pressing Front Bearing on Inter-Axle Differential Case.

Establishing Inter-Axle Differential-To-Cover End Play.

Differential case-to-cover end play is controlled by shims placed between the front bearing and the differential cover, as shown in Fig. 42. The instructions below tell how

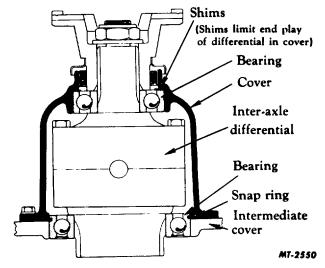


Fig. 42 Location of Shims to Control Inter-Axle Differential End Play.

to determine the thickness of shims required to keep end play within specified limits.

The following instructions show the intermediate case removed from the differential carrier; however, a similar procedure can be followed to determine the shim thickness while the intermediate case is mounted on the differential carrier. Be careful to prevent differential from falling to avoid personal injury or damage to parts.

- Position differential case in intermediate case by inserting rear bearing into bearing bore of intermediate case. Tap on end of input shaft with a fiber or plastic hammer (do not use soft metal hammer) to seat rear bearing snap ring firmly against intermediate case.
- 2. Assemble differential cover to differential case. Do not include shims, differential cover gasket, or differential cover oil seal.
 - Tap cover with a soft hammer to seat cover firmly against intermediate case.
- Using a feeler gauge, measure clearance between front bearing and cover, as shown in Fig. 43. This clearance represents the total amount of case-to-cover end play.

Note and record this amount.



Fig. 43 Measuring Inter-Axle Differential End Play with Feeler Gauge.

4. To determine the thickness of shims required to obtain the specified end play, subtract the amount of permissible end play (. 000. 005) from the total end play found in step 3 above. For Example:

Total End Play (per step 3) .70 mm (.028")

Minus Specified End Play .000-. 13 mm (.000-.005")

Leaves Required Shim Thickness Range of (.023-.028")

Shims are furnished in thicknesses of .13 to .25 mm (.005 and .010"). Select a shim pack with a total thickness within the range of required thickness found above.

- 5. Remove the differential cover from differential case and position shim pack (as determined above) between front bearing and cover (Fig. 9).
- Replace cover on differential case making sure shims are centered on bearing race to avoid pinching shims between cover and O. D. of bearing. Tap cover with a soft hammer to seat cover firmly against intermediate cover.
- 7. Check end play by measuring clearance between the shims and the cover. Clearance (end play) should be within specified limits.

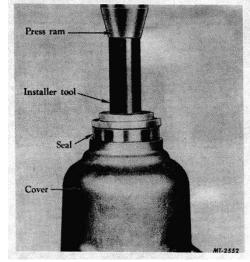


Fig. 44 Installing Inter-Axle Differential Cover Oil Seal.

While .000 end play is permissible, it is important that the bearings not be loaded with side thrust. Therefore, end play between specified limits is desired.

8. After determining amount of shims required to

obtain correct end play, remove differential cover and remove the differential case (with bearings) from the intermediate case.

Press oil seal into differential cover (see Fig. 44). Press oil seal into cover until outer face of seal is flush with end of cover.

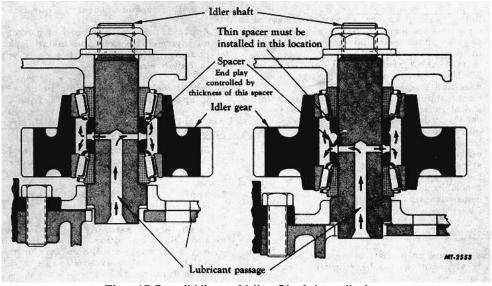


Fig. 45 Detail View of Idler Shaft Installation

- 10. With shim pack in position on bearing, install differential cover (with oil seal) on differential case.
- 11. Install input flange, washer and end nut.
- 12. Using suitable flange holder tool or by clamping assembly in vise (Fig. 7), tighten end nut to specified torque. (See "Torque Chart. ")

Reassemble Power Divider Intermediate Case

- Assemble idler shaft bearings, bearing races and bearing spacer to idler gear. On models RA-351, 355, 386 and 387 position the bearing spacers correctly to index oil groove in rear spacer with oil passage in idler shaft (see Fig. 45).
- Position idler shaft in intermediate case so flats on rear shaft will index with flats in differential carrier
- 3. Support front face of intermediate case and press idler shaft into position.
- 4. Install idler shaft end nut and washer. Tighten nut to specified torque. Use flats on end of

- shaft to hold shaft from turning while tightening nut.
- Using a dial indicator, check end play of idler gear. End play should be within specified limits. (See "Specifications.")
- 6. If end play is not within specified limits, remove idler shaft and idler gear and change the bearing spacer. End play can be reduced by installing a thinner spacer or increased by installing a thicker spacer. Determine spacer thickness with micrometer and make new selection accordingly.

While .000 end play for idler shaft is permissible, it is important that bearings not be loaded with side thrust. Therefore, end play between specified limits is desired.

7. Assemble and install input gear.

RA341:

- a. Press bearing on input gear.
- Install bearing retainer nut. Clamp gear in vise and tighten retainer nut using SE1996 wrench and SE1933 multiplier wrench (Fig. 12). Tighten to specified torque.

- c. Position gear and bearing assembly in intermediate case. Support rear face of case and press bearing into case bearing bore. Press bearing to rear sufficiently to install bearing snap ring.
- d. Install snap ring on bearing and press bearing and gear forward until snap ring seats firmly against shoulder of case.

RA-351, 355, 386 and 387:

- Using bearing spacer previously removed for a trial assembly, install bearings and cage on input gear and clamp assembly in vise.
- b. Install bearing retainer nut and, using SE-2247 bearing nut wrench, tighten to specified torque, Fig. 13.
- c. Check input gear bearing end play with a dial indicator .025-.076 mm (.001.003").
 Use bearing spacers as required to obtain correct end play.
- d. When end play is correct and retainer nut is final torqued, stake retainer nut at milled slot in input gear.
- e. Install input gear bearings and cage assembly into intermediate case. Secure cage with six hex bolts. (See "Torque Chart").

Reassembly of Thru-Shaft Assembly

- 1. Press bearing only shaft using suitable sleeve to press against bearing inner race.
- 2. Press new oil seal into bearing retainer. Install snap ring into bearing retainer.
- 3. Position bearing retainer with oil seal and snap ring onto shaft.
- 4. Install flange, washer and nut.
- 5. Mount shaft assembly in vice. Tighten end nut to specified torque. (See "Torque Chart").

Reassembly of Intermediate Case and Inter-Axle <u>Differential to Differential Carrier</u>

- 1. Apply a 3.1 mm (1/8") bead of gasket sealant on intermediate case and differential cover.
- Position intermediate case assembly on differential carrier. Make sure flats on end of idler shaft index with flats in carrier..

- 3. Install intermediate case bolts. Tighten evenly to specified torque. (See "Torque Chart").
- 4. Position inter-axle lock clutch ring on input gear.
- 5. Apply 3.1 mm (1/8") bead of gasket sealant on intermediate case.
- Position inter-axle differential assembly on intermediate case. Make sure teeth on rear of differential case mesh correctly with teeth on input gear.
- 7. Install differential cover bolts. Tighten to specified torque. (See "Torque Chart").
- Apply 3.1 mm (1/8") bead of gasket sealant on intermediate case and install lock control housing. Make sure shift fork is engaged in clutch ring.
- 9. Install lock control housing bolts. Tighten to specified torque. (See "Torque Chart.")

Reassembly of Power Divider and Differential Carrier to Axle Housing

- Support carrier assembly on roller jack.
 Secure as necessary to prevent carrier assembly from falling from jack.
- 2. Apply 3.1 mm (1/8") bead of gasket sealant on axle housing.
- Align carrier assembly with axle housing and roll into position. A small pinch bar may be used to straighten carrier in housing but be careful to avoid damage to carrier or axle housing.
- Install carrier mounting stud nuts and tighten evenly to specified torque. (See "Torque Chart.")
- Place thru-shaft bearing retainer gasket on axle housing and insert thru-shaft into position. Rotate thru-shaft slightly to mesh shaft splines with splines in inter-axle differential side gear.
- 6. Install bearing retainer bolts. Tighten to specified torque. (See "Torque Chart".)
- 7. Install axle shafts. Tighten axle flange nuts to specified torque. (See "Torque Chart".)
- 8. Connect propeller shaft to input and output flanges.

When installing the rear propeller shaft connecting the forward and rear axles of the tandem, the slip yoke splines of the shaft must be toward the rear as shown in Fig. 46.

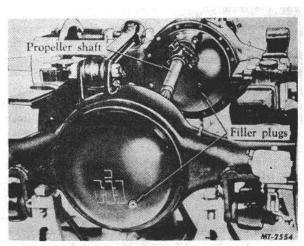


Fig. 46 Rear View of Tandem Axle Showing Installation of Rear Propeller Shaft.

9. Connect inter-axle lock control linkage.

Refill axle with lubricant (see "LUBRICATION").

REAR REAR AXLE:

Installing Differential Carrier in Axle Housing.

Using chain sling and overhead hoist, move differential carrier assembly from rebuild stand to roller type floor jack.

Apply 3.1 mm (1/8") bead of gasket sealant on carrier and housing and roll differential carrier into position on axle housing.

Install the housing stud nuts and lockwashers and tighten to specified torque (see "Torque Chart").

Connect the propeller shaft to companion flange and install the axle shafts. Insert drain plug and fill housing with the prescribed quantity and type of new lubricant. Make sure one pint of lube specified is added to filler hole provided in carrier. Before subjecting rebuilt axle to load, operate truck for a mile or more to circulate lubricant through the differential unit. Do not fail to check lubricant level at recommended intervals. For type of lubricant recommended, refer to CTS-2412 Lubrication.

LUBRICATION

Draining and Refilling Instructions.

To drain the axle lubricant from the forward axle and power divider, remove the drain plugs from the axle housing, the bottom

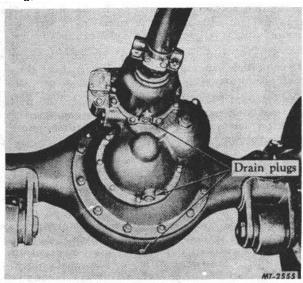


Fig. 47 Location of Lubricant Drain Plugs in Forward Rear Axle.

To drain the rear rear axle, remove the drain plug from the axle housing.

To fill the forward rear axle, make sure all drain plugs are tight. Pour one (1) pint of lubricant into the power divider at the plug on top of the inter-axle differential case. Fill the axle housing to the level of the filler hole.

To fill the rear rear axle, make sure drain plug is tight. Fill to level of filler hole. On initial lubrication of new or rebuilt axles, pour one (1) pint of lubricant into pinion bearing cage at filler plug provided in differential carrier.

To assure initial lubrication of rebuilt axle assemblies, it is recommended that the axles be "run-in" to distribute the lubricant. This is accomplished by raising and securely blocking all rear wheels off the floor and operating the axles at medium speed for approximately two to three minutes. After running in axles, recheck the lubricant level.

The propeller shaft slip joint splines must be free to slip as required to compensate for articulation of the axles. Keep slip joints lubricated. When operating under dusty, wet, or muddy conditions, more frequent lubrication of the propeller shaft may be required.

AIR SHIFT DIFFERENTIAL POWER DIVIDER LOCK

With the introduction of FMVSS-121 brake system, the air shift power divider lock is disengaged (released) by air pressure and spring controlled for engagement (lock position). This arrangement eliminates the need for a spring brake unit at all four rear axle brake groups.

Fig. 48 illustrates typical air supply connections of the various air control valves at the instrument panel.

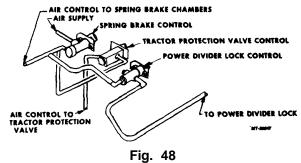
Prior to FMVSS-121, the air operated power divider lock had air supply for engagement (lock position) and spring controlled for disengagement (release).

The air source of the power divider lock system commences in the control line to the spring brake chambers. Therefore, as long as the spring brake control is in the parking brake "release" position, air will pass through the spring brake control and on to the spring brakes holding the brakes in released mode. At the same time air will pass on to the power divider lock (PDL) control. With the PDL in "unlock" or "released" position, air will pass through the PDL control and air pressure will hold the PDL in the disengaged mode.

When the PDL control is placed on the "lock" position air is exhausted and the PDL will shift into "lock" mode.

With the PDL in "unlock" or "released" position and the spring brake control is pulled out to "apply" position, air will be exhausted for both the spring brake system and PDL system.

Thus, the spring brakes will apply and the PDL will automatically shift into the lock mode due to the loss of air in the system.



If a reworked differential with power divide is taken from stock on hand, keep in mind that there is a difference between the shift mechanism.

used on chassis prior to FMVSS-121 and chassis with FMVSS-121 air systems.

Rework of the differential assembly will be required if it has a power lock designed for a chassis with the air brake system prior to FMVSS-121, and is to be used on a chassis with FMVSS-121 air system. The

following itemized operations are to be performed prior to installing the differential carrier assembly.

- 1. Remove the power divider lock shift assembly.
- 2. Separate air control cylinder assembly from the lock shift assembly.
- Replace shift fork shaft assembly and shift fork housing with cups. Use the same shift fork when reassembling the power divider lock shift assembly.
- 4. Reinstall the same air control cylinder kit assembly.
- 5. Reinstall complete lock shift assembly.

SUSPENSION SYSTEM

Service information on the suspension system is covered in the 'Springs' section of the Service Manual.

MAINTENANCE

Axle Housing Breather Valve

Periodically inspect the axle housing breathers to make sure they are open and not clogged with dirt or other foreign matter. The breathers relieve any pressure build-up within the axle housing which might contribute to lubricant leakage.

<u>Alignm</u>ent

The rear axle should also be checked at regular intervals to determine if there is any misalignment of the axle with frame or driveline. Evidence of misalignment may sometimes be noted at the U-bolts. To check for axle misalignment lay a straightedge across and at right angles to the truck frame. The straightedge should be longer than the axle tread and clamped to the frame a short distance ahead of the rear axle.

Measure the distance between the straightedge and identical points at each end of the axle assembly. When distances are not equal, misalignment is indicated, and rear springs and U-bolts must be checked for correct assembly.

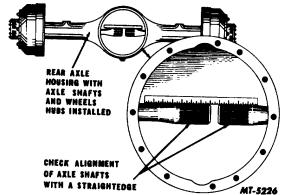


Fig. 49 Method of Checking Axle Alignment

TROUBLE SHOOTING

Serious trouble in a rear axle can be prevented if sufficient attention is given to the various causes of trouble and the proper remedy is applied. The following list gives most of the common kinds of axle trouble and suggests a possible cause to be corrected.

Constant Noise

- 1. Lubricant not to specified level.
- 2. Incorrect kind and weight of lubricant.
- 3. Wheel bearings out of adjustment or defective.
- 4. Drive gear and pinion not in adjustment for correct tooth contact.
- 5. Teeth of drive gear and pinion chipped or worn.
- 6. Too much or too little pinion to gear backlash or overlap of wear pattern.
- 7. Loose or worn pinion bearings.
- 8. Loose or worn side bearings.

Intermittent Noise

- 1. Drive gear does not run true.
 - (a) Uneven pressure on drive gear rivets.
 - (b) Warped drive gear.
- Loose or broken differential bearings in either axle or in inter-axle differential.

Noisy On Turns Only

- 1. Differential pinion gears tight on differential spider.
- 2. Side gears tight in differential case.
- 3. Differential pinion or side gears defective.
- 4. Thrust washers worn or damaged.
- 5. Excessive backlash between side gears and pinions.

Rear Wheels Do Not Drive

(Propeller Shaft Rotating)

- 1. Broken axle shaft.
 - (a) Loose wheel bearings.
 - (b) Axle shaft too short.
 - (c) Loose flange studs or nuts.
 - (d) Bent h.
- 2. Drive gear teeth stripped.
- 3. Side gear or differential pinion broken in either axle or in inter-axle differential.
- 4. Differential spider broken.

It should be noted that noises from other units of the truck such as propeller shafts, universal joints, tires and even transmissions are often incorrectly diagnosed as rear axle noise. This possibility should not be disregarded when trouble shooting.

Lubricant Leaks

- 1. Loss through axle shafts.
 - (a) Lubricant above specified level.
 - (b) Incorrect kind and weight of lubricant.
 - (c) Restricted axle housing breather valve.
 - (d) Worn or incorrectly installed axle shaft oil seal.
- 2. Loss at Pinion Shaft.
 - (a) Lubricant above specified level.
 - (b) Incorrect kind and weight of lubricant.
 - (c) Restricted axle housing breather valve.
 - (d) Pinion oil seal worn or incorrectly installed.
 - (e) Lubricant return passage in differential carrier housing restricted.
 - (f) Universal joints companion flange loose on pinion shaft.

			TORQUE (CHART					
IH MODEL IH CODE	RA-341 14341		-	RA-351, 14351,	386 14386	-	RA-355, 14355,	387 14387	
*Input Shaft End Nut	Size 1 1/4-12	N.m 950	Ft. Lbs. 700	Size 1 1/4-12	N.m 950	Ft. Lbs. 700	Size 1 1/4-12	N.m 950	Ft. Lbs. 700
Inter-Axle Differential Case Bolts	1/2-13	108-135	80-100	1/2-13	108-135	80-100	1/2-13	108-135	80-100
Inter-Axle Differential Cover Bolts (Nylok)	1/2-16	101-115	75-85	1/2-16	101-115	75-85	1/2-16	101-115	75-85
Idler Shaft Nut Power Divider Intermediate Cover- To-Differential Carrier Bolts	1 1/8-12	339-407	250-300	1 1/8-12	339-407	250-300	1 1/8-12	339-407	250-300
(Nylok)	1/2-16	101-115	75-85	1/2-16	101-115	75-85	1/2-16	101-115	75-85
Power Divider Input Gear Bearing Retainer Nut	2 1/2-16	576	425	2 1/2-16	576	425	2 1/2-16	576	425
*Pinion End Nut	1 1/'8-18	441	325	1 1/4-12	950	700	1 1/4-12	950	700
Pinion Cage-To-Carrier Bolts	9/16-12	135-163	100-120	9/16-12	135-163	100-120	9/16-12	135-163	100-120
Differential Carrier-To-Axle Housing Stud Nuts	5/8-18	217-244	160-180	5/8-18	217-244	160-180	5/8-18	217-244	160-180
Differential Case Bolts	1/2-20	109-122	80-90	9/16-18	162-176	120-130	9/16-18	162-176	120-130
Differential Bearing Cap-To-Carrier Bolts	9/16-18	203-217	150-160	1-14	543-678	400-500	1-14	543-678	400-500
Axle Flange-To-Wheel Hub Stud Nuts Inter-Axle Lock Control Housing	5/8-18	163-190	120-140	5/8-18	163-190	120-140	3/4-16	305-339	225-250
Bolts (Nylok)	7/16-14	41-54	30-40	7/16-14	41-54	30-40	7/16-14	41-54	30-40
Thru-Shaft Rear Bearing Retainer Bolts	3/8-16	41-54	30-40	3/8-16	41-54	30-40	3/8-16	41-54	30-40
*Thru-Shaft End Nut	1 1/4-12	950	700	1 1/4-12	950	700	1 1/4-12	950	700
Input Gear Bearing Cage Bolts (Nylok)				3/8-16	41-54	30-40	3/8-16	41-54	30-40

^{*} Minimum Torque - Where cotter pin is used, increase torque as needed to permit installation of cotter pin. Do not back off nut to align cotter pin holes.

TANDEM THRU-DRIVE TYPE WITH CONICAL CARRIER

IH MODEL	CODE	IH MODEL	<u>CODE</u>	IH MODEL	CODE
RA-302	14302	RA-393	14393	RA-492	14492
RA-303	14303	RA-395	14395	RA-493*	14493*
RA-304	14304	RA-487	14487	RA-494*	14494*
RA-306	14306	RA-488	14488	RA-495	14495
RA-390	14390	RA-489	14489	RA-496*	14496*
RA-391	14391	RA-490	14490	RA-497*	14497*
RA-392	14392	RA-491	14491	RA-498*	14498*

^{*} Rectangular Axle Housing

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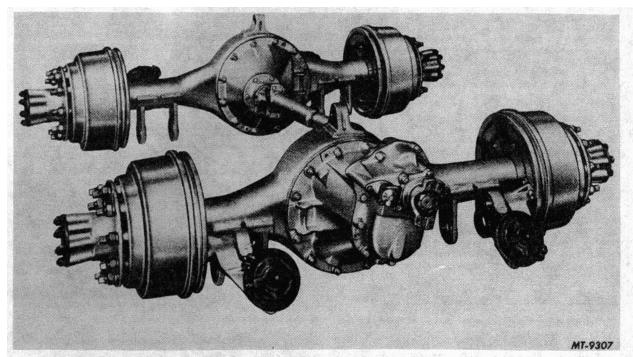


Fig. 1 Thru-Drive Type Tandem Axle Assembly Early Production Shown Late Production Similar Except for Rectangular Axle Housing

DESCRIPTION

The thru-drive tandem axles, Fig. 1, covered by codes listed in this section are of single reduction, double reduction, two-speed and three-speed types. The three-speed axle is basically a two-speed unit electrically controlled through the power divider. The three speeds are obtained as follows. Both axles in single reduction provide "High" speed. Both axles in double reduction provide "Low" speed. forward rear axle is shifted for single reduction and the rear rear axle is shifted for double reduction, an intermediate or third speed is obtained. The inter-axle differential equalizes the difference in RPM between the two axles to give a speed midway between "High" and "Low. " All types are similar in overall construction, and for this reason a single section of the Service Manual is being used to provide servicing information for them. Rebuild procedures, however, cover the forward axle of the tandem only, since the rear rear axles are of the conventional single reduction, two-speed or double reduction design. Servicemen seeking specific information on the conventional parts of these axles should refer to the Rear Axle Section (CTS-2096) Single Reduction or Section (CTS-2097) Two-Speed Planetary or Double Reduction Units.

Forward axle for all types has the power divider mounted integral on forward side of differential carrier, Fig. 2. Power divider and differential carrier may be removed as a single unit from the axle assembly when axle is either mounted in truck or when removed. Power divider itself may also be removed without removing the carrier. This is possible because pinion assembly is not a part of the power divider. Service on the power divider may be performed without disturbing pinion depth or backlash settings between ring gear and pinion.

Instant action forced flow lubrication system supplies lubricant directly to all vital parts, Fig. Z. Input and output shafts are drilled to lubricate the differential and helical side gear from the center out.

OPERATION

The power divider unit equally distributes power from the vehicle transmission to both the forward and rear rear axles. The interaxle differential unit (mounted on the input shaft) operates the same as a conventional axle differential, providing differential action between the forward rear axle and the rear rear axle. The differential in each drive axle unit provides differential action for its respective wheels.

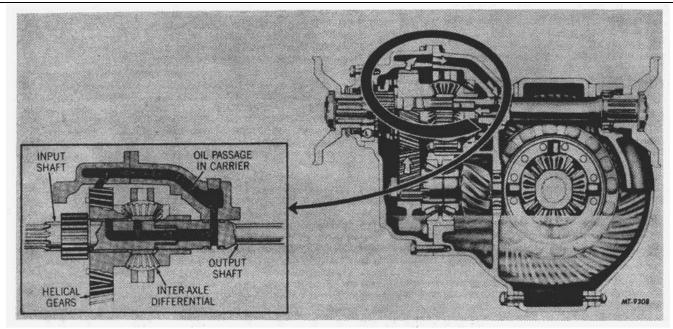


Fig. 2 Cross Section View of Forward Rear Axle with Integral Power Divider

The power flow is shown in Fig. 3. Input torque from vehicle transmission is transmitted to the input shaft and to the splined inter-axle differential spider. At this point torque is transmitted through the inter-axle differential to forward and rear rear axles as follows:

- 1. Power is transferred from spider through a "floating" helical side gear (mounted on input shaft), drive pinion helical gear to drive pinion and ring gear of the forward rear axle.
- 2. Power is transferred from spider through output shaft side gear, output shaft, through inter-axle propeller shaft to the drive pinion and ring gear of the rear rear axle..

Thus, by using the inter-axle differential as a power distribution point for the two axles, differential action is provided between the forward and rear rear axles.

When the inter-axle differential is not in operation (lockout mechanism engaged), the input shaft, input shaft "floating" helical side gear and inter-axle differential rotate as one assembly. Power is then transferred to both axles without differential action. The forward axle drive pinion is driven from input shaft "floating" helical side gear to the drive pinion helical gear. The rear axle drive pinion is driven from output shaft side gear, through output shaft and inter-axle propeller shaft.

LOCKOUT MECHANISM

A lockout mechanism is used on the forward rear axle to lock out the inter-axle differential and provide maximum traction when road conditions are unfavorable.

The lockout mechanism consists of a sliding clutch (mounted on the power divider input shaft), shift fork and push rod, and control system. The shift fork may be operated by an air-operated shift cylinder or vacuum-operated control.

When the lockout mechanism is engaged by the driver, the sliding clutch engages the helical and differential side gear and locks out the inter-axle differential action. This provides a positive drive to both axles.

When the lockout control is released, a spring on the shift fork push rod operates to automatically disengage the sliding clutch from the helical and differential side gear, and interaxle differential action is again restored.

The lockout control should be placed in the locked-out position only at slow speeds. Never move control while wheels are slipping. Continuous unnecessary use of lockout must be avoided, as such use would cause abnormal tire wear.

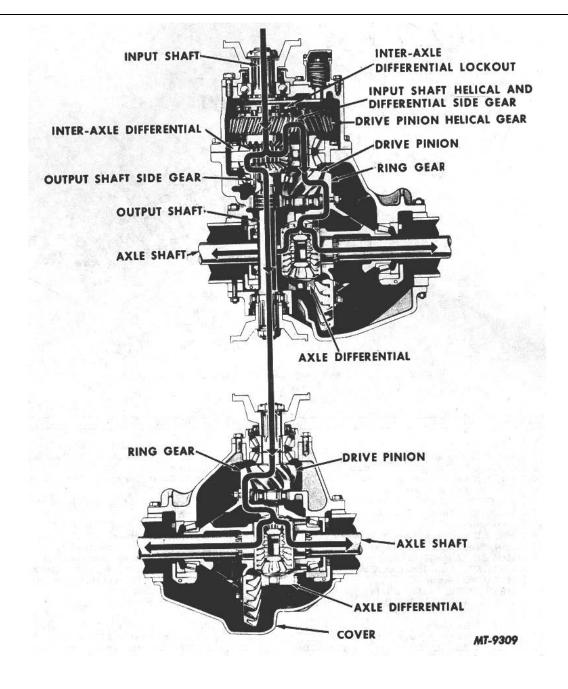


Fig. 3 Power Flow through Single Reduction Tandem Drive Axle

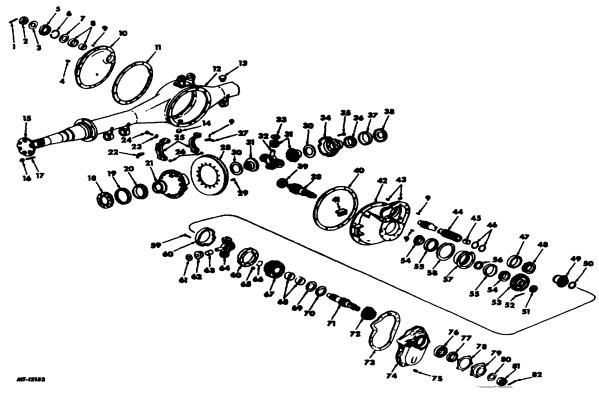


Fig. 4 Single Reduction Forward Rear Axle (Exploded View)

Legend for Fig 4

Key.	<u>Description</u>	Key.	Description
1	PIN, Cotter	21	CASE, Differential, Flanged Half
2	NUT, Companion Flange	22	LOCK, Differential Right Bearing
3	WASHER, Companion Flange		Adjuster
4	PLUG, Axle Housing Filler	23	WASHER, Differential Carrier Bearing
5	SEA L, Output Shaft Oil		Cap Bolt
6	RING, Output Shaft Rear Snap	24	BOLT, Differential Carrier Bearing Cap
7	WASHER, Output Shaft Rear Bearing	25	CAP
	Retainer	26	BUSHING, Bearing Cap Dowel
8	BEARING, Output Shaft	27	LOCK, Differential Left Bearing Adjuster
9	PIN, Housing Cover Dowel	28	GEAR SET, Ring and Pinion
10	COVER, Axle Housing	29	BOLT, Differential Drive Gear
11	GASKET, Axle Housing Cover	30	WASHER, Differential Side Gear Thrust
12	HOUSING, Axle	31	GEAR SET, Differential Side and Pinion
13	BREATHER, Axle Housing	32	SPIDER, Differential
14	PLUG, Axle Housing Drain	33	WASHER, Differential Pinion Gear
15	SHAFT, Axle		Thrust
16	NUT, Hex Lock	34	CASE, Differential, Plain Half
17	STUD, Wheel Flange	35	BOLT, Differential Case
18	ADJUSTER, Differential Right Bearing	36	BEARING, Differential Left Cone
19	BEARING, Differential Right Cup	37	BEARING, Differential Left Cup
20	BEARING, Differential Right Cone	38	ADJUSTER, Differential Left Bearing



AXLE-REAR

Legend for Fig. 4 (Continued)

Key.	<u>Description</u>		<u>Description</u>
39	BEARING, Pinion Pilot	48	BEARING, Output Shaft Front Cone
40	GASKET, Differential Carrier-to-Axle Housing	49 50	GEAR, Output Shaft Side RING, Output Shaft Snap
41	SCOOP, Oil Pick- Up	51	NUT, Companion Flange
42	CARRIER, Differential	52	PIN, Cotter
43	PLUG, Oil Passage Hole	53	GEAR, Helical Pinion Driven
44	SHAFT, Output	54	BEARING, Pinion Cone
45	BUSHING, Output Shaft	55	BEARING, Pinion Cup
46	0-RING, Output Shaft	56	SPACER, Pinion Bearing
47	BEARING, Output Shaft Front Cup	57	CAGE, Pinion Bearing

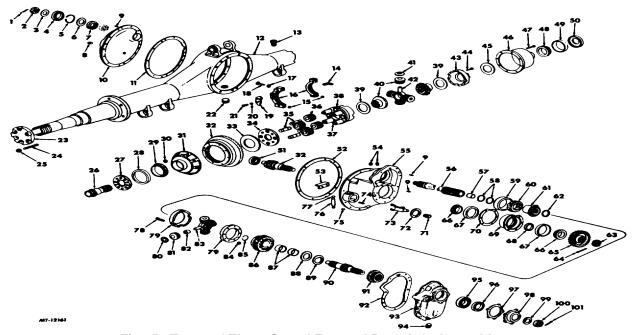


Fig. 5 Two and Three-Speed Forward Rear Axle Assembly

Legend for Fig. 5

Key.	<u>Description</u>	Key.	<u>Description</u>
1	PIN, Cotter	50	ADJUSTER, Differential Left Bearing
2	NUT, Companion Flange	51	BEARING, Pinion Rear, Pilot
3	WASHER, Companion Flange	52	GASKET, Carrier-to-Housing
4	SEAL, Output Shaft Oil	53	SCOOP, Oil Pick-Up
5	RING, Output Shaft Bearing Rear Snap	54	PLUG, Pipe
6	WASHER, Output Shaft Rear	55	CARRIER, Differential
7	BEARING with Outer Race, Output Shaft	56	SHAFT, Output
8	PLUG, Pipe, Filler	57	BUSHING, Output Shaft
9	PIN, Axle Housing Cover Dowel	58	0-RING, Output Shaft
10	COVER, Axle Housing	59	BEARING, Output Shaft Front Cup
11	GASKET, Axle Housing Cover	60	BEARING, Output Shaft Front Cone
12	HOUSING, Axle	61 62	GEAR, Output Shaft Side
13	BREATHER, Assembly	62	RING, Output Shaft Snap
14	LOCK, Differential Left Bearing Adjuster	63	NUT, Companion Flange
15	BUSHING, Differential Carrier Bearing	64	PIN, Cotter
	Cap Bolt	65	GEAR, Helical Pinion Driven
16	CAP	66	BEARING, Pinion Cone
17	WASHER, Differential Bearing Cap Bolt	67	BEARING, Pinion Cup
18	BOLT, Differential Bearing Cap	68	SPACER, Pinion Bearing
19	LOCK, Differential Right Bearing	69	CAGE, Pinion Bearing
	Adjuster	70	SHIM, Pinion Bearing Cage
20	BUSHING, Differential Right Bearing	71	SPRING, Shift Fork
	Adjuster Lock	72	SEAL, Shift Motor
21	BÓLT, Differential Right Bearing	73	FORK, Shift
	Adjuster Lock	74	STUD, Shift Motor Housing
22	PLUG, Axle Housing Drain	75	PLUG, Expansion, Lower
23	SHAFT, Axle	76	SHAFT, Sliding Clutch Shift
24	STUD, Wheel Flange	77	PLUG, Expansion, Upper
25	NUT, Hex Lock	78	BOLT, Input Shaft Differential Case
26	GEAR, Sliding Clutch	79	CASE, Input Shaft Spider, Flanged Half
27	ADJUSTER, Differential Right Bearing	80	WASHER, Input Shaft Pinion Thrust
28	BEARING, Differential Right Cup	81	GEAR, Input Shaft Pinion
29	BEARING, Differential Right Cone	82	BUSHING, Pinion Gear
30	NUT, Differential Gear Support Case	83	SPIDER, Input Shaft
30	Bolt		
24	CASE, Differential Gear Support, Right	84 95	NUT, Input Shaft Spider Case Bolt
31		85	RING, Input Shaft Helical and Side Gear
32	GEAR SET, Ring and Pinion	00	Snap
33	WASHER, Clutch Plate Thrust	86	GEAR, Helical and Side
34	PLATE, High Speed Clutch	87	BUSHING, Input Shaft Helical
35	SHAFT, Differential Idler Gear	88	WASHER, Input Shaft Thrust
36	GEAR, Differential Idler	89	WASHER, Input Shaft Helical Side
37	PIN, High Speed Clutch Plate	90	SHAFT, Input Drive
38	CASE, Differential, Right Half	91	GEAR, Input Shaft Clutch Sliding
39	WASHER, Side Gear Thrust	92	GASKET, Differential Carrier Cover
40	GEAR SET. Pinion and Side	93	COVER, Differential Carrier
41	WASHER, Pinion Gear Thrust	94	PLUG, Pipe, Drain
42	SPIDER, Differential	95	BEARING, Input Shaft
43	CASE, Differential, Left Half	96	SEA L, Input Shaft Oil
44	BOLT, Differential Case	97	SHIM, Oil Seal Retainer
45	WASHER, Differential Gear Support Case	98	RETAINER, Input Shaft Bearing
46	CASE, Differential Gear Support, Left	99	WASHER, Companion Flange
	Half	100	NUT, Companion Flange
47	BOLT, Support Case	101	PIN, Cotter
48	BEARING, Differential Left Cone		, •••••
49	BEARING, Differential Left Cup		
-10	DET II III 10, Dillorolliul Lott Oup		

FORWARD REAR AXLE DISASSEMBLY

Removal of Differential Carrier and Power Divider

It is recommended, but not necessary, that the axle housing cover be removed to replace the differential carrier and power divider assembly.

Reference to Figs. 4 and 5 will aid in unit disassembly and reassembly.

- 1. Drain lubricant. Disconnect propeller shafts at companion flanges and remove axle shafts.
- 2. Remove cotter pin, nut, flat washer, companion flange and retainer washer from output shaft.
- Remove cover-to-axle housing stud nuts and lock washers. Remove cover assembly and discard cover gasket.
- 4. To disassemble axle housing cover, remove oil seal from output shaft opening using suitable puller. Remove snap ring from output shaft opening, then press rear bearing from axle housing cover. Rear bearing sleeve is mounted on the output shaft.
- 5. Disconnect lockout connections.

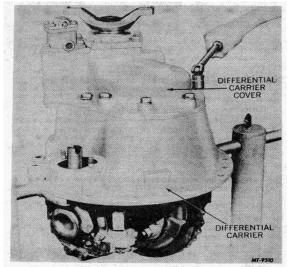


Fig. 6 Differential Carrier and Power Divider Assembly Mounted in Rebuild Stand

- 6. If axle is 2-speed, remove shift units. (Refer to 2-speed axle section of Service Manual.
- Remove carrier-to-axle housing stud nut sand lock washers. Lift and pull differential carrier and power divider assembly out of axle housing.

Disassembly of Differential Carrier and Power Divider

- Place differential carrier and power divider assembly in repair stand, Fig. 6. If preliminary inspection reveals that ring gear and drive pinion are satisfactory, check backlash and tooth contact pattern for easier adjustment in reassembly.
- Remove carrier cover-to-differential carrier capscrews and lock washers, then remove carrier cover assembly.
- Lift inter-axle differential off output shaft side gear, Fig. 7.

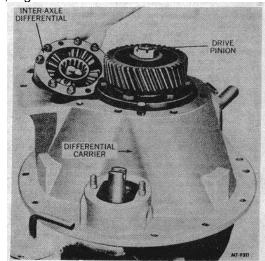


Fig. 7 Removing Inter-Axle Differential

4. Before disassembling inter-axle differential, punch mark cases for correct position during reassembly. Remove locknuts and bolts. (If lockwire is used, cut wire and remove nuts and bolts.) Separate cases and remove thrust washers, side pinions, bushings and spider.

 If output shaft holdout spring and thrust washer are used, remove and discard. Lift output shaft assembly from differential carrier, tapping at companion flange end of shaft, Fig. 8. Remove bearing cup from carrier.

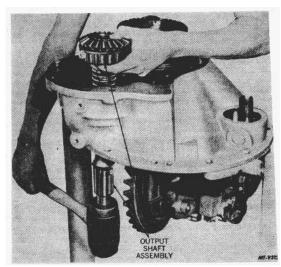


Fig. 8 Removing Output Shaft

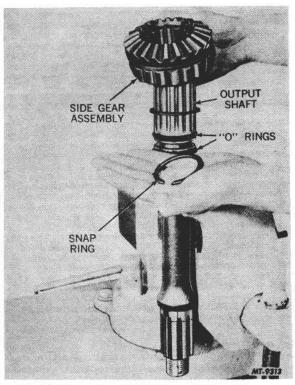


Fig. 9 Disassembling Output Shaft

- To disassemble output shaft, remove snap ring, then lift off side gear assembly, Fig. 9. Discard output shaft O-rings. If replacement is necessary, remove bushing from bore of output shaft.
- 3. To remove output shaft front bearing cone from side gear, place side gear assembly in press with split-type puller plates under front bearing cone, then press side gear out of front bearing cone, Fig. 10.

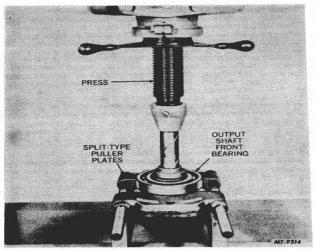


Fig. 10 Separating Output Shaft Side Gear from Front Bearing

Removal and Disassembly of input Shaft

- Remove snap ring from input shaft, then lift off helical side gear, helical side gear thrust washer and "D" washer, Fig. 11. If replacement is necessary, press bushings from bore of helical side gear.
- 2. Remove cotter pin, nut and input companion flange from input shaft, Fig. 12.
- Remove input shaft bearing retainer-todifferential carrier cover capscrews, then lift off bearing cover assembly and shims, Fig. 13. Note size and quantity of shims for easier adjustment during reassembly. Remove oil seal and felt seal (if used) from bearing cover.

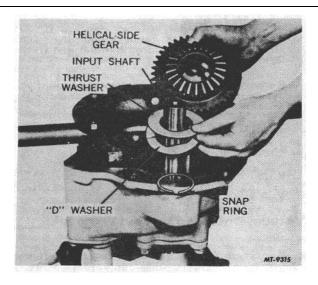


Fig. 11 Removing Side Gear and Washers from Input Shaft

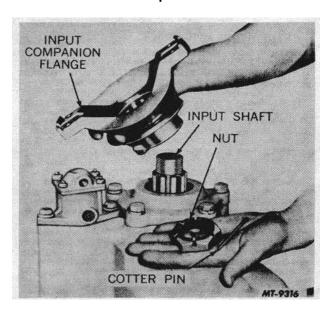


Fig. 12 Removing Companion Flange

- 4. Drive input shaft out of differential carrier cover, Fig. 14.
- 5. To remove bearing from input shaft, place assembly in a press with threaded end of input shaft upward. Press input shaft out of bearing, Fig. 15.

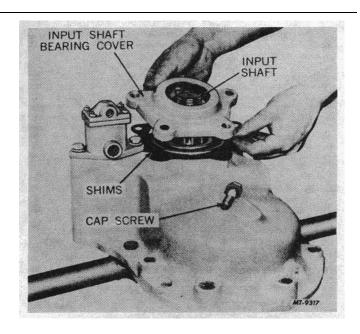


Fig. 13 Removing Bearing Retainer

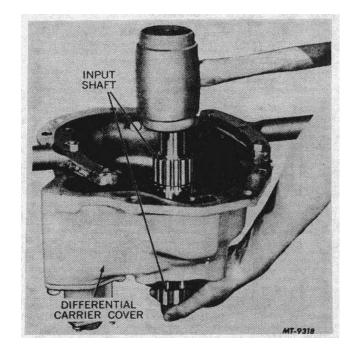


Fig. 14 Removing Input Shaft from Carrier Cover

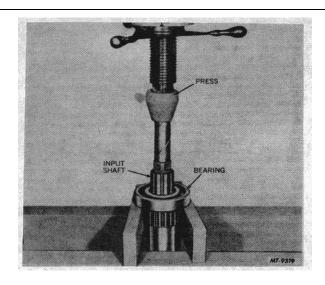


Fig. 15 Pressing Input Shaft from Bearing

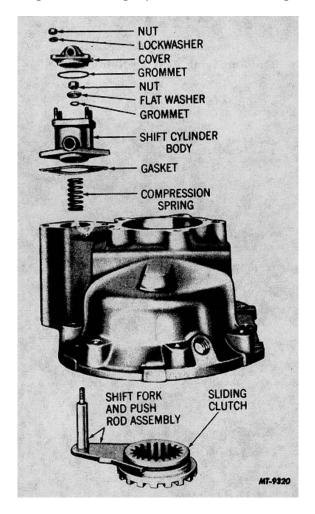


Fig. 16 Air-Operated Lockout

Air-Operated Lockout Removal

- Remove nuts, lock washers and cover from shift cylinder body. Remove nut and flat washer from push rod, Fig. 16.
- Remove capscrews, lock washers, shift cylinder body assembly, gasket and compression spring from carrier cover.

Remove and check strainer plate vent screens and felt for plugged condition. Clean or replace parts.

3. Remove shift fork and push rod assembly and input shaft sliding clutch from carrier cover.

Vacuum-Operated Lockout Removal

- Remove boot from shift lever, Remove cotter pin and clevis pin, then remove shift lever. Remove capscrews, lock washers and shift lever bracket from carrier cover.
- Compress compression spring, then remove pin, Fig. 17, retainer washer and spring from push rod.
 - 3. Remove shift fork and push rod assembly and input shaft sliding clutch from carrier cover.

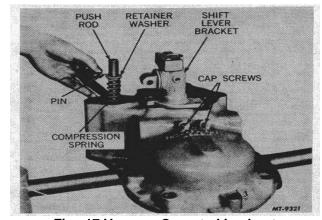


Fig. 17 Vacuum-Operated Lockout

4. Remove shift fork and push rod assembly and input shaft sliding clutch (for air-operated and vacuum- operated lockouts), Fig. 18.

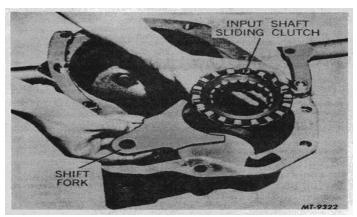


Fig. 18 Removing Sliding Clutch and Shift Fork and Push Rod Assembly

Drive Pinion Removal

In single axle assemblies the pinion assembly is removed with the companion flange and pinion end nut in position. In these tandem assemblies pinion end nut and helical gear, Fig.19, must be removed before the pinion assembly. This is accomplished by first removing cotter pin and pinion shaft end nut. Then by using a suitable puller, grip the helical gear with puller legs and pull helical gear from pinion shaft. Pinion and pinion cage may then be removed the same as from a conventional carrier.

The disassembly of the planetary two-speed and double reduction axles used in tandem assemblies is similar to the disassembly of single planetary 2speed axles except that the double reduction unit uses a sun gear that is held stationary by a lock plate instead of a sliding clutch gear that connects to a shift fork assembly.

As a note of caution, make sure the oil distributor pipe plug, compression spring and oil distributor are removed from the differential carrier before removing the differential assembly.

The balance of the disassembly of the forward axle is identical to the disassembly of a conventional single reduction or planetary two-speed and double reduction axles.

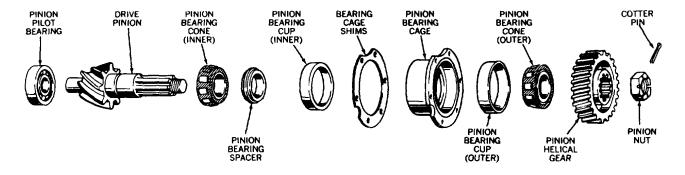
FORWARD REAR AXLE REASSEMBLY

Drive Pinion Adjustments Drive pinion adjustment procedures for the forward rear axle are the same as for the conventional rear rear axle. Refer to rear axle section (CTS-2096) for single reduction units or section (CTS-2097) for two-speed and double reduction axles.

Differential Carrier Reassembly

Reassembly of the differential carrier for axles covered in this section is conventional, and the procedures listed in the rear axle sections (CTS-2096) and (CTS-2097) may be used as a guide except for the following differences.

In assembling the pinion and cage assembly to the carrier the preassembled pinion and cage must be bolted to the differential carrier before the helical differential side gear and input shaft end nut are installed. The other exception affects only the planetary double reduction type. On this type axle a sun gear takes the place of the sliding clutch and is locked into position by a lock plate bolted to the differential bearing cap.



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Fig. 19 Drive Pinion (Exploded View)

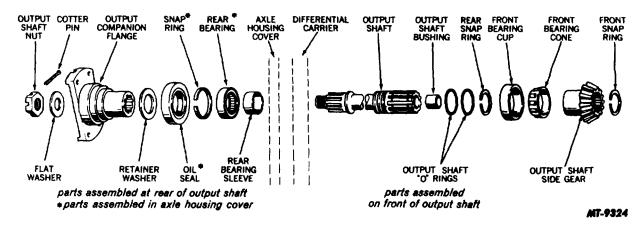


Fig. 20 Output Shaft and Axle Housing Cover Components (Exploded View)

Output Shaft Reassembly

With drive pinion and axle differential assembled in differential carrier and correctly adjusted, install power divider components as indicated in the following instructions.

If output shaft is equipped with a ball bearing, it is recommended that the ball bearing be replaced with a tapered-type bearing cup and cone assembly.

- If removed, press front bearing cup in differential carrier and bushing in bore of output shaft.
- 2. Press front bearing cone on output shaft side gear, Fig. 20.
- 3. Install rear snap ring (adjacent to 0-rings) on output shaft. Place side gear assembly on output shaft and install front snap ring.
- 4. Install two 0rings in grooves of output shaft.

5. Lubricate output shaft O-rings, front bearing and bushing; then install output shaft assembly in differential carrier by placing front bearing cone on bearing cup inbore of carrier.

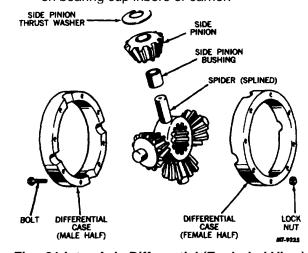


Fig. 21 Inter-Axle Differential (Exploded View)

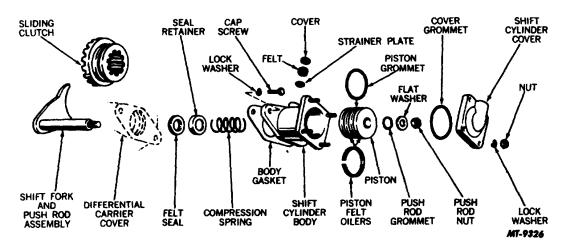


Fig. 22 Air-Operated Lockout Mechanism (Exploded View)

Inter-Axle Differential Reassembly and Installation

- Lubricate internal parts of inter-axle differential during reassembly.
- 1. Install bushings, side pinions and thrust washers on journals of differential spider, Fig. 22.
- Place spider assembly in male differential case. Install female differential case, aligning punch marks (made during disas-sembly) and secure assembly with bolts and nuts. Tighten nuts to correct torque.
- Place inter- axle differential on the output shaft side gear which is mounted on output shaft. Position differential with nuts away from output shaft side gear.

Air-Operated Lockout Installation

- Install push rod, seal retainer and felt seal in carrier cover, Fig. 22. Engage shift fork with groove in input shaft sliding clutch, then place this assembly in carrier cover.
 - Before installing cylinder body, make certain strainer plate vent screens and felt are clean.
- Place compression spring, gasket and shift cylinder body over push rod and on carrier cover. Secure body with capscrews and lock washers. Tighten screws to correct torque.

- Prior to assembly the piston felt oilers should be soaked in SAE-30 oil for one hour.
- Install felt oilers and grommet on piston, then insert piston assembly in body and on push rod. Place grommet on push rod, then install flat washer and nut. Tighten push rod nut to 27.1-35.2 N.m (20-26 ft.lbs.) torque.
- Install grommet on cylinder body cover, then install cover, lockwashers and nuts. Tighten cover nuts to 12.2-14.9 N.m (9-11 ft.lbs.) torque.

Vacuum-Operated Lockout Installation

- Install push rod, seal retainer and felt seal in carrier cover, Fig. 23. Engage lockout shift fork with groove in input shaft sliding clutch. Place this assembly in carrier cover.
- Place compression spring and retainer washer on push rod, depress spring and install retainer washer pin. Coat spring and retainer washer with grease.
- Install new gasket and shift lever bracket on carrier cover and installcapscrews and lock washers. Tighten screws to correct torque. If removed, install grease fitting in bracket.
- 4. Place shift lever in bracket, engaging slot in push rod. Install clevis pin and cotter pin.
- Place boot over shift lever and secure boot to bracket.

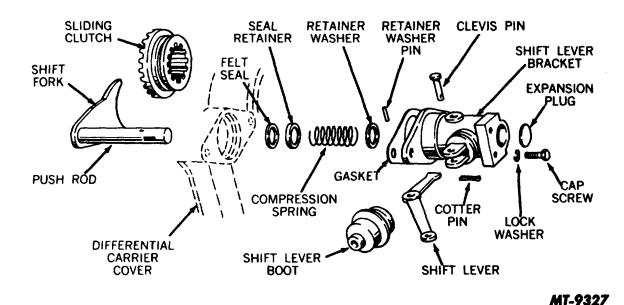


Fig. 23 Vacuum-Operated Lockout Mechanism (Exploded View)

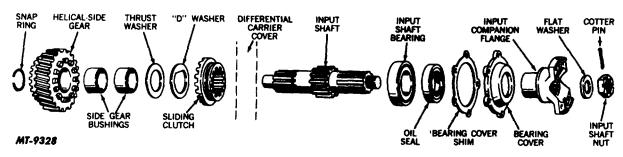


Fig. 24 Input Shaft (Exploded View)

Input Shaft Installation

- 1. Press bearing on threaded end of input shaft, Fig. 24.
- 2. Press input shaft assembly in differential carrier cover, engaging sliding clutch.
 - Make sure that oil drain-back holes in carrier cover, shims and bearing cover are aligned when assembling these parts.
- Install felt seal (if used) and oil seal in input shaft bearing cover. Using same size and quantity of shims removed during disassembly, install shims and bearing cover on carrier cover. Install capscrews (finger tight) and lock washers.
 - To check bearing adjustment or determine thickness of shims required, install bearing cover on carrier cover without shims. Install and tighten capscrews (finger tight). Then using a feeler gauge, measure clearance between bearing cover and carrier cover. This clearance measurement plus .02 mm (.001") would equal the thickness of shims required for correct bearing clearance.
- 4. Install input companion flange, nut and washer on input shaft. Tighten nut to correct torque and install cotter pin. Tighten input shaft bearing cover capscrews to correct torque.
- 5. If removed, press two bushings in bore of helical side gear. Place "D" washer, thrust washer and helical side gear assembly on input shaft. Install snap ring on input shaft to secure these parts.

Differential Carrier Cover Installation

 Place new cover gasket on differential carrier. Place carrier cover assembly on differential carrier, aligning dowel pins with holes in cover. During reassembly of cover to carrier slowly rotate input shaft to engage input shaft splines with splines in bore of inter-axle differential spider. Carefully install two cover capscrews, watching for possible binding between cover and carrier. If cover assembles to carrier without bind, install remaining capscrews and tighten to correct torque.

After carrier cover is assembled to differential carrier, check operation of inter-axle differential. Hold output shaft stationary and rotate input companion flange. If the assembly differentiates, the unit is correctly assembled.

Differential Carrier and Power Divider Installation

- Place new carrier gasket on differential carrier. Install differential carrier and power divider assembly in axle housing. Install lock washers and tighten stud nuts to correct torque.
- Before installing axle housing cover, assemble cover as follows (see Fig. 20): Press output shaft rear bearing in cover. Install snap ring to secure bearing. Press oil seal in same opening in axle housing cover.
- 3. Place new cover gasket on axle housing and install axle housing cover assembly, taking care not to damage oil seal. Install stud nuts and lock washers, Tighten stud nuts to correct torque.
- Install rear bearing sleeve on output shaft. Install retainer washer, output companion flange, flat washer and nut on output shaft. Tighten nut to correct torque and install cotter pin.

ADJUSTMENTS

Refer to Rear Axle Section (CTS-2096) for single reduction or Section (CTS-2097) for two or three-speed and double reduction axle adjustments.

TWO AND THREE-SPEED SHIFT

For information covering the operation and maintenance procedures of the two and three speed axle shift, refer to Rear Axle Section (CTS-2204) for electrically-controlled or Section (CTS-2483) for aircontrolled systems.

LUBRICATION

Draining

Checking Lubricant Level

Axle must be run first, then allowed to stand for 5 minutes. The reason is that the power divider and the forward rear axle use the same lubrication system, and the 5-minute interval allows the lubricant to settle to the proper level in the power divider case and axle housing. After the 5-minute interval, check the lubricant level in the rear filler hole of the forward rear axle only. It is not necessary to check oil level in power divider. If the level is up to the bottom of the filler hole, the power divider is also adequately lubricated. If the level is not up to the bottom of the filler hole, add the necessary lubricant. Check the rear rear-axle lubricant level through the rear filler hole.

Draining is best accomplished immediately after the vehicle has completed a trip. The lubricant is then warm and will run freely, allowing full drainage in minimum time. This is especially desirable in cold weather.

To drain, unscrew plug at bottom of housing and allow sufficient time for all the old oil to run out. On tandem drive axles it is also necessary to unscrew plug at bottom of power divider for drainage of lubricant in power divider.

Magnetic drain plugs should be cleaned each time lubricant is drained.

Filling

Fill the forward drive axle until level with bottom of filler hole in rear cover. Then, add two pints through the forward filler hole located slightly offset to the right in top portion of differential carrier. Do not use the rear hole at top of differential carrier as an oil filler hole.

For type of lubricant refer to Service Manual Section Lubrication CTS-2412.

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REAR AXLE TORQUE CHART

	N.m	(Ft. Lbs.)
Input Shaft End Nut 1 1/2-18	474.7-677.9	350-500
Carrier Cover to Carrier Bolts 9/16-12	155.9-169.5	115-125
Inter-Axle Differential Case Bolts 7/16-20	74.5-81.3	55-60
Input Shaft Bearing Cover to Carrier Cover Bolt 1/2-13	101.7-115.2	75-85
Pinion Shaft End Nut 1 1/2-18	677.9-949.1	500-700
Pinion Bearing Cage to Carrier Bolt 9/16-12	155.9-169.5	115-125
Differential Carrier to Axle Housing Nut 5/8-18	298. 3-325.4	220-240
Differential Bearing Cap Bolt 13/16-10	433.9-515.3	320-380
Differential Case Bolts 1/2-13	115.2-142.4	85-105
Axle Housing Cover to Housing Bolt 7/16-20	94.9-115.2	70-85
Output Shaft End Nut 1 1/4-12	237.3-440.8	175-325
Lockout Unit to Carrier Bolt 7/16-14		
Air Type	40.6-54. 2	30-40
Vacuum Type	61.0-74.5	45-55
Shift Unit to Carrier Nut 7/16-20	61.0-67.7	45-50
Axle Flange to Wheel Hub Stud Nut 5/8-18	203.4-244.1	150-180

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SPECIFICATIONS

				SPECIFICAT	IONS				
IH MODEL	RA-302 RA-487 RA-493*	RA-303 RA-488 RA-498*	RA-304 RA-489	RA-306	RA-390 RA-490 RA-494*	RA-391 RA-491 RA-496*	RA- 392 RA-492 RA-497*	RA-393	RA-395 RA-495
IH CODE	14302 14487 14493*	14303 14488 14498*	14304 14489	14306	14390 14490 14494*	14391 14491 14496*	14392 14492 14497*	14393	14395 14495
TYPE	Single Reduction	Two- Speed	Double Reduction	Three- Speed	Single Reduction	Two- Speed	Double Reduction	Three- Speed	Double Reduction
PINION:									
Drive	Spiral Bevel	Spiral Bevel	Spiral Bevel	Spiral Bevel	Spiral Bevel	Spiral Bevel	Spiral Bevel	Spiral Bevel	Spiral Bevel
Nominal Dimension: Forward Axle mm in.	111.9 4.4062	111.9 4.4062	111.9 4.4062	111.9 4.4062	111.9 4.4062	111.9 4.4062	111.9 4.4062	111.9 4.4062	111.9 4.4062
Rear Axle mm in. SE-1065-9 Disc: Forward Axle	107.1 4.2187 G(1)CC(1)	111.9 4.4062 G(1)M(1)	111.9 4.4062 G(1)M(1)	111.9 4.4062 G(1)M(1)	111.9 4.4062 G(1)M(1)	111.9 4.4062 G(1)M(1)	111.9 4.4062 G(1)M(1)	111.9 4.4062 G(1)M(1)	111.9 4.4062 G(1)M(1)
Rear Axle Cage Rotating Torque:	G(1)CC(I)	G(1)M(I)	G(1)M(l)	G(I)M(1)	G(1)M(1)	G(1)M(1)	G(1)M(1)	G(1)M(1)	G(1)M(1)
kg pounds pull	2.2-5.4 5-12	2.2-5.4 5-12	2.2-5.4 5-12	2.2-5.4 5-12	2.2-5.4 5-12	2.2-5.4 5-12	2.2-5.4 5-12	2.2-5.4 5-12	2.2-5.4 5-12
DIFFERENTIAL: Bearing Preload									
(Adjuster opposite ring gear teeth)	Two Notches	Two Notches	Two Notches	Two Notches	Two Notches	Two Notches	Two Notches	Two Notches	Two Notches
HOUSING: Lube Capacity Liter (Pints):	14 1 (2.1)	11.1(0.1)	44.4 (0.1)	44.4 (0.4)	40.0 (07)	40.0 (07)	10.0 (07)	10.0 (07)	14.4 (0.4)
Forward Axle	11.4 (24)	11.4 (24)	11.4 (24)	11.4 (24)	12.8 (27)	12.8 (27)	12.8 (27)	12.8 (27)	11.4 (24)
Rear Axle	8.6 (18)	8.6 (18)	8.6 (18)	8.6 (18)	9.5 (20)	9.5 (20)	9.5 (20)	9.5 (20)	11.4 (24)
* Forward Axle	15.1 (32)	15.1 (32)			15.1 (32)	15.1 (32)	15.1 (32)		14.6 (31)
* Rear Axle	13.7 (29)	13.7 (29)			13.7 (29)	13.7 (29)	13.7 (29)		13.7 (29)

^{*} Rectangular Axle Housing

IH MODEL	IH MODEL
RA-399	14399
RA-459	14459

RA-461

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14461

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AXLE-REAR

CHAPTER I

DESCRIPTION (FORWARD REAR AXLE)

This single reduction tandem rear axle employs hypoid reduction gears and bevel type gears in the interaxle differential assembly. This unit differs from other front-mounted through drive type drive units by the omission of an idler shaft and the corresponding gear within the transfer gear train.

The input shaft is mounted on two ball bearings mounted in the single-piece carrier and cap assembly. The through-shaft is splined to the rear of the inter-axle differential assembly and is supported by a ball bearing in a rear bearing cage located in the housing.

The hypoid gear set in this carrier must be serviced as a matched set only. Also, the bevel type gears employed in both the inter-axle differential and the carrier differential assembly should be serviced in matched sets; that is, all four pinions, thrust washers and/or side gears and side gear thrust washers should be replaced as individual sets even if only one piece is in need of replacement.

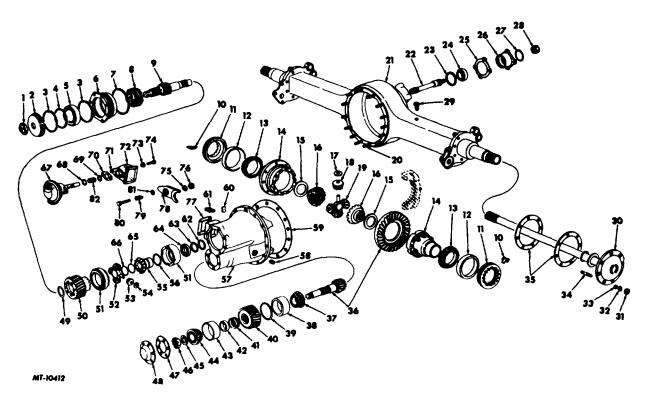


Fig. 1 Exploded View Forward Rear Axle

NUT, Companion Flange SEAL, Input Shaft Oil O-RING, Retainer HS BEARING, Pinion Outer Cup SEAL, Input Shaft Oil O-RING, Retainer HS BEARING, Input Shaft SEARING, Input Shaft HS BEARING, Input Shaft HS WASHER, Pinion Shaft HS WASHER, Pinion Shaft HS WASHER, Pinion Shaft HS WASHER, Pinion Bearing Cover COVER, Pinion Bearing COLLAR, Clutch HS WASHER, Drive Gear Thrust HS WASHER, Drive Gear Thrust HS WASHER, Drive Gear Thrust HS WASHER, Intermediate Differential CASE, Wiscoop, Inter-Differential HS BEARING, Differential Cup HS GEAR, Input HS GEAR, Intermediate Differential HS BEARING, Differential Cup HS GEAR, Intermediate Differential HS CASE, Differential Side HS WASHER, Intermediate Differential HS CASE, Differential Side HS WASHER, Intermediate Differential HS CASE, Differential Side HS WASHER, Intermediate Differential HS GEAR, Differential Pinion HS GEAR, Differential	No.	Description	LEGEND FOR	R FIG. No.	1 Description
2 SEAL, Inpút Shaft Oil 43 BEARINĞ, Pinion Outer Cup 3 O-RING, Retainer 44 BEARING, Pinion Outer Cone 4 SHIM, Bearing Cage 45 WASHER, Pinion Shaft Nut 5 BEARING, Input Shaft Bearing 47 GASKET, Pinion Bearing Cover 6 CAGE, Input Shaft Bearing Cage 48 COVER, Pinion Bearing 8 COLLAR, Clutch 49 WASHER, Drive Gear Thrust 9 SHAFT, Input 50 GEAR, Input Drive 10 PIN, Bearing Adjuster Lock 51 CASE, WiScoop, Inter-Differential 11 ADJUSTER, Differential Cap 53 GEAR, Intermediate Differential 12 BEARING, Differential Cone 54 WASHER, Intermediate Differential 14 CASE, Differential Cone 54 WASHER, Intermediate Differential Side 15 WASHER, Diff Side Gear Thrust 56 GEAR, Intermediate Differential Side 16 GEAR, Differential Pinion 59 GASKET, Diff Carrier to Axle Housing 17 WASHER, Diff Side Gear Thrust 56 WASHER, Diff Carrier to Axle Housing	1	NUT. Companion Flange		42	SPACER. Pinion Gear
3 O-RING, Retainer 4 SHIM, Bearing Cage 5 BEARING, Input Shaft 6 CAGE, Input Shaft 6 CAGE, Input Shaft Bearing 7 O-RING, Input Shaft Bearing Cage 8 COULAR, Clutch 9 CAJER, Pinion Bearing 9 CAJER, Pinion Bearing 17 GASKET, Pinion Bearing Cover 18 COULAR, Clutch 9 WASHER, Drive Gear Thrust 19 SHAFT, Input 10 PIN, Bearing Adjuster Lock 11 ADJUSTER, Differential Bearing 12 BEARING, Differential Cup 13 BEARING, Differential Cup 14 CASE, M/Scoop, Inter-Differential 15 BEARING, Differential Cup 16 GEAR, Intermediate Differential 17 WASHER, Diff Side Gear Thrust 18 GEAR, Differential Side 19 SHDER, Differential Pinion Thrust 19 GEAR, Differential Pinion 19 SPIDER, Differential 19 SPIDER, Differential 10 STUD, Carrier to Axle Housing 10 STUD, Carrier to Axle Housing 11 HOUSING, Axle 12 BEARING, Output Shaft 13 GASKET, Output Shaft 14 CAGE, Wiscoop, Output Shaft 15 GASKET, Output Shaft 16 GEAR, Differential Side 17 WASHER, Differential Pinion 18 GEAR, Differential Pinion 19 SPIDER, Differential 19 SPIDER, Differential 10 SCREW, Drive Gear Thrust Block 20 STUD, Carrier to Axle Housing 21 HOUSING, Axle 22 SHAFT, Output 23 RING, Output Shaft 24 BEARING, Output Shaft 25 GASKZT, Output Shaft 26 CAGE, W/Bearing, Output Shaft 27 SEAL, Output Shaft 28 GASKZT, Output Shaft 29 BEARTHER, Axle Housing 30 SHAFT, Axle 31 NUT, Companion Flange 31 NUT, Companion Flange 32 WASHER, Lock 33 DOWEL, Axle Shaft Stud 34 STUD, Chamber to Housing 35 GASKET, Dxl					
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14 CASE, Differential Assembly, 2 Halves 15 WASHER, Diff Side Gear Thrust 16 GEAR, Differential Side 17 WASHER, Differential Pinion Thrust 18 GEAR, Differential Pinion 19 SPIDER, Differential 10 STUD, Carrier to Axle Housing 11 HOUSING, Axle 12 SHAFT, Output 13 RING, Output Shaft Bearing Snap 14 BEARING, Output Shaft Bearing Cage 15 GASKZT, Output Shaft Oil 16 CAGE, W/Bearing, Output Shaft 17 SEAL, Output Shaft Oil 18 SEAR, Differential 19 SPIDER, Differential 20 STUD, Carrier to Axle Housing 21 HOUSING, Axle 22 SHAFT, Output 23 RING, Output Shaft Bearing Snap 24 BEARING, Output Shaft 25 GASKZT, Output Shaft 26 CAGE, W/Bearing, Output Shaft 27 SEAL, Output Shaft Oil 28 NUT, Companion Flange 29 BREATHER, Axle Housing 30 SHAFT, Axle 31 NUT, Hex 32 WASHER, Lock 33 DOWEL, Axle Shaft Stud 34 STUD, Wheel Flange 35 GASKET, Ring and Pinion 36 GEAR SET, Ring and Pinion 37 GASKET, Shift Housing 38 GASKET, Shift Housing 39 GASKET, Shift Housing 30 GASKET, Shift Housing	12	BEARING, Differential Cup		53	GEAR, Intermediate Diff Pinion
15 WASHER, Diff Side Gear Thrust 16 GEAR, Differential Side 17 WASHER, Differential Pinion Thrust 18 GEAR, Differential Pinion Thrust 18 GEAR, Differential Pinion 19 SPIDER, Differential 20 STUD, Carrier to Axle Housing 21 HOUSING, Axle 22 SHAFT, Output 23 RING, Output Shaft Bearing Snap 24 BEARING, Output Shaft 25 GASKZT, Output Shaft 26 CAGE, W/Bearing, Output Shaft 27 SEAL, Output Shaft Oil 28 NUT, Companion Flange 29 BREATHER, Axle Housing 30 SHAFT, Axle 31 NUT, Hex 32 WASHER, Lock 34 STUD, Chamber to Shift Housing 35 GASKET, Lock 36 CAGEW, Shaft Stud 37 SCREW, Drive Gear Thrust Block 47 SCREW, Drive Gear Thrust Block 48 BLOCK 49 NOT USED 40 NOT USED 41 BEARING, Roller 40 BEARING, Roller 41 BEARING, Output Shaft 41 GF RING, Snap 42 CHAMBER, Snap Ring 43 RING, Snap 44 BEARING, Snap 45 RING, Snap 46 RETAINER, Snap Ring 47 CHAMBER, Assembly 48 RING, Snap 49 WASHER, Spring 40 GASKET, Chamber to Housing 40 SHAFT, Axle 41 STUD, Chamber to Shift Housing 41 NUT, Hex 42 HOUSING, W/Studs, Shift Fork 43 WASHER, Lock 44 STUD, Wheel Flange 45 BALL, Shift Fork Spring 46 SCREW, Drive Gear Thrust Block 46 BLOCK 47 SCREW, Drive Gear Thrust Block 48 RING, Snap 49 BEARING, Roller 40 BEARING, Roller 40 BEARING, Roller 41 BEARING, Roller 42 BEARING, Roller 43 RING, Snap 44 STUD, Chamber to Housing 45 STUD, Chamber to Housing 47 SCREW, Shift Fork 48 STUD, Wheel Flange 49 SCREW, Shift Fork Spring 40 SCREW, Shift Fork Spring 40 SCREW, Shift Fork Spring 41 STUD, Wheel Flange 45 BALL, Shift Fork Spring 46 SCREW, Shift Housing 47 GASKET, Shift Housing	13	BEARING, Differential Cone		54	WASHER, Intermediate Differential
16 GEAR, Differential Side 17 WASHER, Differential Pinion Thrust 18 GEAR, Differential Pinion 19 SPIDER, Differential 20 STUD, Carrier to Axle Housing 21 HOUSING, Axle 22 SHAFT, Output 23 RING, Output Shaft Bearing Snap 24 BEARING, Output Shaft Bearing Cage 25 GASKZT, Output Shaft Bearing Cage 26 CAGE, W/Bearing, Output Shaft 27 SEAL, Output Shaft Oil 28 NUT, Companion Flange 29 BREATHER, Axle Housing 30 SHAFT, Axle 31 NUT, Hex 32 WASHER, Lock 33 DOWEL, Axle Shaft Stud 34 STUD, Wheel Flange 35 GASKET, Ring and Pinion 45 CARRIER, W/Caps, Differential 57 CARRIER, W/Caps, Differential 58 PLUG, Pipe 3/4, Filler. 58 PLUG, Pipe 3/4, Filler. 59 GASKET, Diff Carrier to Axle Housing 50 SCREW, Drive Gear Thrust Block 60 NOT USED 61 NOT USED 62 NOT USED 63 NOT USED 64 BEARING, Roller 65 RING, Snap 66 RETAINER, Snap Ring 67 CHAMBER, Asaembly 68 RING, Snap 79 GASKET, Chamber to Housing 70 GASKET, Chamber to Housing 71 STUD, Chamber to Shift Housing 72 HOUSING, W/Studs, Shift Fork 73 NUT, Hex. 74 SCREW, Shift Fork Adjusting Stop 75 BALL, Shift Fork Adjusting Stop 76 GASKET, Axle Shaft 77 GASKET, Shift Housing 78 GASKET, Axle Shaft 79 NUT, Hex. Slotted 3/8 NF 70 GASKET, Shift Housing	14	CASE, Differential Assembly, 2 Halves		55	GEAR, Intermediate Differential Side
17 WASHER, Differential Pinion Thrust 18 GEAR, Differential Pinion 19 SPIDER, Differential 20 STUD, Carrier to Axle Housing 21 HOUSING, Axle 22 SHAFT, Output 23 RING, Output Shaft Bearing Snap 24 BEARING, Output Shaft Bearing Cage 25 GASKZT, Output Shaft Bearing Cage 26 CAGE, W/Bearing, Output Shaft 27 SEAL, Output Shaft Oil 28 NUT, Companion Flange 29 BREATHER, Axle Housing 30 SHAFT, Axle 31 NUT, Hex 32 WASHER, Lock 33 DOWEL, Axle Shaft Stud 34 STUD, Wheel Flange 35 GASKET, Ring and Pinion 36 GEAR SET, Ring and Pinion 37 GASKET, Shift Housing 38 GASKET, Ring and Pinion 39 GASKET, Shift Housing 30 GASKET, Shift Housing 31 NUT, Hex 32 GASKET, Ring and Pinion 35 GASKET, Ring and Pinion 36 GEAR SET, Ring and Pinion 37 GASKET, Shift Housing 38 GASKET, Shift Housing 39 GASKET, Shift Housing 30 GASKET, Shift Housing 31 NUT, Hex 32 GASKET, Ring and Pinion 35 GASKET, Ring and Pinion 36 GASKET, Ring and Pinion 37 GASKET, Shift Housing	15	WASHER, Diff Side Gear Thrust		56	WASHER, Intermediate Differential Side
18GEAR, Differential Pinion59GASKET, Diff Carrier to Axle Housing19SPIDER, Differential60BLOCK20STUD, Carrier to Axle Housing61SCREW, Drive Gear Thrust Block21HOUSING, Axle62NOT USED22SHAFT, Output63NOT USED23RING, Output Shaft Bearing Snap64BEARING, Roller24BEARING, Output Shaft65RING, Snap25GASKZT, Output Shaft Bearing Cage66RETAINER, Snap Ring26CAGE, W/Bearing, Output Shaft67CHAMBER, Assembly27SEAL, Output Shaft Oil68RING, Snap28NUT, Companion Flange69WASHER, Spring29BREATHER, Axle Housing70GASKET, Chamber to Housing30SHAFT, Axle71STUD, Chamber to Shift Housing31NUT, Hex72HOUSING, W/Studs, Shift Fork32WASHER, Lock73NUT, Hex. Jam 1/2 NF33DOWEL, Axle Shaft Stud74SCREW, Shift Fork Adjusting Stop34STUD, Wheel Flange75BALL, Shift Fork Spring35GASKET, Axle Shaft76NUT, Hex. Slotted 3/8 NF36GEAR SET, Ring and Pinion77GASKET, Shift Housing	16	GEAR, Differential Side		57	CARRIER, W/Caps, Differential
19 SPIDER, Differential 20 STUD, Carrier to Axle Housing 21 HOUSING, Axle 22 SHAFT, Output 23 RING, Output Shaft Bearing Snap 24 BEARING, Output Shaft Bearing Cage 25 GASKZT, Output Shaft Bearing Cage 26 CAGE, W/Bearing, Output Shaft 27 SEAL, Output Shaft Oil 28 NUT, Companion Flange 29 BREATHER, Axle Housing 30 SHAFT, Axle 31 NUT, Hex 32 WASHER, Lock 33 NOT USED 44 BEARING, Roller 55 RING, Snap 56 RETAINER, Snap Ring 57 CHAMBER, Assembly 58 RING, Snap 59 WASHER, Spring 50 GASKET, Chamber to Housing 50 SHAFT, Axle 51 STUD, Chamber to Shift Housing 52 WASHER, Lock 53 NUT, Hex 54 HOUSING, W/Studs, Shift Fork 55 RING, Snap 66 RETAINER, Snap Ring 67 CHAMBER, Assembly 68 RING, Snap 69 WASHER, Spring 69 WASHER, Spring 69 WASHER, Spring 70 GASKET, Chamber to Housing 71 STUD, Chamber to Shift Housing 72 HOUSING, W/Studs, Shift Fork 73 NUT, Hex. Jam 1/2 NF 74 SCREW, Shift Fork Adjusting Stop 75 BALL, Shift Fork Spring 76 GASKET, Axle Shaft 77 GASKET, Shift Housing	17	WASHER, Differential Pinion Thrust		58	PLUG, Pipe 3/4, Filler.
STUD, Carrier to Axle Housing HOUSING, Axle SHAFT, Output SHAFT, Output SHAFT, Output Shaft Bearing Snap SHARING, Output Shaft Bearing Cage GASKZT, Output Shaft Bearing Cage CAGE, W/Bearing, Output Shaft SEAL, Output Shaft Oil SEAL, Output Shaft Oil SEAL, Axle Housing SHAFT, Axle Shaft Stud STUD, Wheel Flange GASKET, Axle Shaft GEAR SET, Ring and Pinion SCREW, Drive Gear Thrust Block NOT USED NOT USED SCREW, Drive Gear Thrust Block NOT USED SCREW, Sniler SCREW, Sniler SCREW, Sniler SCREW, Drive Gear Thrust Block NOT USED SCREW, Sniler SCREW, Sniler SCREW, Drive Gear Thrust Block NOT USED SCREW, Sniler SCREW, Drive Gear Thrust Block NOT USED SCREW, Sniler SCREW, Sniler SCREW, Shift Fork SCREW, Shift Fork SCREW, Shift Fork Adjusting Stop STUD, Wheel Flange SCREW, Shift Fork Spring NUT, Hex. Slotted 3/8 NF	18	GEAR, Differential Pinion		59	GASKET, Diff Carrier to Axle Housing
HOUSING, Axle SHAFT, Output SHAFT, Output SHAFT, Output Shaft Bearing Snap BEARING, Output Shaft Bearing Cage GASKZT, Output Shaft Bearing Cage CAGE, W/Bearing, Output Shaft SEAL, Output Shaft Oil SHAFT, Axle Housing SHAFT, Axle SHAFT, Axle SHAFT, Axle SHAFT, Axle SHAFT, Axle SHAFT, Axle Shaft Stud STUD, Wheel Flange SHAFT, Axle Shaft	19	SPIDER, Differential		60	BLOCK
22 SHAFT, Output 23 RING, Output Shaft Bearing Snap 24 BEARING, Output Shaft 25 GASKZT, Output Shaft Bearing Cage 26 CAGE, W/Bearing, Output Shaft 27 SEAL, Output Shaft Oil 28 NUT, Companion Flange 29 BREATHER, Axle Housing 30 SHAFT, Axle 31 NUT, Hex 32 WASHER, Lock 33 DOWEL, Axle Shaft Stud 34 STUD, Wheel Flange 35 GASKET, Axle Shaft 36 GEAR SET, Ring and Pinion 46 BEARING, Roller 86 RING, Snap 87 CHAMBER, Snap Ring 86 RETAINER, Snap Ring 87 CHAMBER, Snap Ring 88 RING, Snap 99 WASHER, Spring 90 WASHER, Spring 90 GASKET, Chamber to Housing 91 STUD, Chamber to Shift Housing 91 NUT, Hex 92 HOUSING, W/Studs, Shift Fork 93 SCREW, Shift Fork Adjusting Stop 94 STUD, Wheel Flange 95 BALL, Shift Fork Spring 96 NUT, Hex. Slotted 3/8 NF 97 GASKET, Shift Housing	20	STUD, Carrier to Axle Housing		61	SCREW, Drive Gear Thrust Block
RING, Output Shaft Bearing Snap 4 BEARING, Output Shaft 5 RING, Snap 6 RETAINER, Snap Ring 6 RETAINER, Assembly 6 CAGE, W/Bearing, Output Shaft 6 RING, Snap 6 RETAINER, Snap Ring 6 CHAMBER, Assembly 7 SEAL, Output Shaft Oil 8 RING, Snap 8 NUT, Companion Flange 9 WASHER, Spring 9 WASHER, Spring 10 GASKET, Chamber to Housing 11 STUD, Chamber to Shift Housing 12 STUD, Chamber to Shift Housing 13 NUT, Hex 14 STUD, W/Studs, Shift Fork 15 WASHER, Lock 16 RETAINER, Snap Ring 17 CHAMBER, Assembly 18 RING, Snap 19 WASHER, Spring 10 GASKET, Chamber to Housing 10 GASKET, Chamber to Housing 11 STUD, Chamber to Shift Housing 12 HOUSING, W/Studs, Shift Fork 13 DOWEL, Axle Shaft Stud 14 SCREW, Shift Fork Adjusting Stop 15 BALL, Shift Fork Spring 16 GASKET, Axle Shaft 17 GASKET, Shift Housing	21	HOUSING, Axle		62	NOT USED
24BEARING, Output Shaft65RING, Snap25GASKZT, Output Shaft Bearing Cage66RETAINER, Snap Ring26CAGE, W/Bearing, Output Shaft67CHAMBER, Assembly27SEAL, Output Shaft Oil68RING, Snap28NUT, Companion Flange69WASHER, Spring29BREATHER, Axle Housing70GASKET, Chamber to Housing30SHAFT, Axle71STUD, Chamber to Shift Housing31NUT, Hex72HOUSING, W/Studs, Shift Fork32WASHER, Lock73NUT, Hex. Jam 1/2 NF33DOWEL, Axle Shaft Stud74SCREW, Shift Fork Adjusting Stop34STUD, Wheel Flange75BALL, Shift Fork Spring35GASKET, Axle Shaft76NUT, Hex. Slotted 3/8 NF36GEAR SET, Ring and Pinion77GASKET, Shift Housing	22	SHAFT, Output		63	NOT USED
GASKZT, Output Shaft Bearing Cage CAGE, W/Bearing, Output Shaft SEAL, Output Shaft Oil SEAL					
26 CAGE, W/Bearing, Output Shaft 27 SEAL, Output Shaft Oil 28 NUT, Companion Flange 29 BREATHER, Axle Housing 30 SHAFT, Axle 31 NUT, Hex 32 WASHER, Lock 33 DOWEL, Axle Shaft Stud 34 STUD, Wheel Flange 35 GASKET, Axle Shaft 36 GEAR SET, Ring and Pinion 37 CHAMBER, Assembly 68 RING, Snap 69 WASHER, Spring 69 WASHER, Spring 70 GASKET, Chamber to Housing 71 STUD, Chamber to Shift Housing 71 STUD, Chamber to Shift Housing 72 HOUSING, W/Studs, Shift Fork 73 NUT, Hex. Jam 1/2 NF 74 SCREW, Shift Fork Adjusting Stop 75 BALL, Shift Fork Spring 76 NUT, Hex. Slotted 3/8 NF 77 GASKET, Shift Housing		BEARING, Output Shaft		65	RING, Snap
27SEAL, Output Shaft Oil68RING, Snap28NUT, Companion Flange69WASHER, Spring29BREATHER, Axle Housing70GASKET, Chamber to Housing30SHAFT, Axle71STUD, Chamber to Shift Housing31NUT, Hex72HOUSING, W/Studs, Shift Fork32WASHER, Lock73NUT, Hex. Jam 1/2 NF33DOWEL, Axle Shaft Stud74SCREW, Shift Fork Adjusting Stop34STUD, Wheel Flange75BALL, Shift Fork Spring35GASKET, Axle Shaft76NUT, Hex. Slotted 3/8 NF36GEAR SET, Ring and Pinion77GASKET, Shift Housing					RETAINER, Snap Ring
28NUT, Companion Flange69WASHER, Spring29BREATHER, Axle Housing70GASKET, Chamber to Housing30SHAFT, Axle71STUD, Chamber to Shift Housing31NUT, Hex72HOUSING, W/Studs, Shift Fork32WASHER, Lock73NUT, Hex. Jam 1/2 NF33DOWEL, Axle Shaft Stud74SCREW, Shift Fork Adjusting Stop34STUD, Wheel Flange75BALL, Shift Fork Spring35GASKET, Axle Shaft76NUT, Hex. Slotted 3/8 NF36GEAR SET, Ring and Pinion77GASKET, Shift Housing					
BREATHER, Axle Housing TO GASKET, Chamber to Housing SHAFT, Axle TI STUD, Chamber to Shift Housing HOUSING, W/Studs, Shift Fork NUT, Hex NUT, Hex. Jam 1/2 NF NUT, Hex. Jam 1/2 NF SCREW, Shift Fork Adjusting Stop STUD, Wheel Flange GASKET, Axle Shaft RUT, Hex. Slotted 3/8 NF GEAR SET, Ring and Pinion GASKET, Shift Housing					
30 SHAFT, Axle 31 NUT, Hex 32 WASHER, Lock 33 DOWEL, Axle Shaft Stud 34 STUD, Wheel Flange 35 GASKET, Axle Shaft 36 GEAR SET, Ring and Pinion 37 STUD, Chamber to Shift Housing 37 HOUSING, W/Studs, Shift Fork 38 NUT, Hex. Jam 1/2 NF 39 NUT, Hex. Jam 1/2 NF 30 SCREW, Shift Fork Adjusting Stop 31 STUD, Wheel Flange 32 BALL, Shift Fork Spring 33 NUT, Hex. Slotted 3/8 NF 34 GASKET, Shift Housing					
31NUT, Hex72HOUSING, W/Studs, Shift Fork32WASHER, Lock73NUT, Hex. Jam 1/2 NF33DOWEL, Axle Shaft Stud74SCREW, Shift Fork Adjusting Stop34STUD, Wheel Flange75BALL, Shift Fork Spring35GASKET, Axle Shaft76NUT, Hex. Slotted 3/8 NF36GEAR SET, Ring and Pinion77GASKET, Shift Housing					
32WASHER, Lock73NUT, Hex. Jam 1/2 NF33DOWEL, Axle Shaft Stud74SCREW, Shift Fork Adjusting Stop34STUD, Wheel Flange75BALL, Shift Fork Spring35GASKET, Axle Shaft76NUT, Hex. Slotted 3/8 NF36GEAR SET, Ring and Pinion77GASKET, Shift Housing					
33DOWEL, Axle Shaft Stud74SCREW, Shift Fork Adjusting Stop34STUD, Wheel Flange75BALL, Shift Fork Spring35GASKET, Axle Shaft76NUT, Hex. Slotted 3/8 NF36GEAR SET, Ring and Pinion77GASKET, Shift Housing					
34 STUD, Wheel Flange 75 BALL, Shift Fork Spring 35 GASKET, Axle Shaft 76 NUT, Hex. Slotted 3/8 NF 36 GEAR SET, Ring and Pinion 77 GASKET, Shift Housing					
35 GASKET, Axle Shaft 76 NUT, Hex. Slotted 3/8 NF 36 GEAR SET, Ring and Pinion 77 GASKET, Shift Housing					
36 GEAR SET, Ring and Pinion 77 GASKET, Shift Housing					
37 BEARING, Pinion Inner Cone 78 FORK, Shift, Assembly					
	37	BEARING, Pinion Inner Cone		78	FORK, Shift, Assembly
38 BEARING, Pinion Inner Cup 79 SPRING, Shift Fork					
39 SHIM, Pinion Bearing 80 BOLT, Shift Fork					
40 GEAR, Pinion Driven 81 WASHER, Shift Fork Spring Seat					
41 SPACER, Pinion Bearing 82 SPRING, Shift	41	SPACER, Pinion Bearing		82	SPRING, Shift

REMOVAL (DRIVE UNIT)

- A. Remove plug from bottom of axle housing and drain lubricant.
- B. Remove the axle shaft stud nuts, lockwashers and tapered dowels.

IMPORTANT

To loosen the dowels, hold a brass drift against the center of the axle shaft head, INSIDE THE CIRCULAR DRIVING LUGS. Strike the drift a sharp blow with a hammer or sledge.

CAUTION

Do not hit the circular driving lugs on the shaft head this may cause the lugs to shatter and splinter. Do not use chisels or wedges to loosen the shaft or dowels this will damage the hub, shaft and oil seal.

- Remove the axle shaft from the drive unit and housing.
- D. Disconnect the forward and rear propeller shafts.
- E. Remove carrier to housing stud nuts and lockwashers. Loosen two top nuts but leave on studs to prevent carrier from falling.
- F. Break carrier loose from housing with a rawhide mallet.

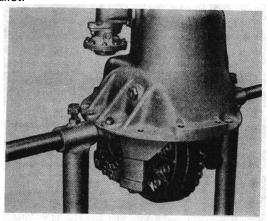


Fig. 2

G. To remove carrier from housing, place roller jack under carrier. Remove top nuts and lockwashers and work carrier free. A small pinch bar may be used to straighten carrier in housing bore. However, the end must be rounded to prevent indenting the carrier flange.

- H. Place carrier in suitable holding fixture (Fig. 2).
- J. Loosen jam nut and back off adjusting screw. Roll differential gear slightly to allow thrust block to drop out (Fig. 3).

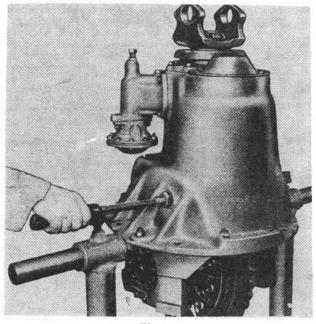


Fig. 3

REMOVAL (SHIFT UNIT)

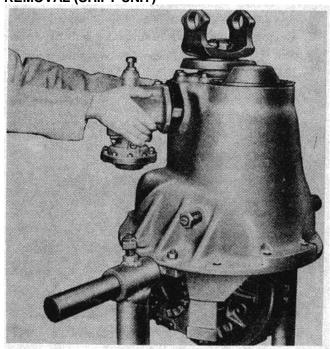


Fig. 4

- A. Remove the shift housing capscrews and lockwashers.
- B. Remove the shift housing assembly and gasket (Fig. 4).

DISASSEMBLY (SHIFT UNIT)

A. To disassemble the shift housing assembly remove the shift lever attaching nut cotter key and nut. Tap body fit bolt back far enough to remove lever from shift shaft slot. Remove lever cup and spring (Fig. 5).

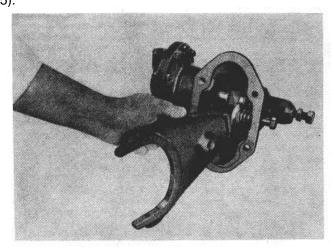


Fig. 5

- B. Remove the shift chamber attaching nuts and lockwashers. By use of snap ring pliers, expand lock ring to clear shaft groove and slide out shaft and chamber assembly (Fig.6).
- C. Remove from the housing the spring retainer and spring.

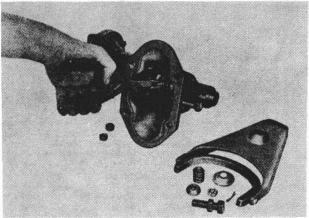


Fig. 6

REMOVAL (INTER-AXLE 3RD DIFFERENTIAL)

A. Remove the pinion bearing cover capscrews and lockwashers. Remove cover and gasket (Fig. 7).

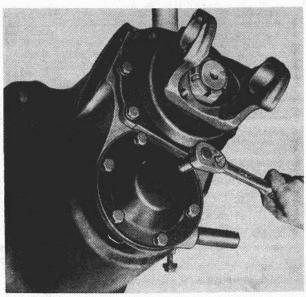


Fig. 7

B. Remove pinion nut cotter key if used, and loosen pinion nut (Fig. 8). (Do not remove pinion nut at this time.)

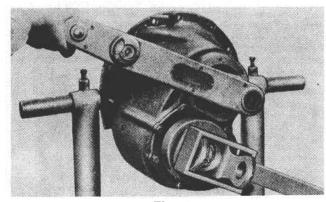


Fig. 8

C. Remove input shaft cotter key if used and loosen yoke or flange nut (Fig. 9). (Do not remove nut at this time.)

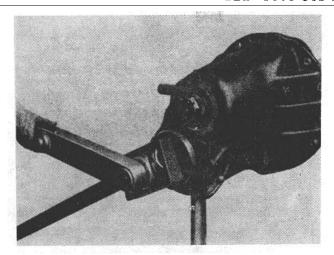


Fig. 9

D. Remove the input shaft cage capscrews and lockwashers (Fig. 10).

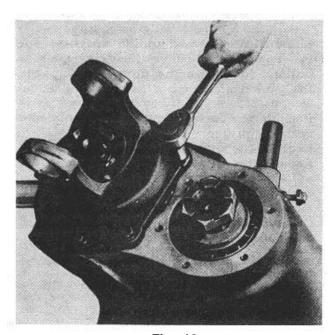


Fig. 10

- E. Turn the drive unit assembly to a vertical position in the carrier stand and remove the inter-axle differential assembly with a chain fall (Fig. 11).
- F. Lightly tap housing with rawhide hammer to free assembly. It may be necessary to rotate the input shaft to align one flat at rear of inter-axle differential case with the transfer gear.

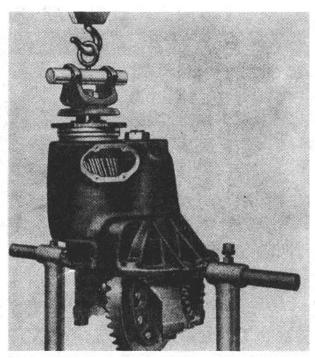


Fig. 11

REMOVAL (DIFFERENTIAL CASE AND GEAR)

A. Center punch one differential carrier leg and bearing cap to identify in reassembly (Fig.12)

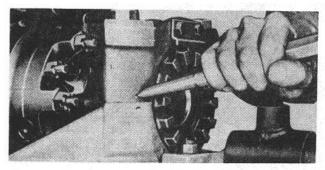


Fig. 12

- B. Cut the lockwire, if used, and remove the leg capscrews and cotter key.
- C. Remove the bearing adjusting ring and the carrier cap.
- D. Repeat Steps B and C for removal of carrier cap on the opposite side.

E. Lift out the differential and gear assembly (Fig. 13).

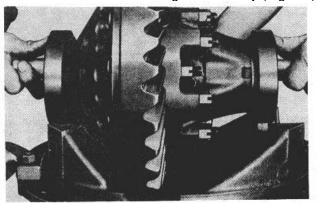


Fig. 13

- F. If original identification marks are not clear, mark the differential case halves with a punch or chisel for correct alignment on reassembly.
- G. Remove the lockwire, if used, and capscrews and separate the case halves.
- H. Remove spider, spider pinions, side gears and thrust washers.
- J. If gear is to be replaced for any reason, remove rivets and separate gear from case.
 - 1. Carefully center-punch rivets in center of head (Fig. 14).
 - 2. Use drill .79 mm (1/32") smaller than body of rivet to drill through head from gear side.
 - 3. Press out rivets.

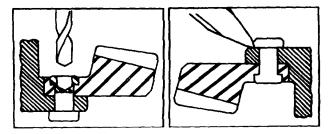


Fig. 14

K. If necessary to replace differential bearings, remove with a suitable puller.

REMOVAL (PINION ASSEMBLY)

A. Position the drive unit in a press supported by press plates under the carrier to housing mounting flange.

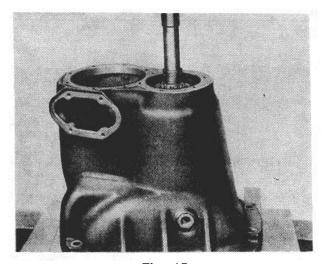
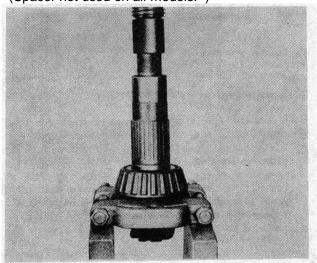


Fig. 15

- Remove the pinion nut (previously loosened) and spacing washer.
- C. Press the pinion shaft through the forward pinion bearing cone and drive gear (Fig. 15).
- D. Lift out the forward pinion bearing cone and two spacers. Remove the drive gear and pinion. (Remove the drive gear spacer from the pinion shaft not used on all models.)
- E. Remove the forward pinion bearing cup with suitable puller.
- F. Remove the rear pinion bearing cup with a suitable puller and remove the cup spacer and shim pack. (Spacer not used on all models.)



- G. Wire shim pack together to facilitate reassembly. This shim pack controls the depth of pinion in relation to the hypoid gear and it may be increased or decreased to change the tooth contact at time of reassembly.
- H. If necessary to remove the rear pinion bearing, use a suitable puller that bears against bearing inner race or press off with a fixture that supports inner race (Fig. 16).

DISASSEMBLY (INTER-AXLE 3RD DIFFERENTIAL WITH BALL AND STRAIGHT ROLLER BEARINGS)

A. If a snap ring is used, fold out the tabs on rear bearing snap ring retainer and remove snap ring with snap ring pliers. Remove snap ring retainer (Fig. 17).

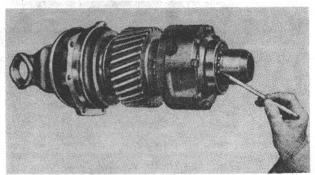


Fig. 17

B. Cut and remove the inter-axle case bolt locking wire, if used. Remove the case bolts and hardened washers. Center, punch each case half before separating to insure correct alignment in reassembly Fig. 18).

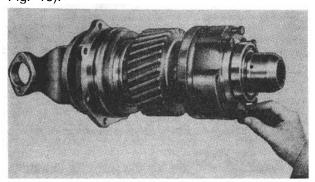


Fig. 18

C. Separate the inter-axle differential case halves (Fig. 19).

Before disassembly is started, record gear backlash. Gear must be reset to this figure at reassembly.

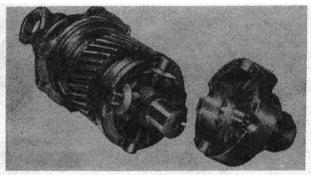


Fig. 19

D. Set the rear case half up on press plates and press the rear side gear from bearing (Fig. 20).

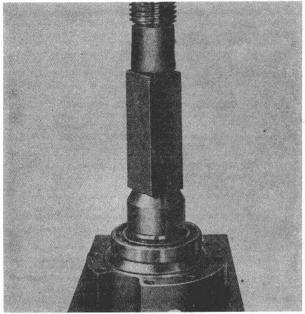


Fig. 20

E. Push spider and snap ring retainer forward and remove snap ring with snap ring pliers. Slide off snap ring retainer (Fig. 21).

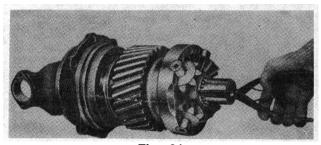


Fig. 21

F. Slide spider, pinion and thrust washer assembly off shaft splines (Fig. 22).

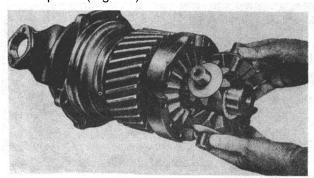


Fig. 22

G. Remove the inter-axle differential forward case half (Fig. 23).

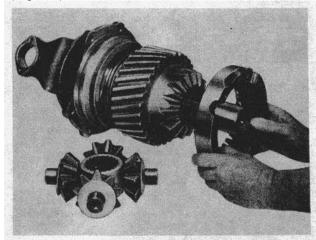


Fig. 23

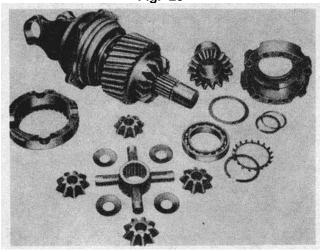


Fig. 24

- H. Separate the inter-axle differential pinions and thrust washers from spider (Fig. 24).
- I. Remove the transfer gear and thrust washer from input shaft. (Transfer gear and forward side gear are integral.)(Fig. 25).

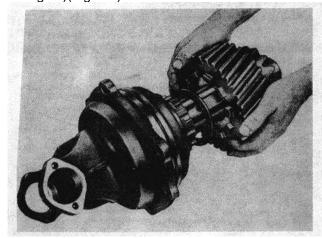


Fig. 25

J. Slide off the clutch collar (Fig. 26).



Fig. 26

K. Remove the radial bearing rear snap ring from bearing cage (Fig. 27).

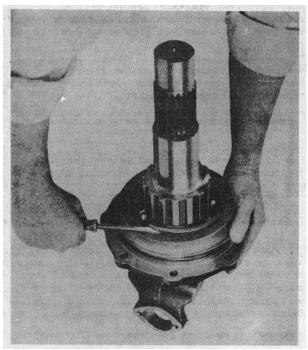


Fig. 27

- L. Remove the input shaft nut and remove yoke or flange with suitable puller.
- M. Tap or press shaft and radial bearing assembly from cage. Remove the radial bearing spacer (Fig. 28).
- N. Remove snap ring from cage.
- O. Press out the oil seal with a suitable sleeve and discard (Fig. 29).
- P. Remove the radial bearing with a suitable puller equipped with fingers that bear against inner race (Fig. 30).

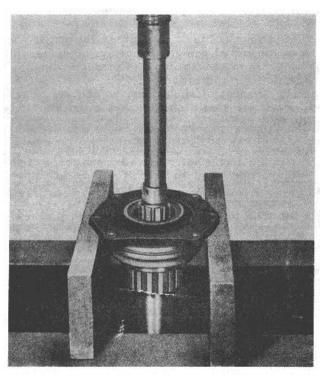


Fig. 28

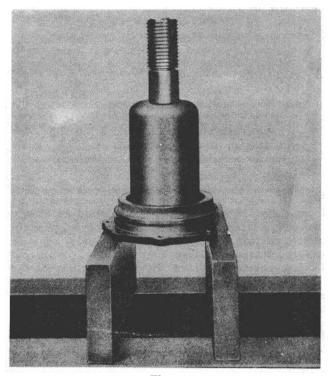


Fig. 29

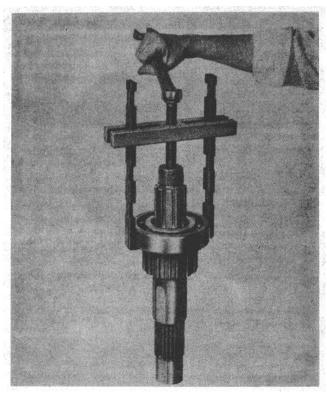


Fig. 30

CLEANING

Parts having ground and polished surfaces such as gears, bearings, shafts and collars, should be cleaned in a suitable solvent such as kerosene or diesel fuel oil.

CAUTION

GASOLINE MUST BE AVOIDED.

Do NOT clean these parts in a hot solution tank or with water and alkaline solutions as sodium hydroxide, orthosilicates or phophates.

We do NOT recommend steam cleaning assembled drive units after they have been removed from the housing. When this method of cleaning is used, water is trapped in the cored passage of the castings and in the close clearances between parts as well as on the parts. This can lead to corrosion (rust) of critical parts of the assembly and the possibility of circulating rust particles in the lubricant. Premature failure of bearings, gears and other parts can be caused by this practice. Assembled drive units cannot be properly cleaned by steam cleaning, dipping or slushing. Complete drive unit disassembly is a necessary requisite to thorough cleaning

Rough parts such as differential carrier castings, cast brackets may be cleaned in hot solution tanks with mild alkali solutions providing these parts are not ground or polished. The parts should remain in the tank long enough to be thoroughly cleaned and heated through. This will aid the evaporation of the rinse water. The parts should be thoroughly rinsed after cleaning to remove all traces of alkali.

CAUTION

Exercise care to avoid skin rashes and inhalation of vapors when using alkali cleaners.

DRYING

Parts should be thoroughly dried immediately after cleaning. Use soft, clean, lintless absorbent paper towels or wiping rags free of abrasive material, such as lapping compound, metal filings or contaminated oil. Bearings should never be dried by spinning with compressed air.

CORROSION PREVENTION

Parts that have been cleaned, dried, inspected and are to be immediately reassembled should be coated with light oil.

INSPECTION

It is impossible to overstress the importance of careful and thorough inspection of drive unit parts prior to reassembly. Thorough visual inspection for indications of wear or stress, and the replacement of such parts as are necessary will eliminate costly and avoidable drive unit failure.

- A. Inspect all bearings, cups and cones, including those not removed from parts of the drive unit, and replace if rollers or cups are worn, pitted or damaged in any way. Remove parts needing replacement with a suitable puller or in a press with sleeves. Avoid the use of drifts and hammers. They may easily mutilate or distort component parts.
- B. Inspect hypoid gears for wear or damage. Gears which are worn, ridged, pitted or scored, should be replaced. When necessary to replace either the pinion or gear of hypoid set, the entire gear set should be replaced.

•

- C. Inspect the differential assembly for the following:
- Pitted, scored or worn thrust surfaces of differential case halves, thrust washers, spider trunnions and differential gears. Thrust washers must be replaced in sets. The use of a combination of old and new washers will result in premature failure.
- 2. Wear or damage to the differential pinion and side gear teeth. Always replace differential pinions and side gears in sets.
- D. Inspect axle shafts for signs of torsional fractures or other indication of impending failure.

REPAIR

- A. Replace all worn or damaged parts. Hex nuts with rounded corners, all lockwashers, oil seals and gaskets should be replaced at the time of overhaul.
 - Use only genuine replacement parts for satisfactory service. For example, using gaskets of foreign material generally leads to mechanical trouble due to variations in thickness and the inability of certain materials to withstand compression, oil, etc.
- B. Remove nicks, mars and burrs from machined or ground surfaces. Threads must be clean and free to obtain accurate adjustment and correct torque. A fine mill file or India stone is suitable for this purpose. Studs must be tight prior to reassembling the parts.
- C. All bronze bushed differential pinions should be ball burnished after bushing installation. Install the bushing with a small stepped drift. The small O.D. should be .25 mm (.010") smaller than the bushing burnished I.D. and 1-1/2 times bushing length. Always install bushings so end is even with the I.D. chamfer or about 1.58 mm (1/16") below the spherical surface.
- D. When assembling component parts use a press where possible.
- E. Tighten all the nuts to the specified torque. Use soft iron locking wire to prevent possibility of wire breakage.
- F. The burrs, caused by lockwashers, at the spot face of stud holes of cages and covers should be removed to assure easy reassembly of these parts.

ASSEMBLY (PINION)

A. Press the rear cone squarely and firmly against the pinion head. Use a suitable sleeve that will bear against cone race (Fig. 31).

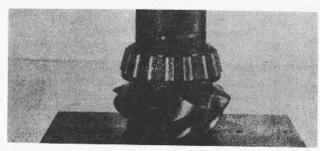


Fig. 31

- B. Prior to assembling the rear bearing cup, spacer and shim pack (install gear spacer if used).
- C. Install rear bearing cup against the shim pack (and spacer, if used).
- D. Install the outer pinion bearing cup to bottom in cup bore.
- E. Lubricate bearing and cups with light machine oil.
- F. Place the carrier and cap under a press, carrier legs down. Hold transfer gear in position and thread pinion shaft up through inner bearing cup and transfer gear. Support pinion and carrier under pinion head. Install "fixed" (thick) cone spacer.
- G. Start outer bearing cone on pinion shaft. Press bearing on with a suitable sleeve that will bear against the cone race. Press bearing in place with two tons pressure to seat rollers.
- H. Assemble pinion nut washer and nut with only 135.6 N.m (100 ft.lbs.) torque. Hold pinion by placing a hardwood block between pinion teeth and carrier wall.

ASSEMBLY (DIFFERENTIAL AND RING GEAR)

A. Rivet the hypoid gear to the case half with new rivets. Rivets should not be heated, but always upset cold. When the correct rivet is used, the head being formed will be at least 3.17 mm (1/8") larger in diameter than the rivet hole. The head will then be approximately the same height as the preformed head. Excessive pressure will cause distortion of the case holes and result in gear eccentricity.

Tonnage required for squeezing cold rivets: These pressures are approximate for annealed steel rivets and pressure can be adjusted to suit individual working conditions.

Diameter of Rivet	Metric Ton	US Tons Required
7/16"	19.9	22
1/2 f	27.2	30
9/16"	32.6	36
5/8 "	40.8	45

Final pressure should be held for approximately one minute to make sure the rivet has filled the hole.

Differential case and gear bolts are available for service replacement of rivets. The use of bolts greatly facilitates servicing these units in the field and eliminates the need for special equipment necessary to correctly cold upset rivets.

- B. Lubricate differential case inner walls and all component parts with axle lubricant.
- C. Position thrust washer and side gear in bevel gear and case half assembly.
- D. Place spider with pinions and thrust washers in position.
- E. Install second side gear and thrust washer.
- F. Align mating marks, position component case half and draw assembly together with equally spaced capscrews (Fig. 32).

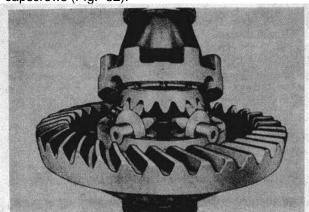


Fig. 32

- G. Install remaining bolts and capscrews, tighten to the correct torque and lock wire, if used.
- H. If bearings are to be replaced, press squarely and firmly on differential case halves.

INSTALLATION (DIFFERENTIAL AND RING GEAR)

- A. Lubricate differential bearings and cups with axle lubricant.
- B. Place cups over bearings and position assembly in carrier housing.
- C. Insert bearing adjusting nuts and turn handtight against bearing cups.
- D. Install bearing caps in the correct location as marked and tap lightly into position (Fig. 33).

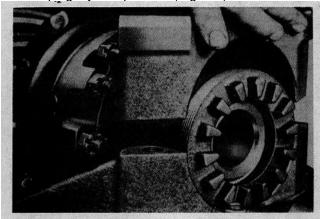


Fig. 33

If bearing caps do not position properly, adjusting nuts might be cross threaded. Remove caps and reposition the adjusting nuts. Forcing caps into position will result in irreparable damage to the carrier housing or bearing caps.

E. Install carrier leg capscrews and tighten to required torque. Install adjusting nut lock (cotter keys or lock plate). If carrier leg capscrews are drilled or castellated, lock wire after final adjustments are made.

ADJUSTMENT (DIFFERENTIAL BEARING PRELOAD)

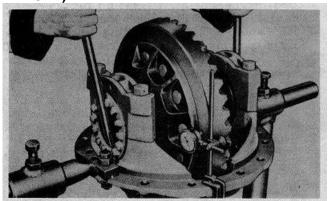


Fig. 34

- A. Using dial indicator at backface of gear, loosen the bearing adjusting nut on the side opposite gear only sufficient to notice end play on the indicator (Fig. 34).
- B. Tighten the same adjusting nut only sufficient to obtain .000" end play.
- C. Check gear for runout. If runout exceeds .20 mm (.008"), remove differential and check for cause.
- D. Tighten adjusting nuts one notch each from .000 end play to pre-load differential bearings.

ADJUSTMENT (GEAR BACKLASH)

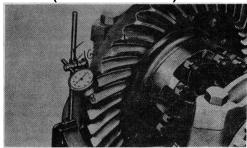


Fig. 35

If the drive gear is not going to be replaced, we suggest the established backlash recorded before disassembly be used. For new gears the new backlash should be initially set at .25 mm (.010"). Adjust backlash by moving the gear only. This is done by backing off one adjusting ring and advancing the opposite ring the same amount (Fig. 35).

ADJUSTMENT (TOOTH CONTACT)



Fig. 36

Apply oiled red lead lightly to the gear teeth. When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts (Fig. 36).

Sharper impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the gear teeth. Coast side should be automatically correct when drive side is correct. As a rule, coating about twelve teeth is sufficient for checking purposes.

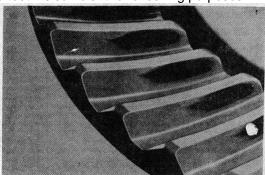


Fig. 37 SATISFACTORY TOOTH CONTACT (GEARS UNLOADED)

With adjustments properly made (pinion at correct depth and backlash set at .25 mm (.010") the above contacts will be procured. The area of contact favors the toe and is centered between the top and bottom of the tooth (Fig. 37).

The hand rolled pattern shown above (gears unloaded) will result in a pattern centered in the length of the tooth when the gears are under load, shown on top of this page. The loaded pattern will be almost full length and the top of pattern will approach the top of the gear.

SATISFACTORY TOOTH CONTACT (GEARS LOADED)

The pattern on the coast side of teeth will appear the same width as the drive side shown above; however, the overall length will be centered between the toe and heel of gear tooth (Fig. 38).

Set used hypoid gears so the tooth contacts match existing wear patterns. Hand rolled patterns of used gears will be smaller in area and should be at the toe end of wear patterns.

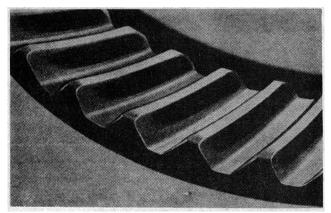


Fig. 38

INCORRECT HYPOID TOOTH CONTACT

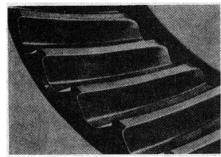




Fig. 39

A high contact indicates pinion is too far out. Set the pinion to the correct depth by removing shims under the pinion cage. Slight outward movement of hypoid gear may be necessary to maintain correct backlash (Fig. 39).

A low contact indicates pinion is too deep. Set the pinion to the correct depth by adding shims under the pinion cage. Slight upward movement of the hypoid gear may be necessary to maintain correct backlash (Fig. 40).

Unsatisfactory tooth contact on two gear transfer trains (over-hung pinion) may be corrected by the following procedures: Fig. 40 To correct for high tooth contact (pinion is too far out) add shims to the inner

pinion bearing cup. When adding shims, an equal thickness must be removed from the outer bearing spacer to prevent the pinion bearing pre-load from decreasing.

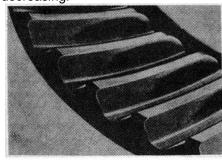




Fig. 40

To correct for low tooth contact (pinion is set too deep) remove shims from the inner pinion bearing cup. Further, when removing shims an equal thickness must be added to the outer bearing spacer to prevent the pinion bearing preload from increasing.

ADJUSTMENT (PINION BEARING PRE-LOAD)

Now that the proper tooth contact and shim pack for the rear bearing cup have been determined, determine the pinion bearing pre-load.

- A. Remove the differential and gear assembly and associated parts.
- B. Remove pinion nut and washer. Press the hypoid pinion out of outer bearing cone. Press transfer gear back in position on pinion.
- C. Make sure "fixed" (thick) spacer is in position against transfer gear. Cut two lengths of bar lead (or solder) approximately 14.2 mm (9/16") long and insert both on top of the "fixed" spacer, 180 deg. apart. Press bearing cone in place with two tons pressure and with a suitable sleeve that will bear against the cone race. This process will compress the bar lead (or solder).

- D. Press pinion out of outer bearing cone.
- E. Measure the compressed bar lead (or solder) thickness with a micrometer. To this figure add .10 mm (.004") to determine the thickness of the required variable spacer to be employed to obtain pinion bearing pre-load.
- F. Install variable spacer over pinion stem against gear side.
- G. Place a support under pinion head and press on the outer pinion bearing cone with a suitable sleeve that will bear against the bearing inner race. Apply press pressure of approximately two tons to seat bearing rollers. Rotate carrier and cap in this process. Remove from under press.
- H. Assemble pinion washer and nut. Tighten to specified torque. To apply proper torque hold pinion by placing a hardwood block between pinion teeth and carrier wall.
- I. Check for proper pinion bearing pre-load of 2.2-6.8 Kg (5-15 in.lbs.) by installing appropriate wrench socket over pinion nut. Wrap a cord or soft wire around socket and pull on horizontal line with a pound "fish" scale. Use rotating torque, not starting torque. If rotating torque is not within 2.2-6.8 Kg (5-15 in.lbs.), use thinner hardened spacer to increase, or thicken spacer to decrease pre-load.

ASSEMBLY (INTER-AXLE 3RD DIFFERENTIAL WITH BALL AND STRAIGHT ROLLER BEARINGS)

- A. Install the input forward radial bearing snap ring into cage.
- B. Press the input shaft oil seal into cage from forward side, flush with snap ring.
- C. Press the forward radial bearing on input shaft with suitable sleeve bearing against inner race.
- D. Position the input shaft radial bearing into the cage bore flush with forward snap ring and install the rear radial bearing snap ring.
 - If input cage "O" ring has been scuffed or damaged in any way, replace with new.
- E. Install yoke or flange on splines and install washer, if used, and nut. Nut may be run up on threads only sufficient for handling assembly in chain falls and later tightened to correct torque when assembly is mounted into housing.

F. Install the dog clutch collar on input shaft splines with the smooth side next to cage (Fig. 41).

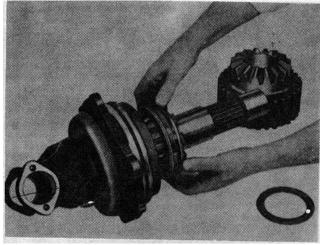


Fig. 41

- G. Install the transfer gear thrust washer and transfer gear.
- H. Position the inter-axle differential forward case half over the forward side gear and assemble the spider pinions and thrust washers on spider (Fig. 42).

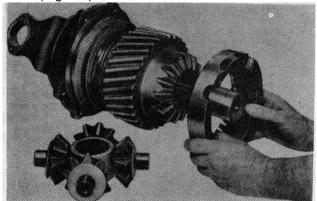
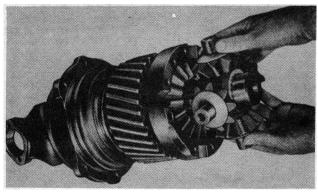


Fig. 42

- Locate the assembly on input shaft splines. Turn the case half so that trunnion holes align with trunnions and slide assembly into case half (Fig. 43).
- J. Install the spider retainer and snap ring.
- K. Set the rear case half and rear side gear and thrust washer up on press plates and press the rear bearing into position (Fig. 44).



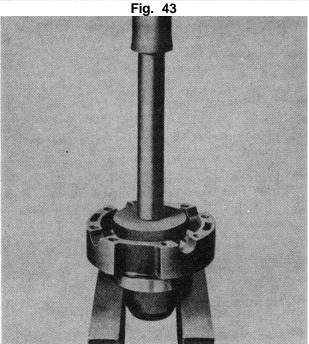


Fig. 44

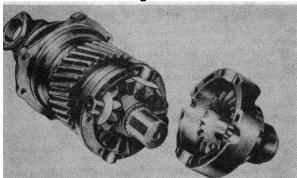


Fig. 45

L. Position the rear case half, side gear and bearing assembly to mate with forward case half and next assembly. Install hardened washers and case bolts (Fig. 45).

- M. Tighten the case bolt to specified torque and install lock wire.
- N. Install snap ring tab lock and snap ring. Fold down the lock tabs to secure snap ring.
- O. Position the carrier housing with pinion and differential assembly upright in the carrier stand. By use of chain falls lower the inter-axle differential and input shaft assembly against a new gasket (Fig. 46).

Production drive gears and driven gears are mated at time of lapping. One drive gear tooth is marked with an "X" and one driven gear tooth space is marked with a corresponding symbol (). We suggest these mating marks be lined up.

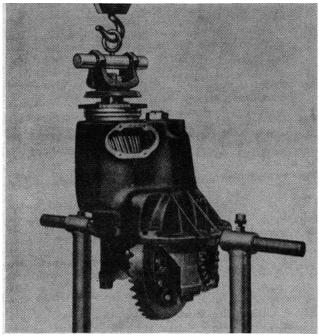


Fig. 46

- P. Install the input cage lockwashers and capscrews. Tighten capscrews to specified torque.
- Q. Tighten the input shaft or flange nut to specified torque and install cotter key, if used.
- R. Tighten the pinion nut to specified torque and install cotter key, if used.

S. Clean the pinion cover gasket surfaces on both the carrier and pinion cover. Dry both surfaces thoroughly and apply a 3.1 mm (1/8") diameter bead of room temperature vulcanizing gasket material (liquid gasket) to the pinion cover face of the carrier. Apply the gasket material to one surface only.

Apply a continuous bead around the complete surface and around each capscrew hole.

CAUTION

Minor concentrations of acetic acid vapor may be produced during application. Adequate ventilation should be provided when applied in confined areas.

Eye contact may cause irritation. If eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

T. Assemble the pinion cover immediately to carrier to permit the gasket material to spread evenly. Secure cover to carrier with capscrews and hardened flat washers. Tighten capscrews.

ASSEMBLY (THRUST SCREW OR BLOCK)

- A. Remove carrier from stand and position with back face of hypoid or spiral bevel gear upward.
- B. Remove thrust screw and lock nut. Current carrier designs employ only the thrust screw, which replaces the thrust screw and thrust block assembly.
- C. If a thrust block is employed, place thrust block on rear face of hypoid gear and rotate gear until the hole in the thrust block is aligned with the thrust screw hole.
- D. Install thrust screw and lock nut, and tighten thrust screw sufficiently to locate thrust block, if used, firmly against back face of hypoid gear.
- E. To secure the correct adjustment of .25-.38 mm (.010"-.015") clearance, loosen adjusting nut or thrust screw 1/4 turn and lock securely with nut.
- F. Recheck to assure minimum clearance of .25 mm (.010") during full rotation of bevel gear.

A. Install the shift shaft and chamber assembly into housing assembly and install snap ring in shaft groove (Fig. 47).

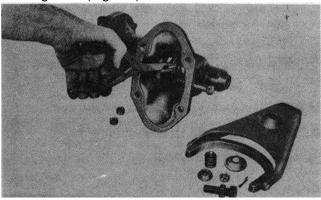


Fig. 47

- B. Install next to snap ring the snap ring spring retainer and spring.
- C. Proceed with inserting the shaft until chamber mates with housing studs and gasket. Install lockwashers and nut and tighten nuts to specified torque. Install the adjusting screw and lock nut.
- D. Install on the body fit housing bolt the spring, cup and lever. Make sure lever end enters the shift shaft slot. Install the button and nut. Tighten nut securely with box wrench and cotter key, if used. Shim as required to obtain slight compression on spring.
- E. Position the shift and housing assembly into the carrier assembly against a new gasket or gasket material (Fig. 48).

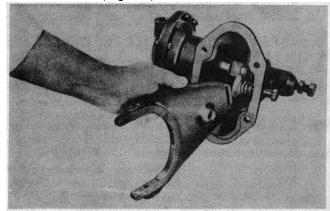


Fig. 48

ASSEMBLY (SHIFT UNIT)

ADJUSTMENT (SHIFT SHAFT)

- A. Back-off adjusting screw lock nut so screw is free-turning.
- B. Shift assembly to engaged position with power chamber. Be sure shift collar is fully engaged with rear gear.
- Turn-in screw until it is finger-tight against push rod.
- D. Turn-in screw 1/2 revolution more to center fork in groove.
- E. Tighten lock nut to specified torque.

ASSEMBLY (DRIVE UNIT)

A. Install new drive unit to housing gasket over housing studs.

Roll carrier into position on roller jack. Start carrier into housing with four flat washers and nuts equally spaced.

Do not drive carrier into housing with a hammer at the carrier stud flange. The flange may easily be distorted and cause severe oil leakage.

Install lockwashers and stud nuts on any studs under carrier housing offsets. It is impossible to start these nuts after carrier is drawn into housing.

- B. Tighten the four nuts over flat washers alternately to draw carrier squarely into axle housing.
- C. Remove nuts and flat washers. Install taper dowels, lockwashers and stud nuts. Tighten to the correct torque.
- D. Connect universal at pinion shaft.
- E. Install axle shafts.

DISASSEMBLY (INTER-AXLE 3RD DIFFERENTIAL WITH TAPER BEARINGS)

- A. Remove rear inter-axle differential side gear and bearing cone from carrier.
- B. If bearings require replacement, remove rear side gear bearing cup from carrier, using a suitable puller. Remove the bearing cone from rear side gear using a press and bearing puller.
- C. Remove the spider retaining snap ring from input shaft and slide inter-axle differential next from shaft.
- D. Disassemble inter-axle case halves by removing capscrews and washers. This will free the spider, 4 pinions and thrust washer. Before

- splitting inter-axle differential case halves, make certain identification marks are clear for correct reassembly. If markings are not clear use a punch or chisel and re-mark.
- E. Slide off helical drive gear, thrust washer and clutch collar from input shaft.
- F. Remove yoke or flange nut and washer, if used, from input shaft. Using a suitable puller remove yoke or flange. This will free the input bearing cage, lift cage off from shaft. Inspect input bearing cage to carrier "O" ring for cracks, breaks, etc. Remove "O" ring from cage and discard if found defective in any way. Also inspect input oil seal in bearing cage, replace if required.
- G. If bearings require replacement, remove bearing cone from input shaft and bearing cup from bearing cage.

ASSEMBLY (INTER-AXLE 3RD DIFFERENTIAL WITH TAPER BEARINGS)

Before reassembly and installation of interaxle differential (input) assembly into carrier, first install hypoid pinion, differential and ring gear assembly and adjust for correct pinion bearing pre-load, tooth contact, etc.

- A. Press the input shaft rear bearing cup into bore in carrier. Use a press and sleeve of the correct diameter to press in cup.
- B. Press the input shaft forward bearing cone onto the new input shaft. Use a sleeve to press on cone by the inner race only. Coat the bearing rollers with the recommended axle lubricant.
- C. Install the clutch collar onto the input shaft splines with the clutch teeth facing the rear of shaft.
- D. Prelubricate both sides of the helical drive gear thrust washer and the gear journal of the input shaft. Place the thrust washer into its pilot bore in the helical drive gear and install the gear and washer onto the input shaft.
- E. Assemble the inter-axle differential spider, pinions and thrust washers between the case halves. Thoroughly prelubricate both sides of the thrust washers and spider legs as the parts are being assembled.

- F. Secure the assembly together with hardened washers and capscrews. Tighten capscrews to 81.3-101.7 N.m (60-75 ft.lbs.) torque.
- G. Prelubricate the forward side gear teeth (integral with helical drive gear) and install the inter-axle differential nest assembly onto the input shaft with the capscrew heads facing toward rear of shaft.
- H. Retain the inter-axle differential nest assembly on the input shaft by installing the new snap ring into groove in shaft.
- J. Press the input shaft rear bearing cone onto rear side gear. Use a sleeve to press on cone by the inner race only.
- K. Prelubricate the bearing rollers and side gear teeth. Position the carrier upright and place the rear side gear with bearing cone into carrier against bearing cup previously installed.
- L. Using a chain fall, carefully lower the new input shaft assembly into carrier.

IMPORTANT

One helical gear is marked with an "X" at one tooth, while the other helical gear is marked with a corresponding symbol "()" at one tooth. These marks must be aligned at installation for correct gear contact.

- M. Install new "O" ring in groove in the input bearing cage pilot O.D. Applying axle lubricant to "O" ring will facilitate installation.
- N. Place the input bearing cage and cup into position over the shaft against the input bearing cone. Continue by adjusting input shaft end play.

ADJUSTMENT (INPUT SHAFT END PLAY WITH TAPER MARINGS)

- A. Install bearing cage to carrier capscrews and tighten to finger tight only. As capscrews are tightened rotate the input shaft several revolutions to seat bearings. Keep the hypoid ring gear from rotating by blocking gear with wood wedge.
- Using a feeler gauge measure the gap between the bearing cage and machined carrier face.
 Add .17 mm (.007") to the gap measurement .17

- mm (.007") + gap measurement and select a new shim pack to correspond to this value.
- Use a minimum of three shims in the pack with the thinnest shims positioned at both sides to allow pack to compress for sealing.
- C. Remove the cage capscrews and lift the input assembly slightly using a chain fall. Slide the shim pack into position under the bearing cage and lower the input shaft assembly and cage back into carrier. The shims may be split. With split shims it is not necessary to completely remove the cage or input shaft assembly from carrier to install shim pack.
- D. Secure the cage to carrier with two capscrews and lockwashers positioned in opposite holes. Tighten capscrews to 54.2-74.5 N.m (40-55 ft.lbs.) torque. As capscrews are tightened rotate the input shaft several revolutions to seat bearings.
- E. Mount a dial indicator onto the front face of carrier with the pointer (plunger) seated against the end of the input shaft. Turn the input shaft in both directions while pushing inward. Set the dial indicator to zero. The use of a magnetic base will facilitate mounting the indicator.
- F. While observing the dial indicator pull the input shaft outward and take note of reading. Final end play must be .12-.25 mm (.005"-.010"). If end play is not within correct range adjust shim pack by adding or removing shims as required. Adding shims will increase end play, while removing shims will decrease end play. If shim pack requires further adjustment, repeat steps C thru F.
- G. After correct end play has been established, assemble the remaining capscrews and lockwashers. Tighten capscrews to 54.2-74.5 N.m (40-55 ft.lbs.) torque.
- H. Clean the pinion cover gasket surfaces on both the carrier and pinion cover. Dry both surfaces thoroughly and apply a 3.1 mm (1/8") diameter bead of room temperature vulcanizing gasket material (liquid gasket) to the pinion cover face of the carrier. Apply the gasket material to one surface only. Apply a continuous bead around the complete surface and around each capscrew hole.

CAUTION

Minor concentrations of acetic acid vapor may be produced during application. Adequate ventilation should be provided when applied in confined areas.

Eye contact may cause irritation. If eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

J. Assemble the pinion cover immediately to carrier to permit the gasket material to spread evenly. Secure cover to carrier with capscrews and hardened flat washers. Tighten capscrews to specified torque.

INSTALLATION (THROUG-SHAFT YOKE)

- A. For original design carriers (with slip fit splines), install the through-shaft yoke on splines with a suitable sleeve.
- B. For current design carriers employing interference fit splines use three-piece installation tool SE-2708 and the following procedure.

IMPORTANT

Do not drive yokes onto pinion, input, output or through-shafts by pounding or tapping. This will damage the yoke, splines, shafts and bearings.

- Clean all parts thoroughly. Coat yoke seal elements with recommended axle lubricant. Also ensure that there are no burrs or nicks on the yoke wiper surface or on any surfaces that will pass through the seal during installation.
- 2. Thread the yoke installation shaft onto pinion input, output or through-shaft until installation shaft bottoms.
- 3. Slide the yoke over the installation shaft aligning yoke and shaft splines of drive unit.
- 4. Place installation collar over the installation shaft, against yoke.
- 5. Thread nut onto installation shaft, against the collar. Continue threading the nut against collar until yoke seats against bearing. A torque value of 271 N.m (200 ft.lbs.) on nut may be required to properly install and seat the yoke.

CAUTION

Do not use a prevailing torque nut to install the yoke, as damage to the threads will result. Use only the nut furnished with tool.

- 6. Remove all parts of the installation tool from the drive unit.
- C. Install pinion input, output-or through-shaft washer (if employed) and nut. Tighten nut to the required torque value.

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AXLE REAR

CHAPTER II

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DESCRIPTION (REAR REAR AXLE)

This Single-Reduction Final Drive (Fig. 1) employs a heavy duty spiral bevel or hypoid pinion and gear. The differential and gear assembly is mounted on tapered roller bearings. The straddle mounted pinion

has two tapered roller bearings in front of the pinion teeth which take the forward and reverse thrust and a third bearing behind the pinion teeth to carry the radial load.

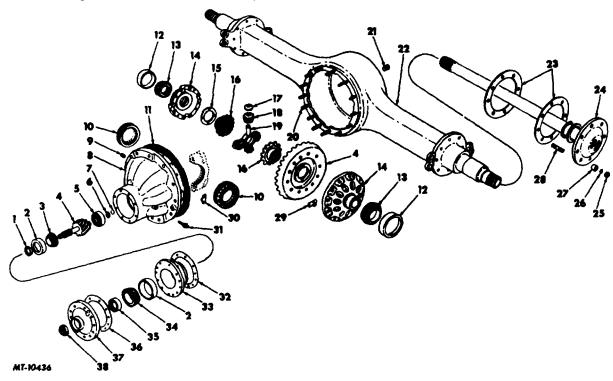


Fig. 1 Exploded View Rear Rear Axle

LEGEND FOR Fig. 1

<u>No</u> .	<u>Description</u>	<u>No.</u>	<u>Description</u>
1	SPACER, Pinion Bearing	20	STUD, Carrier to Axle Housing
2	BEARING, Pinion Cup	21	PLUG, Magnetic Drain
3	BEARING, Pinion Inner Cone	22	HOUSING, Axle, Assembly
4	GEAR SET, Ring and Pinion	23	GASKET, Axle Shaft
5	BEARING, Pinion Rear Pilot	24	SHAFT, Axle
6	RETAINER, Pilot Bearing Snap Ring	25	NUT, Hex. 5/8 NF
7	RING, Pilot Bearing Snap	26	WASHER, Lock 5/8 External
8	CARRIER, W/Caps, Differential	27	BUSHING, Axle Shaft Stud
9	PLUG, Filler	28	STUD, Wheel Flange
10	ADJUSTER, Differential Bearing	29	BLOCK
11	GASKET, Diff Carrier to Axle Housing	30	PIN, Bearing Adjuster Lock
12	BEARING, Differential Cone	31	SCREW, Drive Gear Thrust
13	BEARING, Differential Cup	32	SHIM, Pinion Bearing Cage
14	CASE, Differential	33	CAGE, W/Cups, Pinion Bearing
15	WASHER, Diff Side Gear Thrust	34	BEARING, Pinion Outer Cone
16	GEAR, Differential Side	35	SEAL, Pinion Oil
17	WASHER, Differential Pinion Thrust	36	GASKET, Pinion Bearing Cage Cover
18	GEAR, Differential Pinion	37	RETAINER, W/Seal, Pinion Brg Cage
19	SPIDER, Differential	38	NUT, Companion Flange

REMOVAL (DRIVE UNIT)

- A. Remove plug from bottom of axle housing and drain lubricant.
- B. Remove the axle shaft stud nuts, lockwashers and tapered dowels.

IMPORTANT

To loosen the dowels, hold a brass drift against the center of the axle shaft head, INSIDE THE CIRCULAR DRIVING LUGS. Strike the drift a sharp blow with a hammer or sledge.

CAUTION

Do not hit the circular driving lugs on the shaft head this may cause the lugs to shatter and splinter. Do not use chisels or wedges to loosen the shaft or dowels this will damage the hub, shaft and oil seal.

- Remove the axle shaft from the drive unit and housing.
- D. Disconnect universal at pinion shaft.
- E. Remove carrier to housing stud, nuts and washers. Loosen two top nuts and leave on studs to prevent carrier from falling.
- F. Break carrier loose from axle housing with rawhide mallet.
- G. Remove top nuts and washers and work carrier free. A small pinch bar may be used to straighten the carrier in the housing bore. However, the end must be rounded to prevent indenting the carrier flange. A roller jack may be used to facilitate removal of carrier.
- H. Place carrier in suitable holding fixture (Fig. 2).

If the initial inspection indicates that the drive gear is not going to be replaced, we suggest the established backlash be measured and noted for reference and used at reassembly.

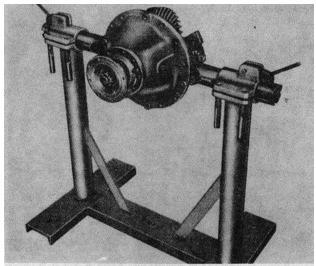


Fig. 2
REMOVAL (DIFFERENTIAL CASE AND GEAR)

A. Loosen jam nut and back off thrust block adjusting screw (Fig. 3).

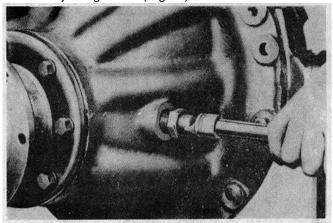


Fig. 3

- B. Center punch one differential carrier leg and bearing cap to identify for properly reassembling (Fig. 4).
- C. Cut lock wire. Remove capscrews and adjusting nut locks.
- D. Remove bearing cap stud nuts or capscrews, bearing caps and adjusting nuts.
- E. Lift out differential and gear assembly (Fig. 5).

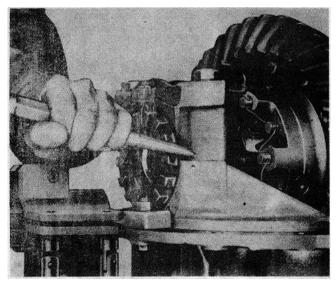
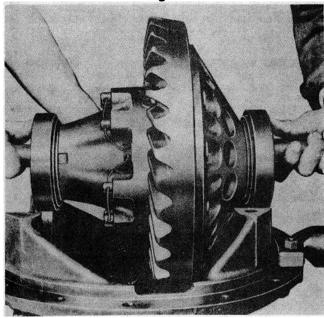


Fig. 4



F. Remove thrust block from inside of carrier housing.

DISASSEMBLY (DIFFERENTIAL)

- A. If original identification marks are not clear, mark differential case halves with a punch or chisel for correct alignment on reassembling (Fig. 6).
- B. Cut lock wire, remove bolts and separate case halves.

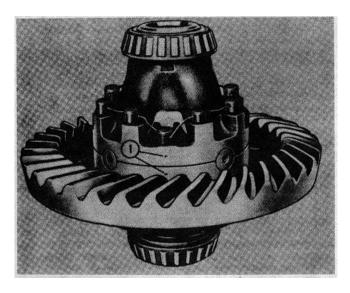
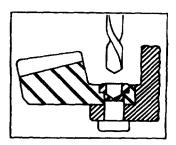


Fig. 6

- C. Remove spider, pinions, side gears and thrust washers.
- D. If necessary, remove rivets and separate gear and case (Fig. 7).

REMOVE GEAR RIVETS



Wrong

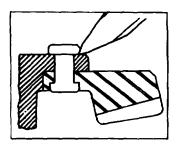


Fig. 7

- 1. Carefully center punch rivets in center of head.
- 2. Use drill .79 mm (1/32") smaller than body of rivet to drill through head.
- 3. Press out rivets.

E. If necessary to replace differential bearings, remove with a suitable puller (Fig. 8).

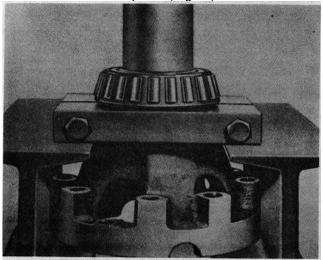


Fig. 8

REMOVAL (PINION)

A. Hold flange or yoke with suitable tool and remove pinion shaft nut and washer (Fig. 9).

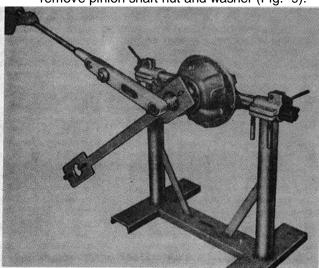


Fig. 9

- B. Remove flange or yoke with a suitable puller. Driving the flange off will cause runout (Fig. 10).
- C. Remove pinion cage stud nuts or capscrews (Fig. 11).
- D. Remove bearing cover and oil seal assembly.

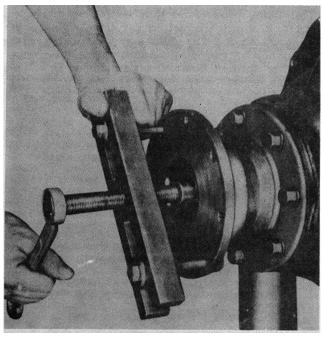


Fig. 10

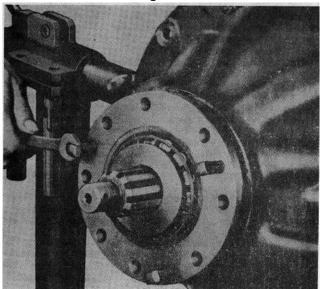


Fig. 11

- E. Remove bearing cage. Original may have puller holes.
 - The use of a pinch bar will damage the shims. Driving pinion from inner end with a drift will damage the bearing lock ring groove.
- F. Wire shim pack together to facilitate adjustment on reassembling.

DISASSEMBLY (PINION ASSEMBLY)

Both splined and tapered pinion shafts are used in single reduction carriers. Where the tapered shaft is used, the thrust bearings are adjusted by means of adjusting the lock nuts. On the splined shaft this adjustment is secured with a selective spacer or spacer combinations.

Splined Shaft

- A. Tap shaft out of cage with soft mallet or press shaft from cage.
- B. Remove outer bearing from cage.
- C. Remove spacer or spacer combination from pinion shaft.
- D. If necessary to replace rear thrust bearing or radial bearing, remove with suitable puller (Fig. 12).

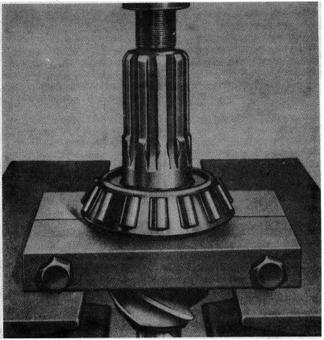


Fig. 12

E. Remove oil seal assembly from bearing cover.

Tapered Shaft

- A. Straighten lockwasher and remove lock nut, washer adjusting nut and thrust washer.
- B. Tap pinion out of cage with soft mallet or press shaft from cage.
- C. Remove bearing from cage.
- D. Remove bearings from shaft with suitable puller if necessary.

E. Remove oil seal assembly from bearing cover.

For Cleaning, Drying, Corrosion Prevention, Inspection and Repair, refer to Chapter I.

ASSEMBLY (PINION AND CAGE)

Splined Shaft

- A. If new cups are to be installed, press firmly against pinion bearing cage shoulders.
- B. Lubricate bearings and cups with light machine oil.
- C. Press rear thrust and radial bearings firmly against the pinion shoulders with a suitable sleeve that will bear only on bearing inner race (Fig. 13).

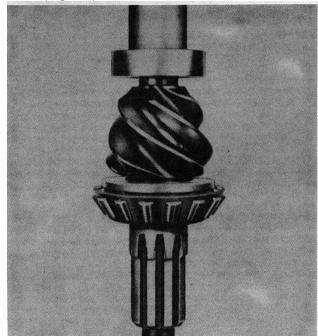


Fig. 13

- D. Install radial bearing lock ring and squeeze ring into pinion shaft groove with pliers.
- E. Insert pinion and bearing assembly in pinion cage and position spacer or spacer combination over pinion shaft.
- F. Press front bearing firmly against spacer.
- G. Rotate cage several revolutions to assure normal bearing contact.

H. While in press under pressure, check bearing pre-load torque. Wrap soft wire around cage and pull on horizontal lines with pound scale. If a press is not available, the pinion nut may be tightened to the correct torque and pre-load checked (Fig. 14).

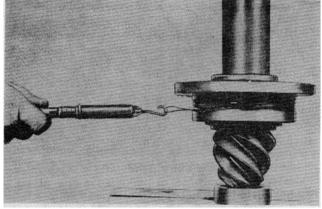


Fig. 14

If rotating torque is not within 2.2-6.8 Kg (5-15 in.lbs.), use thinner spacer to increase or thicker spacer to decrease pre-load.

Example: Assuming pinion cage diameter to be 152.4 mm (6 inches), the radius would be 76.2 mm (3 inches) and with 22.2 N (5 lbs.) pull would equal 6.8 Kg (15 in.lbs.) preload torque.

- I. Press flange or yoke against forward bearing and install washer and pinion shaft nut.
- J. Place pinion snap cage assembly over carrier studs, hold flange and tighten pinion shaft nut to the correct torque. The flange must be held with a suitable tool or fixture to tighten nut (Fig. 15).

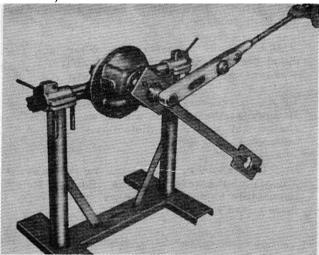


Fig. 15

- K. Recheck pinion bearing preload torque. If rotating torque is not within 2.2-6.8 Kg (5-15 in.lbs.), repeat the foregoing procedure.
- L. Hold flange and remove pinion shaft nut and flange.
- M. Lubricate pinion shaft oil seal and cover outer edge of seal body with a non-hardening sealing compound. Press seal against cover shoulder with seal driver (Fig. 16).

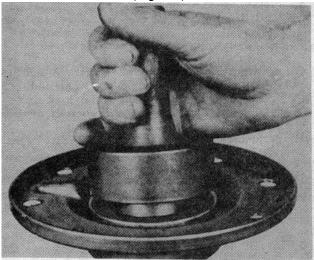
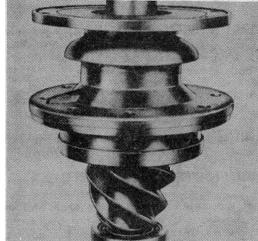


Fig. 16

- N. Install new gasket and bearing cover.
- O. Press flange against forward bearing and install washer and pinion shaft nut (Fig. 17).



P. Tighten to the correct torque and install cotter key. Do not back off nut to align cotter key holes.

Tapered Shaft

- A. Press rear thrust and radial bearings firmly against the pinion shaft shoulder.
- B. Install radial bearing lock ring and squeeze ring into pinion shaft groove with pliers.
- C. If new cups a: -e to be installed, press firmly against pinion cage shoulders.
- D. Lubricate bearings and cups with light machine
- E. Install forward bearing, thrust washer and adjusting nut.
- F. Install new lockwasher and lock nut.
- G. Adjust pinion bearing preload to 2.2-6.8 Kg (5-15 in.lbs.) with lock nut tightened securely against washer. The lock nut must be tight to secure the correct preload.
- H. Bend lockwasher when correct adjustment has been secured.
- Lubricate pinion shaft oil seal and cover outer edge of seal body with a non-hardening sealing compound. Press seal against cover shoulder with seal driver.
- J. Install new gasket and bearing cover. Cover should be carefully installed to prevent cutting seal on keyway.
- K. Install key, press flange on taper and install washer and pinion shaft nut.
- Tighten to the correct torque and install cotter key. Do not back off nut to align cotter key holes.

ASSEMBLY (PINION AND GEAR)

- A. Install correct shim pack. Locate thin shims on both sides for maximum sealing ability.
- B. Position pinion and cage assembly over stude and tap into position with soft mallet.
- C. Install lockwashers and stud nuts or capscrews. Tighten to the correct torque.

ASSEMBLY (DIFFERENTIAL AND GEAR)

A. Rivet the hypoid gear to the case half with new rivets. Rivets should not be heated, but always upset cold. When the correct rivet is used, the head being formed will be at least 3.1 mm (1/8") larger in diameter than the rivet hole. The head will then be approximately the same height as the preformed head. Excessive pressure will

cause distortion of the case holes and result in gear eccentricity.

Tonnage required for squeezing cold rivets: These pressures are approximate for annealed steel rivets and pressure can be adjusted to suit individual working conditions.

DIAMETER OF RIVET	METRIC TONS	US TONS
7/16"	19.9	22
1/2 "	27.2	30
9/16"	32.6	36
5/8 "	40.8	45

Final pressure should be held for approximately one minute to make sure the rivet has filled the hole.

Differential case and gear bolts are available for service replacement of rivets. The use of bolts greatly facilitates servicing these units in the field and eliminates the need for special equipment necessary to correctly cold upset rivets. Consult chart for service bolt instruction shown with the torque chart on last page of manual.

B. Lubricate differential case inner walls and all component parts with axle lubricant.

ASSEMBLY (DRIVE UNIT)

- A. Inspect housing for cracks, loose studs, nicks and burrs at machined surfaces. Remove nicks and burrs with stone or file. Make all necessary repairs or parts replacement before installing drive unit in housing.
- B. Install new drive unit to housing gasket over housing studs.

Roll carrier into position on roller jack. Start carrier into housing with four flat washers and nuts equally spaced.

Do not drive carrier into housing with a hammer at the carrier stud flange. The flange may easily be distorted and cause severe oil leakage.

Install lockwashers and stud nuts on any studs under carrier housing offsets. It is impossible to start these nuts after carrier is drawn into housing.

- C. Tighten the four nuts over flat washers alternately to draw carrier squarely into axle housing.
- If necessary, remove nuts and flat washers and install taper dowels, lockwashers and stud nuts.
 Tighten to the correct torque.
- E. Connect universal at pinion shaft.
- F. Install axle shafts.

INSTALLATION (PINION AND GEAR)

- A. Position thrust washer and side gear in bevel gear and case half assembly.
- B. Place spider with pinions and thrust washers in position.
- C. Install component side gear and thrust washer.
- D. Align mating marks, position component case half and draw assembly together with four bolts or capscrews equally spaced (Fig. 18).

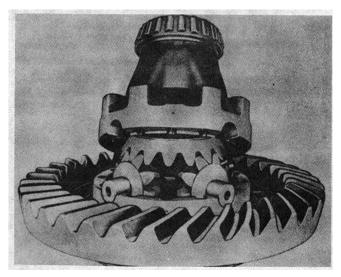


Fig. 18

- E. Check assembly for free rotation of differential gears and correct if necessary.
- F. Install remaining bolts and capscrews, tighten to the correct torque and lock wire.
- G. If bearings are to be replaced, press squarely and firmly on differential case halves.

INSTALLATION (DIFFERENTIAL AND GEAR)

- A. After checking related parts, coat the differential bearing cones and cups with specified rear axle lubricant.
- B. Place the bearing cups over the assembled differential bearing cones, then position the differential assembly in the carrier.
- C. Insert bearing adjusting nuts and turn handtight against bearing cups.
- D. Install bearing caps in the correct location as marked and tap lightly into position (Fig. 19).

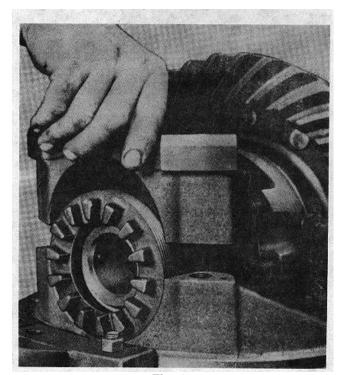


Fig. 19

- If bearing caps do not position properly, adjusting nuts may be cross threaded. Remove caps and reposition the adjusting nuts. Forcing caps into position will result in irreparable damage to the carrier housing or bearing caps.
- E. Install flat washers where used and stud nuts or capscrews. Tighten stud nuts or capscrews to correct torque.

ASSEMBLY (THRUST BLOCK)

- A. Remove carrier from stand and position with back face of hypoid or spiral bevel gear upward.
- B. Remove adjusting screw and lock nut.

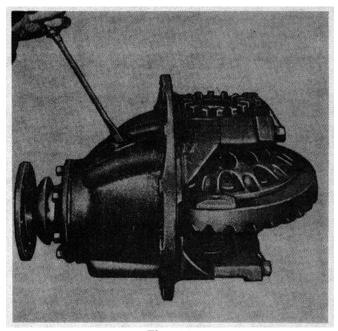


Fig. 20

- C. Place thrust block on rear face of hypoid gear and rotate gear until the hole in the thrust block is aligned with the adjusting screw hole.
- D. Install adjusting screw and lock nut and tighten adjusting screw sufficient to locate thrust block firmly against back face of hypoid gear (Fig. 20).

- E. To secure the correct adjustment of .25-.38 mm (.010"-.015") clearance, loosen adjusting screw 1/4 turn and lock securely with nut (Fig. 21).
- F. Recheck to assure minimum clearance of .25 mm (.010") during full rotation of bevel gear.

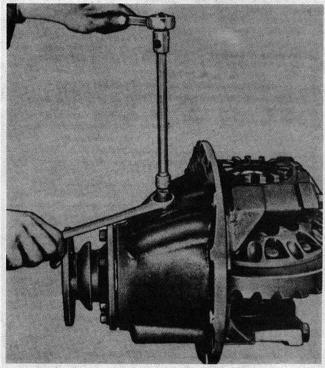


Fig. 21

For Adjustments pertaining to Differential Pinion Bearing Pre-Load, Gear Backlash and Gear Tooth Contact, refer to Chapter I.



AXLE-REAR CHAPTER III TORQUE CHART FORWARD REAR AXLE

DIFFERENTIAL CASE CAPSCREW (LONG AND SHORT)			
Size	N.m	Lbs.Ft.	
9/16-12	176.3-230.5	130-170	
5/8-11	150.9-318.7	185-235	
THRUST SC	REW JAM NUT		
Size	N.m	Lbs.Ft.	
7/8-14	196.6-257.6	145-190	
AIR CHAMBE	ER TO SHIFT HO	USING STUD NUT	
Size	N.m	Lbs.Ft.	
3/8-24	40.6-54.2	30-40	
SHIFT HOUS	SING TO CARRIE	R CAPSCREW	
Size	N.m	Lbs.Ft.	
3/8-16	40.6-54.7	30-40	
SHIFT SHAF	T ADJUSTING S	CREW LOCK NUT	
Size	N.m	Lbs.Ft.	
1/2-20	61.0-81.3	45-60	
SHIFT YOKE	NUT AND BOLT	-	
Size	N.m	Lbs.Ft.	
3/8-24	27.1-40.6	20-30	
INPUT BEAR	RING CAGE CAP	SCREW	
Size	N.m	Lbs.Ft.	
7/16-14	54.2-74.5	40-55	
INPUT SHAF	T YOKE OR FLA	NGE NUT	
Size	N.m	Lbs.Ft.	
* 1 3/4-12	406.8-542.5	300-400	
1 3/4-12	677.9-813.5	500-600	

INTER-AXLE	DIFFERENTIAL	CASE BOLT
Size	N.m	Lbs.Ft.
7/16-14	81.3-101.7	60-75
1/2-20	122.0-162.7	
	IAL BEARING CA	P TO CARRIER
CAPSCREW		
Size	N.m	Lbs.Ft.
	637.3-705.0	
* 1-14		
7/8-9	637.3-705.0	470-550
1-14	637.3-705.0	470-550
PINION CAG	SE COVER SCRE	W
Size	N.m	Lbs.Ft.
3/8-16	33.9-54.2	25-40
3/8-24		35-50
PINION SHA	FT NUT	
Size	N. m	
	1085.0-1491.4	
1 3/4-12	1220.4-1762.6	900-1200
REAR BEAR	ING CAGE CAPS	CREW
Size	N.m	Lbs.Ft.
3/4-16	40.6-54.2	30-40
3/8-24	47.4-67.7	35-50
7/16-14	81.3-101.7	60-75
THROUGH-S NUT	SHAFT (OUTPUT)	YOKE OR FLANGE
Size	N. m 406.8-542.5	Lbs.Ft.
* 1 1/2-18	406.8-542.5	300-400
1 1/2-18	677.9-813.5	500-600



TORQUE CHART (Continued)

ADJUSTING RING LOCK TO DIFFERENTIAL BEARING CAPSCREWS				
Size	N. M	Lbs. Ft.		
5/16-18	29.8-37.9	22-28		

CARRIER TO HOUSING STUD NUTS				
Size	N.m	Lbs.Ft.		
1/2-20	108.5-142.4	80-105		
5/8-20	108.5-277.9	160-205		
3/4-16	391.9-501.8	290-370		

REAR REAR AXLE

PINION BEARING CAGE TO CARRIER CAPSCREWS			
Size 3/8-16 7/16-14 1/2-13 5/8-11	40.6-54.2	50-65 80-105	
PINION SHA	FT (INPUT) NUTS	;	
* /8-20 (Elastic Stop * 1-20 * 1 1/4-18 * 1 1/2-18 * 1 3/4-12 7/8-20 1-20 1 1/4-18	406.8-542.5 949.3-1220.5 1085.0-1491.4 1085.0-1491.4 271.2-372.9 406.8-542.5 949.3-1220.5 1085.0-1491.4	200-275 300-400 700-900 800-1100 800-1100 200-275 300-400 700-900 800-1100 900-1200	
THRUST SC	REW JAM NUT		
Size 3/4-16 7/8-14	N.m 196.6-257.6 196.6-257.6		

DIFFERENTIAL BEARING CAP TO CARRIER			
CAPSCREW	/S		
Size	N.m	Lbs.Ft.	
	157.3-174.9		
* 5/8-11	216.9-244.1		
* 3/4-10			
* 7/8-14	508.6-562.8		
* 7/8-9			
9/16-12			
5/8-11			
3/4-10			
7/8-14			
7/8-9	637.3-745.6	470-550	
ADJUSTING	RING LOCK TO	DIFFERENTIAL	
BEARING C	AP CAPSCREWS	3	
Size	N.m	Lbs.Ft.	
5/16-18		15-20	
5/16-18	29.8-37.9	22-28	
GEAR TO D	IFFERENTIAL CA	ASE BOLT NUTS	
Size	N.m	Lbs.Ft.	
	284.8-366.2		
	142.4-183.0		
5/8-11			
1/2-13			

TORQUE CHART (Continued)

DIFFERENTIAL CASE CAPSCREWS OR BOLTS AND NUTS (LONG AND SHORT)

Size	N.m	Lbs. Ft.
3/8-16	47.4-67.7	35-50 Capscrew
7/16-14	81.3-101.7	60-75 Capscrew
1/2-13	122.0-162.7	90-120 Capscrew - Bolt and Nut
1/2-20	142.4-183.0	105-135 Capscrew - Bolt and Nut
5/8-11	150.9-318.7	185-235 Capscrew - Bolt and Nut
5/8-18	284.8-366.2	210-270 Capscrew - Bolt and Nut

The correct pressures and torque for checking pinion bearing preload are as follows:

Pinion Shaft Pressure Required To Obtain Thread Size Correct Preload			Nut Torque Required To Obtain Correct Preload	
	Metric Tons	US Tons	N.m	
1" x 20	5.4	6	406.8-542.5	300-400 lbs.ft.
1-1/4" x 18	9.9	11	949.3-1220.6	700-900 lbs.ft.
1-1/2" x 12	12.7	14	1085.0-1491.8	800-1100 lbs.ft.
1-1/2" x 18	12.7	14	1085.0-1491.8	800-1100 lbs.ft.
1-3/4" x 12	12.7	14	1085.0-1491.8	800-1100 lbs.ft.

Use rotating torque, not starting torque.

All other torque values are for fasteners not using lock wire or cotter pins.

FOR ALL FASTENERS

All torques given apply to parts coated with machine oil:

For Dry Parts - Increase torques 10%

For Parts Coated with Multi-purpose Gear Oil - Decrease torques 10%

Nuts on studs to use the same torque as for driving the stud.

^{* =} Torque values for fasteners using lock wire or cotter pins.



AXLE-REAR

CHAPTER IV

LUBRICATION

DA 000			
RA-399 Pints	34	28	2 .9
Liters	16	13.2	
RA-459 Pints	32	28	.9
Liters	15.1	13.2	2
RA-461 Pints	32	28	.9
Liters	15.1	13.2	2



TRUCK SERVICE MANUAL

AXLE REAR

IH THRU DRIVE TANDEM

IH MODEL IH CODE

RA-472 14472
RA-474 14474

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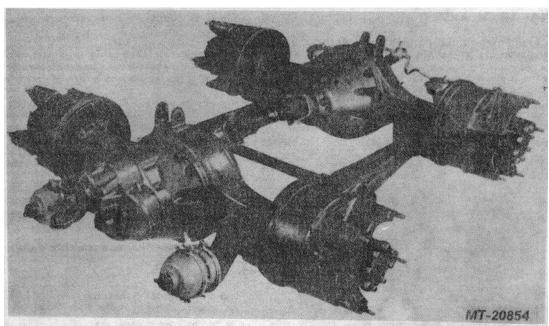


Fig. 1 IH Thru-Drive Tandem Rear Axle

GENERAL

This service manual covers rebuild procedures and specifications for both the forward rear and rear rear axles of the models RA-472, 474 Rear Axle Assembly.

DESCRIPTION

The IH thru-drive tandem rear axle (Fig. 1) consists of a heavy-duty single reduction axle with integral power divider and inter-axle differential for the forward rear axle and a conventional heavy-duty single reduction axle for the rear rear axle. Differential parts, drive gear and pinion sets, bearings and axle shafts are common between the forward and rear axles.

The forward axle has the power divider and interaxle differential mounted on the forward side of the differential carrier. A thru-shaft carries driving torque through the forward axle housing to the rear rear axle. Driving torque is delivered to the forward rear axle via the intermediate idler gear and a driven gear mounted on the pinion shaft of the forward axle.

The complete differential carrier and power divider may be removed from the forward axle housing as a unit with the axle mounted in the truck as well as when the axle is removed. Also the power divider may be removed individually without removing the differential carrier. This permits servicing the power divider without disturbing the forward axle differential.

Cleanliness is important during the overhaul procedure. Entry of dirt into the unit could result in damage and early failure of component parts. The unit should be thoroughly cleaned externally before disassembly. After disassembly, all parts should be thoroughly washed in clean solvent.

All parts should be inspected carefully for wear, damage or other indications of short service life to determine what repairs are needed and what corrective measures should be taken to prevent recurrence of difficulties. Any questionable parts should be replaced. Reference to "TROUBLE SHOOTING" given in this section will aid in analyzing difficulties as well as provide corrective suggestions.

The unit is designed to operate efficiently only when parts are assembled and adjusted properly. Special attention must be given to assure correct reassembly of parts.

When reassembling the unit, always use new seals. All gears, bearings and other moving or contacting parts should be pre-lubricated with clean axle lubricant at time of assembly.

DISASSEMBLY

FORWARD REAR AXLE:

Removal of Power Divider and Differential Carrier Assembly from Axle Housing

 Drain lubricant from axle housing and power divider. To drain power divider, remove plugs from bottom of inter-axle differential cover and bottom of power divider intermediate case.

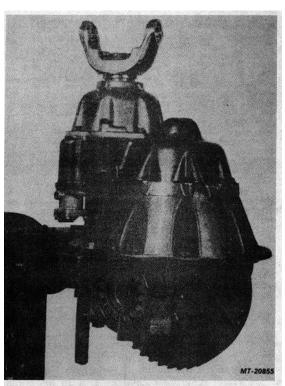


Fig. 2 Power Divider and Differential Carrier Assembly Mounted in Rebuild Stand

- 2. Remove axle shafts.
- 3. Disconnect inter-axle lockout.
- 4. Disconnect propeller shafts from input and output shaft flanges.
- Remove output shaft bearing retainer bolts.
 Use a soft hammer to loosen bearing retainer from axle housing. Withdraw bearing cage and output shaft from axle housing.
- Loosen differential carrier-to-axle housing bolts. Remove all bolts except top two.
 - These two bolts will prevent carrier assembly from falling.

- 7. Support carrier assembly on roller jack. Secure as necessary to prevent carrier from falling from jack when removed from housing.
- 8. Remove top two carrier bolts. Loosen locknuts and turn puller screws in to break carrier away from housing. A small pinch bar may be used to straighten carrier assembly in housing, but be careful to avoid damage to carrier flange. Remove carrier assembly from axle housing.
- Roll jack and carrier assembly from under truck. Mount carrier assembly in suitable rebuild stand (Fig. 2).

Removal of Power Divider Assembly from Differential Carrier

1. Remove lockout cylinder cover and detach lockout cylinder assembly (Fig. 3).



Fig. 3 Removing Inter-Axle Lockout Cylinder Assembly

2. Remove inter-axle differential cover bolts and lift inter-axle differential assembly from power divider intermediate case (Fig. 4).

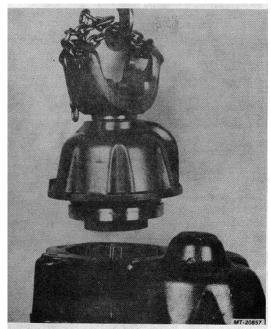


Fig. 4 Removing Inter-Axle Differential

3. Remove intermediate case-to-differential carrier bolts and lift intermediate case from differential carrier (Fig. 5).

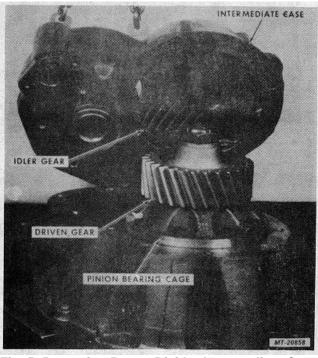


Fig. 5 Removing Power Divider Intermediate Case Assembly

Disassembly of Inter-Axle Differential

 Remove input flange nut. Secure flange with suitable flange holder tool or by clamping in vise (Fig. 6). Use torque multiplier wrench (SE-1933).

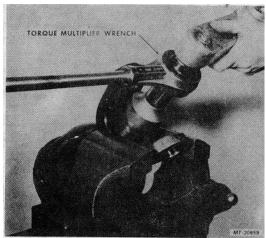


Fig. 6 Removing Input Flange Nut

2. Use puller or press and remove inter-axle differential assembly from cover (nose cone) and flange (Fig. 7).

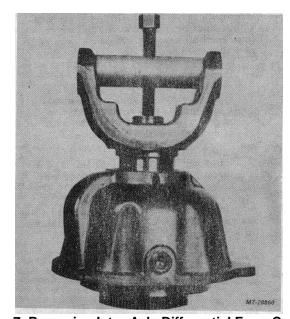


Fig. 7 Removing Inter-Axle Differential From Cover

3. Note and retain shims located between front bearing cup and cover. Shims limit end play of differential assembly in cover (Fig. 8).

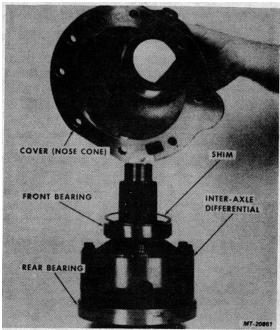


Fig. 8 Shims for Limiting Differential Case-To-Cover End Play

- 4. If necessary to remove bearings from differential case note spiral type snap ring which must first be removed before removing rear ball bearing. Remove snap ring as follows (Fig. 9).
 - a. Position two small thin blade screwdrivers on snap ring as shown, placing one screwdriver under spiral band end of snap ring and second screwdriver in slot "A".
 Pry end of snap ring out from groove.
 - Apply pressure under and around, band until snap ring is free. Additional prying with screwdriver may be required at slot "B".
- 5. Both front and rear bearings of differential are removed from case by using suitable pullers (Fig. 9a).
- Match mark differential case halves with a punch or chisel to assure correct alignment upon reassembly.
- Remove differential case bolts and separate case halves.

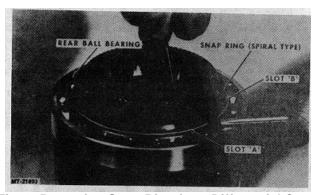


Fig. 9 Removing Snap Ring from Differential Case

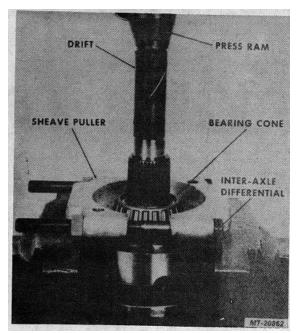


Fig. 9a. Removing Front Bearing from Inter-Axle Differential

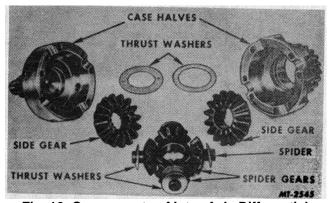


Fig. 10 Components of Inter-Axle Differential

- 8. Remove spider, spider gears, side gears and thrust washers (Fig. 10).
- 9. Remove oil seal from inter-axle differential cover. Discard seal.
- 10. Keep inter-axle differential parts together and protect from damage while removed.

Disassemble Power Divider Intermediate Case

1. Lift inter-axle clutch shift collar and fork from power divider input gear (Fig. 11).

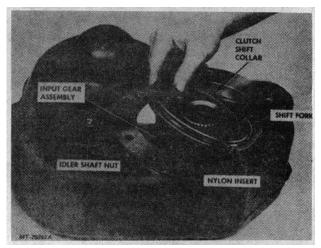


Fig. 11 Removing Clutch Shift Collar and Fork

2. Remove and disassemble input gear assembly (Fig. 12).



Fig. 12 Removing Input Gear Assembly

IMPORTANT

Inner bearing is a press fit on gear and will likely be damaged if removed. Remove only if to be replaced.

- Loosen idler shaft end nut using torque multiplier wrench (SE-1933). Use flats on shaft end to hold shaft from turning while nut is loosened. Remove nut and washer.
- 4. Support rear face of intermediate case and press idler shaft out of case.
- 5. Separate bearings, bearing cups and bearing spacer from idler gear (Figs. 13 & 14).



Fig. 13 Removing Idler Shaft and Gear

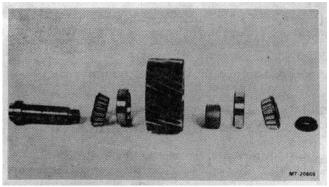


Fig. 14 Exploded View of Idler Gear Components

Disassemble Output-Shaft Assembly

- Remove output-shaft and cage from forward axle housing.
- Mount output-shaft in vise by clamping flange in jaws of vise.
- 3. Loosen end nut and remove nut, washer and flange.
- 4. Use snap ring tool to remove snap ring from bearing retainer. Drive or press bearing and shaft from retainer.
- 5. Using a suitable sleeve to support bearing inner race, press bearing from shaft.
- 6. Using suitable sleeve, press seal from retainer.

REAR REAR AXLE: Remove Differential Carrier from Axle Housing

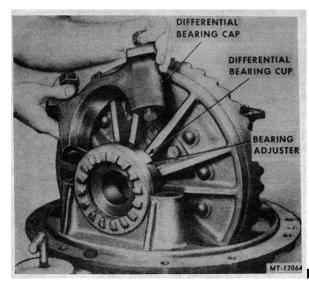
- 1. Drain lubricant from axle housing.
- 2. Remove axle shafts.
- 3. Remove mounting bolts from carrier to axle housing flange.
- 4. Use puller screws provided in carrier mounting flange to start carrier from housing.
- Support weight of carrier safely oh roller type floor jack or portable floor lift and roll jack and carrier out from under truck.
- 6. Mount differential carrier in rebuild stand.

FORWARD AND REAR REAR AXLES:

The remaining disassembly will be the same for both Forward and Rear Rear Axles.

Disassembly of Differential Carrier Assembly

- Remove cotter pins from bearing adjuster locks and remove locks.
- 2. Mark one bearing cap and leg of carrier with a punch or chisel to identify each for correct reassembly.
- 3. Remove bearing cap bolts and detach bearing caps and bearing adjusters (Fig. 15).
- 4. Lift differential assembly from differential carrier (Fig. 16). Tilt differential assembly to allow ring gear to pass pinion radial bearing. Place differential assembly on bench.



15 Removing Differential Bearing Caps

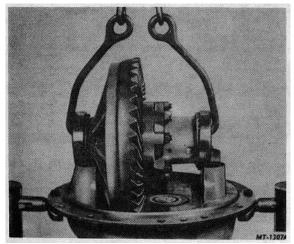


Fig. 16 Lifting Differential From Carrier

Disassemble Differential

- 1. Remove differential bearings from differential case using suitable puller.
- Match mark differential case halves with a punch or chisel to assure correct alignment upon reassembly.
- 3. Remove self-locking nuts from differential case bolts and separate the differential case halves (Fig. 17).
- 4. Remove differential spider shaft, spider gears, side gears and thrust washers from differential case halves (Fig. 18).



Fig. 17 Separating Differential Case Halves

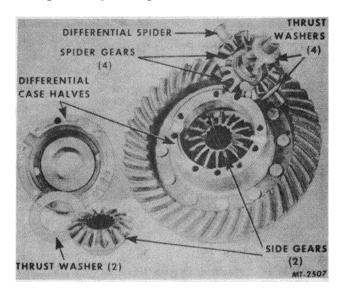


Fig. 18 Component Parts of Differential

5. If necessary to remove ring gear from differential case, carefully center punch each rivet head on the ring gear side and drill through the rivet head with a drill 0.8 mm (1/32") smaller than the rivet body (Fig. 19). Use a punch to press out the remaining portion of rivet. Never use a chisel to cut off rivet heads as damage to the differential case might result.

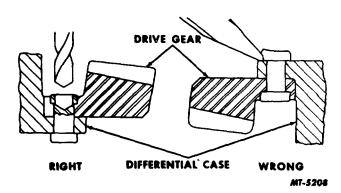


Fig. 19 Drive Gear Rivet Removal

Remove Pinion and Cage Assembly from Differential Carrier

- Remove bolts holding pinion cage to differential carrier.
- 2. Strike against rear of pinion shaft with a brass drift and hammer to start pinion and cage out of carrier (Fig. 20).

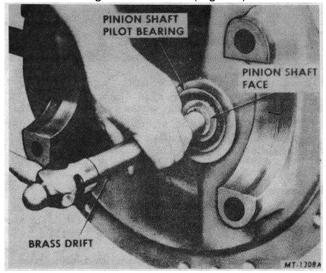


Fig. 20 Starting Pinion and Cage Assembly from Carrier

3. Remove pinion and cage assembly from carrier (Fig. 21). Temporarily install stud bolts to aid in removal.

WARNING

Be careful to avoid dropping the pinion and cage assembly. Personal injury or damage to parts may result if assembly is allowed to fall.

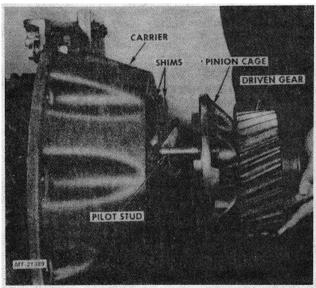


Fig. 21 Removing Pinion and Cage Assembly (forward rear axle shown)

 Retain pinion cage shims to aid in readjustment upon reassembly. Do not damage shims.

Disassembly of Pinion and Cage

- 1. Mount pinion and cage assembly in a heavy duty vise or holding tool (Fig. 22).
- 2. Because of the high torque load on pinion end nut, use the torque multiplier wrench (SE-1933) and another long handle wrench to remove nut.

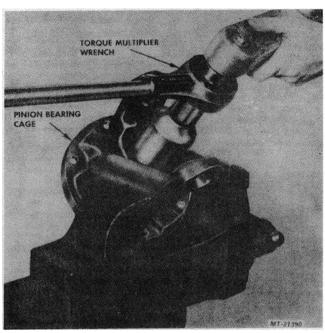


Fig. 22 Removing Pinion End Nut (rear rear axle shown)

- 3. Pull pinion shaft driven gear or companion flange from pinion.
- 4. Remove spacer from pinion shaft.
- 5. Tap pinion from cage.
- 6. Remove forward pinion bearing from cage.
- 7. Remove bearing spacer from pinion shaft.
- 8. Remove rear pinion bearing and pinion radial bearing from pinion shaft.

IMPORTANT When axle disassembly is complete, keep parts in order and undamaged. Be especially careful to protect the finely machined surfaces that are now exposed.

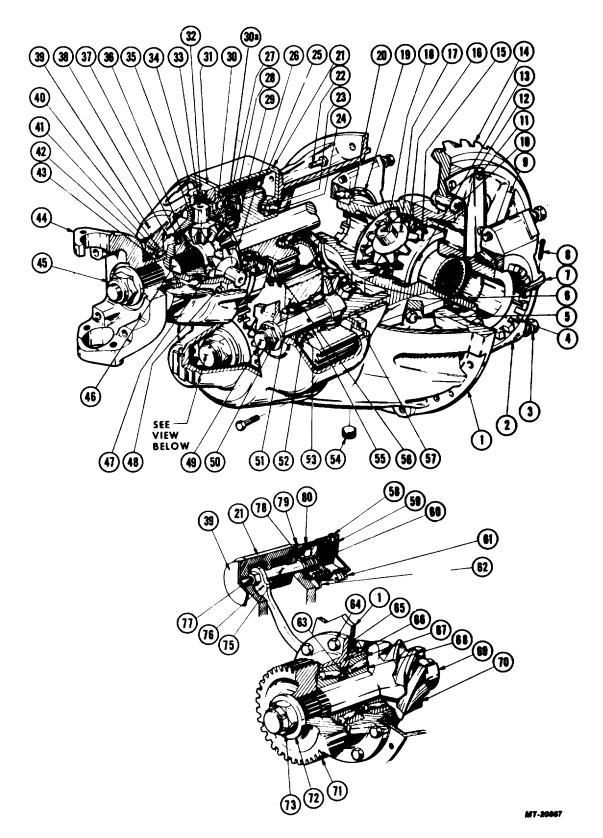


Fig. 23 Differential Carrier Assembly - Forward Axle (Cut-away View)



LEGEND FOR FIGURE 23

<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
<u>,</u>	<u>= = = = = = = = = = = = = = = = = = = </u>	41	Cone, Bearing, Power Divider Front
1	Carrier, Differential	42	Shim, Power Divider
2	Cap, Differential Bearing	42	Seal, Nose Cone
3	Bolt, Diff Bearing Cap 3/4-10	43 44	Flange, Companion
4	Adjuster	45	Nut, Input Shaft End 1 3/4-12
5	Bolt, Diff Case 9/16-18	46	Shaft, Output
6	Case, Differential, Plain Bolt	40 47	Gear, Spider, Power Divider
7	Lock, Bearing Adjuster	48	Bolt, Case Power Divider 1/2-13
8	Pin, Cotter	49	Shaft, Idler Gear
9	Case, Diff, Flange Half	50	Nut, Idler Shaft 1 1/4-18
10	Rivet, Drive Gear to Case	50 51	Gear, Idler
11	Bolt. Oil Scoop 1/4 x 20	52	Cup, Bearing Idler Gear
12	Scoop, Oil	53	Cone, Bearing Idler Gear
13	Washer, Thrust, Side Gear	53 54	Plug, Drain
14	Gear, Drive	55	Spacer, Idler Gear
15	Gear, Side, Main Diff.	56	Collar, Shift Clutch
16	Gear, Spider, Main Differential	57	Gasket, Plastic Liquid
17	Washer, Thrust, Spider Gear	58	Inlet Port
18	Shaft, Spider, Main Differential	59	Cylinder, Lockout
19	Cup, Differential Bearing	60	Bolt, Piston, Hex head 3/8-24
20	Cone, Main Bearing	61	Bolt, Cylinder Cover 1/4-20
21	Case, Intermediate	62	Bolt, Cylinder Cover 174-20 Bolt, Cylinder Mounting 3/8-16
22	Bolt, Carrier to Intermed Case 1/2-13	63	Spacer, Pinion Bearing
23	Cup, Bearing Input Gear Rear	64	Bolt, Pinion Cage Mounting 9/16-12
24	Cone, Bearing Input Gear Rear	65	Shim, Pinion Bearing Cage
25	Gear, Input	66	Cage, Pinion Bearing Cage
26	Gear, Side, Power Divider Rear Half	67	Cup, Pinion Bearing
27	Case, Power Divider, Rear Half	68	Cone, Pinion Bearing
28	Cup, Bearing, Power Divider Case	69	Bearing, Pilot
29	Cone, Bearing, Power Divider Case	70	Gear, Pinion
30	Bearing, Ball Power Divider	71	Gear, Driven
30a	Ring, Snap, Bearing Retaining	72	Washer, Pinion Shaft
31	Gasket, Plastic, Liquid	73	Nut Pinion Shaft End 1 1/4-18
32	Plug, Filler	73 74	Not Used
33	Shaft, Spider, Power Divider	75	Shift, Power Divider Shift Fork
34	Bolt, Nose Cone to Intermed Case 1/2-13	76	Fork, Power Divider Shift
35	Washer Thrust, Spider Gear	77	Thread Seal
36	Gear, Side Power Divider Front	78	Spring, Power Divider Shift Fork
37	Bearing, Thrust	78 79	Plastic Gasket
38	Case, Power Divider, Forward Half	80	Wiper, Felt
39	Cover, Power Divider (Nose Cone)	00	Wipoi, i oit
40	Cup. Bearing, Power Divider Front		
_	· • • • • • • • • • • • • • • • • • • •		

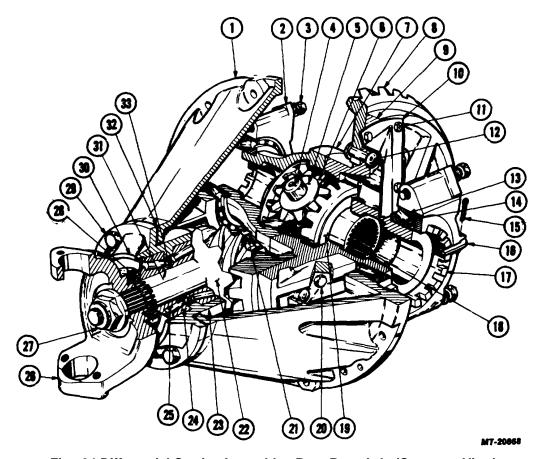


Fig. 24 Differential Carrier Assembly - Rear Rear Axle (Cut-away View)

LEGEND FOR FIGURE 24

<u>Key</u>	Description	<u>Key</u>	<u>Description</u>
1	Carrier	17	Adjuster, Bearing
2	Cap, Carrier Bearing	18	Gear, Differential Side
3	Bolt, Bearing Cap 3/4-10	19	Washer, Thrust
4	Spider, Differential	20	Bolt, Diff Case 1/2-13
5	Washer, Thrust	21	Bearing, Pilot
6	Gear, Spider	22	Gear, Pinion
7	Case, Diff, Plain Half	23	Cage, Pinion Bearing
8	Gear, Drive	24	Bearing, Cup
9	Case, Diff, Flanged Half	25	Bearing, Cone (Thrust)
10	Scoop, Oil	26	Flange, Companion
11	Bolt, Oil Scoop	27	Nut, Pinion End 1 3/4-12
12	Rivet, Drive Gear to Case	28	Spacer, Input Flange
13	Cup, Bearing	29	Bolt, Cage Mounting 5/8-12
14	Bearing	30	Seal, Input Flange Oil
15	Pin, Cotter	31	Spacer, Pinion Bearing
16	Lock, Bearing Adjuster	32	Shim, Bearing Case

CLEANING, INSPECTION AND REPAIR

Remove all dirt, old lubricant, and liquid gasket material from components of the rear axle. Immerse in cleaning solvent and use a stiff brush if necessary. Bearings should be cleaned separately in clean solvent and special efforts taken to protect their finely machined surfaces. If compressed air is used for drying, do not spin bearings while drying.

Examine all <u>bearings</u> for roughness, damage or wear by rotating each bearing slowly in the hand. If in doubt as to bearing condition, replace. Ring gear, drive pinion, differential pinions and any other gears should be checked for damaged teeth, worn spots, or distortion. Inspect differential case assembly for cracks, damage or distortion. Make sure splined ends of axle shafts are neither twisted or cracked. Shim packs should be uniform thickness. Discard thrust washers and obtain new even when only slight wear is indicated.

ADJUSTMENTS

The principal adjustments made on the differential carrier assembly are devised for establishing the proper gear tooth contact and thereby obtaining a long wearing, quiet running rear axle. Fundamentally, there are five adjustments to be covered and these are accomplished as the differential carrier assembly is assembled. To emphasize their importance, these five steps or adjustments are listed here as well as in the actual assembly procedure. These adjustments are:

- 1. Preload the pinion bearings.
- 2. Set pinion nominal dimension.
- 3. Set gear lash.
- 4. Preload the differential bearings.
- 5. Check gear tooth contact.

REASSEMBLY FORWARD AND REAR REAR AXLES: Reassemble Pinion and Cage

- 1. Place rear pinion bearing on pinion shaft and press into place against pinion.
- Place pilot bearing on stud end of pinion shaft and press firmly against shoulder of pinion. Stake face of pinion shaft in six (6) evenly spaced places to secure pilot bearing in place (Fig. 25).

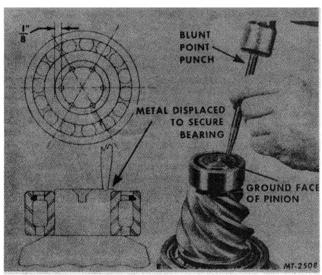


Fig. 25 Staking Pinion Pilot Bearing

- 3. Pre-lubricate the bearings with rear axle gear lubricant.
- 4. Place bearing spacer on pinion shaft and press against rear pinion bearing.

IMPORTANT The bearing spacer is furnished in various thicknesses in graduation of .025 mm (.001") to permit changing of spacer thickness to obtain correct pinion bearing preload.

- 5. Insert pinion (with rear pinion bearing and spacer) into pinion cage.
- 6. Mount pinion and cage in arbor press. Place pre-lubricated front pinion bearing on pinion.
- 7. Press bearing into place firmly against bearing preload spacer.
- 8. Revolve pinion cage around pinion several times to seat bearings correctly.
- 9. Remove pinion and cage from press.

Preload the Pinion Bearing

Pinion bearing preload is established by selecting the correct size spacer located between the two pinion thrust bearings and tightening pinion end nut to the specified torque (see "Torque Chart").

1. Temporarily install companion flange nut and washer on end of pinion shaft.

IMPORTANT For ease of handling, it is advisable to obtain a spare companion flange for temporary installation on pinion in lieu of driven gear when preloading forward rear axle pinion.

- 2. Clamp pinion assembly in a vise so as to hold companion flange.
- Rotate pinion cage while tightening end nut to specified torque (see "Torque Chart").

Rotation of cage is important so as to seat and align bearings, otherwise, a false condition of bearing load could exist. Bearing rollers must be seated against face of bearing cone (Fig. 26).

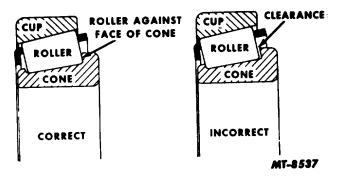


Fig. 26 Pinion Bearing Roller Position

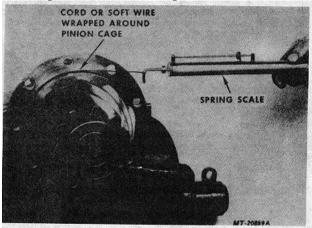


Fig. 27 Measuring Pinion Bearing Preload

- 4. Measure bearing preload by wrapping a strong cord or soft wire about the pinion cage and attach end to spring scale (Fig. 27). Read scale only while cage is rotating. Compare this scale reading with the figure shown in "Specifications".
 - When preload does not agree with Specifications bearing load may be increased by installing a thinner spacer or decreased by using a thicker spacer. Determine spacer thickness using a micrometer (Fig. 28) and make a new selection accordingly. Closer adjustment may be obtained by working spacer to desired thickness, using emery cloth on a flat surface.
- 5. Wash spacer clean of emery cuttings before installing on pinion.

After pinion bearing preload is established, good practice would be to check bearing roller ends to see whether they are in contact with bearing cone face. Use a feeler gauge ribbon. There must be no clearance at ends of rollers (Fig. 26).

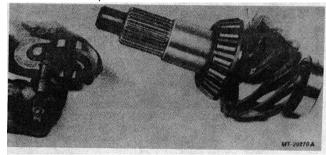


Fig. 28 Measuring Spacer Thickness

- 6. Remove end nut and companion flange.
- 7. FORWARD AXLE: Install pinion shaft driven gear. nut and washer. Clamp pinion shaft driven gear in jaws of vise using jaw shields or other soft material to avoid damage to gear.

REAR REAR AXLE: Install seal in pinion cage and place cage and end nut on pinion shaft.

- 8. Tighten pinion end nut to specified torque (see "Torque Chart").
- 9. Recheck pinion bearing preload.

Reassembly of Pinion and Cage to Differential Carrier

- Place original shim pack on pinion cage and mount cage in differential carrier.
 Tap cage into place with a soft hammer.
- 2. Install pinion cage bolts and tighten to specified torque (see "Torque Chart").

Set Pinion Nominal Dimension

To establish pinion nominal dimension, which is the distance from the face or finished end of the installed pinion to the centerline of the ring gear or cross shaft, proceed as follows:

Obtain step plate and clamp assembly from SE-1065 Pinion Setting Gauge set and attach it to differential carrier flange, locating step plate clamp screw over center of pinion (Fig. 29).



Fig. 29 Locating Step Plate Clamp

Install step plate under clamp screw and tighten screw to hold step plate securely in position (Fig. 30).

The step plate is necessary to project the face of the pinion where it can be measured by the gauge which is on the centerline of the drive gear.

IMPORTANT Be certain lugs on step plate straddle the bearing staking indentations on end of pinion.



Fig. 30 Installing Step Plate

Mount assembled SE-1065 gauge in bearing bores of carrier (Fig. 31). See "Specifications" for correct disc size.

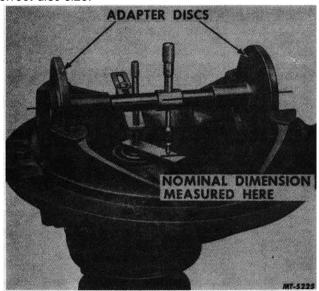


Fig. 31 Assembled Gauge in Position

Make certain that bearing bores are clean and free of nicks and burrs. Adjust micrometer so it is directly over end at a 90 deg. angle to step plate.

Run micrometer thimble down to measure distance between center of ring gear and step plate. Make a note of this reading along with the nominal dimension given in "Specifications". Locate on pinion the etched marking which indicates variation from zero cone setting. If it is a minus figure, subtract if from specified dimension, and if a plus figure, add it to specified dimension. Results of calculation will provide the corrected pinion nominal dimension to which pinion Comparison of corrected nominal must be set. dimension with the actual or measured dimension indicates amount of change necessary for correct pinion position. It may be necessary to add or remove shims between pinion cage and differential carrier to provide correct pinion nominal dimension.

Remove gauge and prepare to install ring gear and differential carrier in differential housing.

Reassemble Differential

- If ring gear was removed from differential case, rivet gear to differential case flange. Use riveting fixture SE-2222 with hydraulic press. Rivet pressures (tons) should be within the range given in "Specifications".
- Apply rear axle lubricant to the inner walls of the differential case halves and to all differential component parts.
- Place side gear thrust washer and side gear in flanged half of differential case and assemble spider, spider gears and spider gear thrust washers to side gear.
- 4. Place opposite side gear and thrust washer in other half of differential case.
- Align the match marks and assemble the differential case. Draw assembly together with four equally spaced bolts and nuts. Make sure side gears and spider gears mesh correctly.
- Check for free rotation of side gears and spider gears. If satisfactory, install remaining differential case bolts and nuts.
- 7. Tighten differential case bolt nuts to specified torque (see "Torque Chart").
- 8. Install differential bearing by pressing them squarely onto differential case.

Installing Differential on Differential Carrier

- 1. Pre-lubricate differential bearings with rear axle lubricant and place bearing cups over bearings.
- 2. Lift differential assembly and place into position in differential carrier. Tilt differential assembly to allow ring gear to pass pinion pilot bearing.
- 3. Place bearing adjusters in carrier and turn hand tight against bearing cups.
- 4. Assemble bearing caps to carrier. Align identifying marks on bearing cap and carrier leg.
- 5. Install bearing cap bolts and washers. Tighten to specified torque (see "Torque Chart").
- 6. Tighten bearing adjusters alternately until all end play is eliminated. Revolve differential while tightening bearing adjusters to correctly seat bearings.

Set Gear Lash

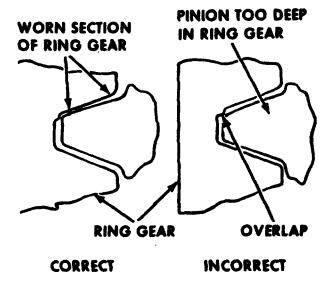


Fig. 32 Setting Correct Backlash

A special effort should be made to set the backlash between pinion and ring gear to the same amount as was originally built into them (.15-.3 mm or .006-.012"). Generally the amount of backlash is stamped or etched on the ring gear. When installing new gears, backlash is measured with a dial indicator mounted on

differential housing (Fig. 32). To adjust the backlash move the ring gear toward or away from the pinion. This is done by backing off one adjusting ring and advancing the opposite ring the same amount.

When original gear and pinion sets are being reinstalled the wear pattern of the gear teeth must be considered in the backlash adjustment. Gears that have been in service for long periods form running contacts which should not be greatly changed. If, in checking backlash, the amount measured is in excess of the amount shown on the ring gear, the lash may be reduced only in the amount that will avoid overlap of the worn tooth section (Fig. 33). A slight overlap at the worn section will cause gear operation to be noisy and rough.



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Fig. 33 Correct and Incorrect Lash Adjustment Where Worn Gears Are Reinstalled

Preload Differential Bearings

To set the bearing preload, mount dial indicator at side of ring gear (Fig. 34). With the bearing capscrews loosened to permit bearing movement, loosen adjusting nuts only enough to notice end play on indicator.

IMPORTANT While gear is held in .000 end play and before loading bearings, check gear for runout by revolving ring gear. If runout exceeds .2 mm (.008"), remove differential and check for cause.

Tighten both adjusting nuts from .000 end play to preload the differential bearings (see "Specifications").

Tighten bearing cap bolts to specified torque (see "Torque Chart").



Fig. 34 Adjusting Bearing Preload

Recheck gear lash to make certain that the lash setting has not been changed.

Install adjusting ring locks and cotter pins.

Check Gear Tooth Contact

The final check of differential assembly adjustment is checking the gear tooth contact by the paint impression method.

Apply oiled red lead lightly to the hypoid gear teeth. When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts (Fig. 35).

Sharper impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the gear teeth. Coast side should be correct when drive side is correct. Generally, coating approximately twelve teeth is sufficient for checking purposes.

With adjustments properly made, a correct tooth contact similar to that shown in Fig. 35 will be secured. The area of contact starts near the toe of the gear and extends about $62\frac{1}{2}$ percent

of the tooth length. This adjustment results in a quiet running gear and pinion set which, because the load is distributed over the teeth within the proper area, will deliver all the long service built into it.



Fig. 35 Tooth-Contact Impressions

When checking paint impressions on gear teeth of an axle under heavy load, the impressions usually spread out somewhat longer than the patterns obtained from a bench test. This can be considered as normal. Ring gears when mounted should show a bearing toward the toe or small end of the tooth, but never at the heel or large end. The reason being that it is practically impossible to make gears and gear mounting so rigid that no deflection will occur when full torque is applied. This deflection causes the bearing to approach the heel of the tooth.

And when gears are adjusted so that the bearing is toward the heel of the tooth, it results in a concentration of load on the top corner of the heel and breakage will follow

FORWARD REAR AXLE: Reassembly of Inter-Axle Differential

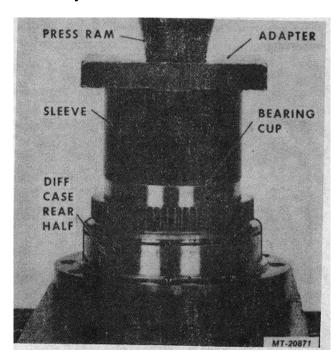


Fig. 36 Installing Bearing in Rear Half of Differential Case

- If removed, apply a coating of rear axle lubricant to bearing and install in rear half of differential case using installer tool and proper disc from SE-1905.
- 2. Apply rear axle lubricant to differential case halves and to all differential component parts.
- 3. Position thrust washer and rear side gear in rear half of differential case.

- 4. Place spider, spider gears and pinion gear thrust washers in position in rear half of differential case.
- 5. Position thrust washer and front side gear in front half of differential case.
- Align the notch marks and assemble the differential case. Draw assembly together with four equally spaced bolts. Make sure side gears and spider pinion gears mesh correctly.
- Check for free rotation of gears. If satisfactory, install remaining differential case bolts.
- 8. Tighten case bolts to specified torque (see "Torque Chart").
- 9. Press front bearing onto case, using suitable adapter to press against inner bearing race (Fig. 37). Set unit aside for later installation.

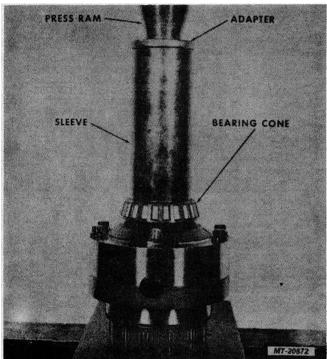
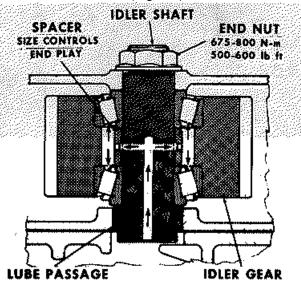


Fig. 37 Pressing Front Bearing On Inter-Axle Differential Case

IMPORTANT Inter-axle differential rear bearing should be installed later. This ball bearing unit is left out of assembly at this stage to simplify setting of inter-axle differential bearing end play adjustment.

Reassemble Power Divider Intermediate Case

 Assemble idler shaft bearings and bearing spacer to idler shaft. (End play on idler bearings is controlled by the bearing spacer.) Position spacer so oil groove inside spacer will index with oil hole in idler shaft (Fig. 38).



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Fig. 38 Details of Idler Shaft Installation

 Position idler shaft in intermediate case so flats on rear of shaft will be positioned in case as shown in Fig. 39. This is necessary to facilitate installation of intermediate case to differential carrier.



Fig. 39 Positioning of Idler Shaft Flats

- 3. Support intermediate case and press idler shaft into case.
- Install idler shaft end nut and tighten to specified torque 675-800 N-m (500-600 ft. lbs.). Mount intermediate case in vise so as to hold flats on idler shaft end while tightening (Fig. 40).

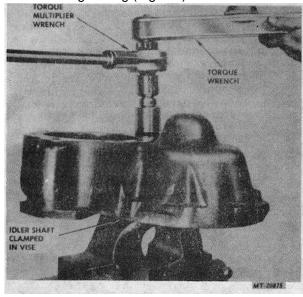


Fig. 40 Tightening Idler Shaft End Nut

- Check end play on idler gear. If not to specifications, disassemble idler shaft and select a thicker or thinner spacer as required.
- 6. Assemble and install input gear.
 - a. Install bearing cone on input gear.
 - b. Install input gear rear bearing cup and input gear and bearing assembly into intermediate case.
- 7. Position clutch shift collar and shift fork on input gear:

IMPORTANT Shift fork may be eitherof two types a stamped steel type or0 a cast type with nylon wear pads. If wear surfaces of fork are rough or fork fits loosely in shift collar, replace fork or wear pads.

Install Inter-Axle Differential and Nose Cone Assembly(Fig. 41)

1. Install input gear front bearing cup into differential case rear half bore.

 Install inter-axle differential case assembly (less rear bearing) into intermediate case:.

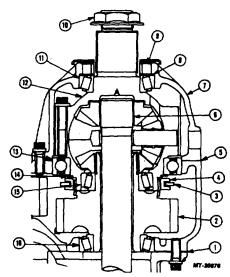


Fig. 41 Inter-Axle Differential Nose Cone Cross Section

LEGEND FOR FIGURE 41

Key Description

- 1 Carrier, Differential
- 2 Gear, Input
- 3 Fork, Power Divider Shift
- 4 Collar, Shift Clutch
- 5 Case. Intermediate
- 6 Shaft, Output
- 7 Cover, Power Divider (Nose Cone)
- 8 Shim
- 9 Seal
- 10 Nut, Input Shaft End
- 11 Bearing, Power Divider, Front
- 12 Differential, Inter-axle
- 13 Bearing, Power Divider, Rear
- 14 Ring. Snap, Bearing Retaining
- 15 Bearing, Input Gear, Front
- 16 Bearing, Input Gear, Rear
 - 3. Tap on end of input shaft with soft hammer to seat the bearings.
 - Temporarily assemble differential cover (nose cone) to intermediate case. (Cover should include forward bearing cup but no shims or oil seal.)
 - 5. Tap cover with soft hammer to seat nose cone assembly firmly against intermediate case and install two or three bolts to secure cover. Details of nose cone assembly are shown in Fig. 41.

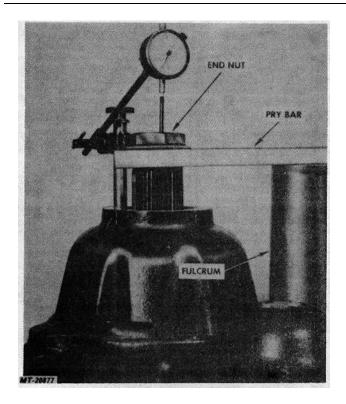


Fig. 42 Measuring Input Shaft Fore & Aft Movement Establish Inter-Axle Differential Bearing End Play

- 1. Thread input shaft end nut onto end of input shaft and mount dial indicator over end of input shaft (Fig. 42).
- 2. Using a pry bar under input shaft end nut measure amount of shaft fore and aft movement (Fig. 42).

IMPORTANT When all inter-axle differential bearings are seated, there should be 1.0 - 1.9 mm (.040 - .075") fore and aft movement of input shaft. If movement is not within this range, check assembly for cause.

Reduce this shaft fore and aft movement to .00 - .12 mm (.000 - .005") by shim between bearing cup and nose cone (Fig. 45). For Example: If total shaft movement as read on dial indicator (Fig. 42) is 1.40 mm (.055") you will need a 1.38 mm (.054") thickness shim to obtain specified end play of .00 - .12 mm (.000 - .005").

- 4. Remove inter-axle differential cover (nose cone) and inter-axle differential from intermediate case.
- 5. Install ball bearing assembly to rear of inter-axle differential (Fig. 43). Secure with spiral type snap ring as follows --
 - a. Insert one end of spiral snap ring in groove on rear of inter-axle differential. Apply thumb pressure to and around spiral band. Snap ring will now be partially seated in groove (Fig. 44).
 - b. Using blunt point punch or screwdriver and small hammer, tap snap ring at slot "B" into groove (Fig. 44).
 - c. Move punch to slot "A" and after positioning punch as shown, tap snap ring into its seated position (Fig. 44).

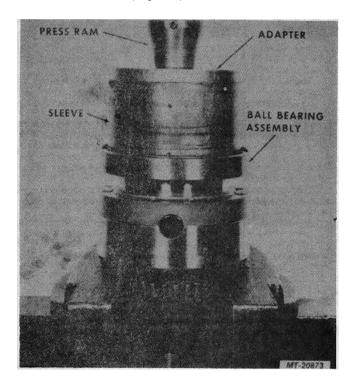


Fig. 43 Pressing Ball Bearing Assembly on Inter-Axle Differential

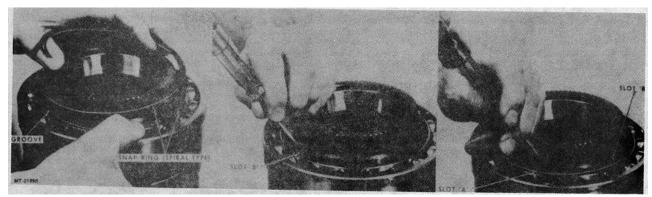


Fig. 44. Procedure for Installing Spiral Type Snap Ring

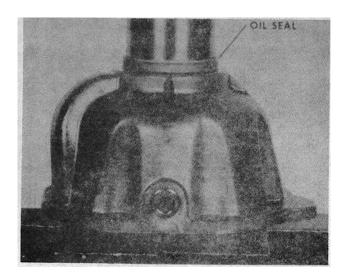


Fig. 45 Installing Nose Cone Seal

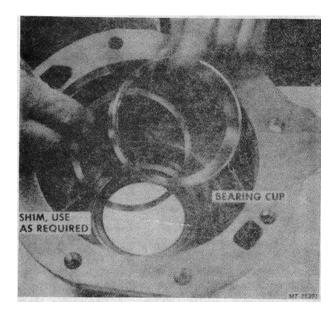


Fig. 46 Location for Installing End Play Adjusting Shim

- 6. Install input flange seal in nose cone (Fig. 45).
- 7. Place required thickness shim and bearing cup to inside of nose cone (Fig. 46).

Install Cover (Nose Cone) and Companion Flange to Inter-Axle Differential

- Assemble diff case into cover (nose cone) and install companion flange and end nut to input shaft end.
- 2. Hold assembly in vise or hold flange with flange holder tool and tighten end nut to 675-800 N-m (500-600 ft lbs).
- Install nose cone assembly to intermediate case, install mounting bolts and tighten to 96-115 N-m (70-85 ft lbs).

Reassemble Output Shaft Assembly

- 1. Support output shaft bearing and press output shaft into bearing.
- 2. Tap bearing cage of retainer over bearing and secure with snap ring.

Install seal in bearing cage.

Install flange and end nut.

Clamp flange in vise or use flange holder tool and tighten output shaft end nut to 675-800 N-m (500-600 ft lbs).

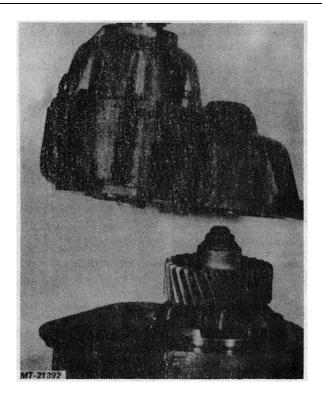


Fig. 47 Installing Power Divider Assembly

Reassemble Power Divider Assembly to Differential Carrier (Fig. 47)

- 1. Apply liquid gasket on the differential carrier mounting face.
- Position power divider assembly on differential carrier. Make sure flats on end of idler shaft index with flats in carrier.
- 3. Install intermediate case bolts. Tighten evenly to 96-115 N-m (70-85 ft lbs).

Assemble and Install Lockout Cylinder

- Apply thread seal and locking compound to threads of power divider shift fork shaft and install shaft (Fig. 48) to shift fork previously installed inside case.
- 2. Place liquid gasket on mounting face of lockout cylinder and install to intermediate case (Fig. 49). Torque mounting bolts to 40-50 N-m (30-38 ft lbs).
- Place shift spring on shift fork shaft; large "O" ring and two felt wipers on piston, and small "O" ring and washer on piston bolt. Use thread seal and locking compound on bolt and secure piston to shift fork shaft.

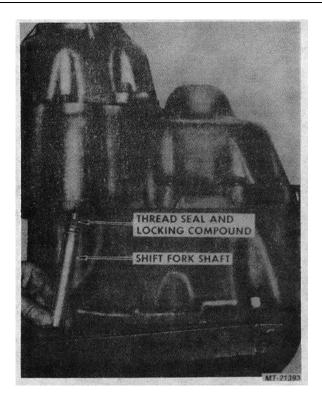


Fig. 48. Installing Shift Fork Shaft

IMPORTANT Soak felt wipers in differential lube for one minute before installing. Also be sure wiper ends butt together but do not overlap when installed.

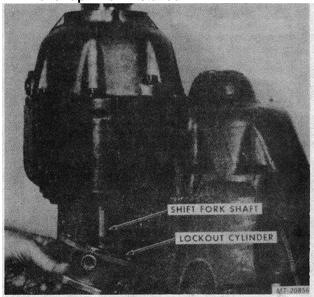


Fig. 49. Installing Lockout Cylinder

- Torque piston shaft bolt to 20-27 N-m (15-20 ft lb) and then loosen 1/2 turn to facilitate operation of power divider lock.
- Install lockout cylinder cover and secure with four hex head bolts. Torque to 10-13 N-m (90-110 in lbs.).

Reassemble Power Divider and Differential Carrier to Axle Housing

- Support carrier assembly on roller jack. Secure as necessary to prevent carrier assembly from falling from jack.
- 2. Apply liquid gasket on axle housing.
- Align carrier assembly with axle housing and roll into position. Use a small pinch bar to straighten carrier in housing but avoid damage to carrier or axle housing.
- 4. Install carrier mounting bolts and tighten evenly. Torque to 217-240 N-m (160-175 ft lb).
- Place liquid gasket on axle housing mounting face and insert output shaft into position (Fig. 50). Rotate output shaft slightly to mesh shaft splines with inter-axle differential side gear.



Fig. 50. Installing Output Shaft

- 6. Install bearing retainer bolts. Tighten to specified torque 41-52 N-m (30-38 ft lbs).
- 7. Install axle shafts. Tighten axle flange bolts to 295-326 N-m (217-240 ft lbs).
- 8. Connect propeller shaft.

IMPORTANT

When installing rear propeller shaft connecting forward and rear axles of the tandem, the slip yoke splines of shaft must be toward rear.

9. connect inter-axle lockout air line. rear axle with lubricant (see "Lubrication").

REAR REAR AXLE: Installing Differential Carrier In Axle Housing.

Using chain sling and overhead hoist, move differential carrier assembly from rebuild stand to roller type floor jack.

Apply liquid gasket and roll the differential carrier into position on the axle housing.

Install housing bolts and tighten to specified torque 217-240 N-m (160-175 ft lbs).

Connect propeller shaft to companion flange and install axle shafts. Insert drain plug and fill housing with prescribed quantity and type of new lubricant.

LUBRICATION Draining And Refilling Instructions

To drain axle lubricant from forward axle and power divider, remove drain plugs from bottom of axle housing and bottom of the power divider intermediate case.

To drain the rear rear axle, remove the drain plug from the axle housing.

To fill the forward rear axle, make sure all drain plugs are tight. Pour 0.5 liter (1 pint) of lubricant into the power divider at plug on top of inter-axle differential case. Fill axle housing to the level of filler hole.

To fill rear rear axle, make sure drain plug is tight. Fill to level of filler hole. On initial lubrication of new or rebuilt axles, pour 0.5 liter (1 pint) of lubricant into pinion bearing cage at filler plug provided in differential carrier.

To assure initial lubrication of rebuilt axle assemblies, it is recommended that the axles be "run-in" to distribute the lubricant. This is accomplished by raising and securely blocking all rear wheels off the floor and operating the axles at medium speed for approximately two to three minutes. After running in axles, recheck lubricant level.

The propeller shaft slip joint splines must be free to slip as required to compensate for articulation of the axles. Keep slip joints lubricated. When operating under dusty, wet or muddy conditions, more frequent lubrication of the propeller shaft may be required. Inspect slip yoke dust seals and replace worn or damaged seals to prevent entry of dirt or moisture which might cause binding or seizing of slip joint splines.

INTER-AXLE LOCKOUT SYSTEM Operation

During normal operation, the inter-axle lockout is kept disengaged by vehicle air pressure. When the lockout control on dash is operated, air pressure is relieved from lockout cylinder and shift fork spring activates shift fork shaft (Fig. 51).

The sliding clutch ring then connects the interaxle differential case to the power divider input gear, locking out the inter-axle differential action and providing positive drive to both forward and rear axle units. Thus equal driving power is provided to the forward and rear axles giving maximum traction for pulling thru deep sand. mud or snow.

The lockout mechanism must be engaged only when the truck is standing still. It should be kept engaged only at long as positive traction is required. Continuous unnecessary engagement of the lock mechanism will result in excessive tire wear and may damage the axles.

The lockout shift fork is controlled by an air control valve on the vehicle instrument panel. This air control system also has a light on the instrument panel which indicates when lockout mechanism is engaged.

The control valve, control cylinder, hoses and pipe connections of air control systems should be inspected periodically for leakage and necessary repairs. The control valve and control cylinder should be checked for correct operation. When tests indicate that control cylinder assembly leaks, it should be replaced.

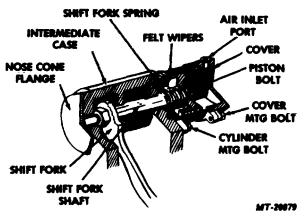


Fig. 51. Lockout Cylinder

At time of axle overhaul, control cylinder and control valve should be inspected carefully and worn or damaged parts replaced.

MAINTENANCE

Axle Housing Breather Valve

Periodically inspect the axle housing breathers to make sure they are open and not clogged with dirt or other foreign matter. The breathers relieve any pressure build-up within the axle housing which might contribute to lubricant leakage.

Alignment

The rear axle should also be checked at regular intervals to determine if there is any misalignment of the axle with frame or driveline. Evidence of misalignment may sometimes be noted at the U-bolts. To check for axle misalignment lay a straightedge across and at right angles to the truck frame. The straightedge should be longer than the axle tread and clamped to the frame a short distance ahead of the rear axle. Measure the distance between the straightedge and identical points at each end of the axle assembly. When distances are not equal, misalignment is indicated, and rear springs and U-bolts must be checked for correct assembly.

Axle Shafts

Many axle failures can be attributed to the axle shafts, therefore, it is most important that shafts be installed correctly, be of correct size and length for splines to engage fully, and be kept free from runout or bends.

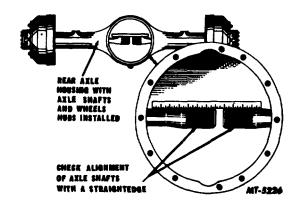


Fig. 52. Method of Checking for Bent Housing

Axle Housing

The axle housing is of one piece construction with an opening in the center for mounting the differential and carrier. A flange is welded to the outer ends of the axle housing for mounting the brake backing plates. A bent axle housing can be the cause of early axle failure and whenever an axle is rebuilt, this condition should always be checked before going ahead with the assembly. Figure 52 gives a quick way of checking for a bent housing.

TROUBLE SHOOTING

Serious trouble in a rear axle can be prevented if sufficient attention is given to the various causes of trouble and the proper remedy is applied. The following list gives most of the common kinds of axle trouble and suggests a possible cause to be corrected.

It should be noted that noises from other units of the truck such as propeller shafts, universal joints, tires and even transmissions are often incorrectly diagnosed as rear axle noise. This possibility should not be disregarded when trouble shooting.

Constant Noise

- 1. Lubricant not to specified level.
- 2. Incorrect kind and weight of lubricant.
- 3. Wheel bearings out of adjustment or defective.
- Drive gear and pinion not in adjustment for correct tooth contact.
- 5. Teeth of drive gear and pinion chipped or worn.
- 6. Too much or too little pinion to gear backlash or overlap of wear pattern.
- 7. Loose or worn pinion bearings.
- 8. Loose or worn side bearings.

Intermittent Noise

- 1. Drive gear does not run true.
 - (a) Uneven pressure on drive gear rivets.
 - (b) Warped drive gear.
- Loose or broken differential bearings in either axle or in inter-axle differential.

Lubricant Leaks

Loss through axle shafts.

- (a) Lubricant above specified level.
- (b) Incorrect kind and weight of lubricant.
- (c) Restricted axle housing breather valve.
- (d) Worn or incorrectly installed axle shaft oil seal.

2. Loss at pinion shaft.

- (a) Lubricant above specified level.
- (b) Incorrect kind and weight of lubricant.
- (c) Restricted axle housing breather valve.
- (d) Pinion oil seal worn or incorrectly installed.
- (e) Lubricant return passage in differential carrier housing restricted.
- (f) Universal joints companion flange loose on pinion shaft.

Noisy On Turns Only

- 1. Differential pinion gears tight on differential spider.
- 2. Side gears tight in differential case.
- 3. Differential pinion or side gears defective.
- 4. Thrust washers worn or damaged.
- Excessive backlash between side gears and pinions.

Rear Wheels Do Not Drive (Propeller Shaft Rotating)

- 1. Broken axle shaft.
 - (a) Loose wheel bearings.
 - (b) Axle shaft too short.
 - (c) Loose flange studs or nuts.
 - (d) Bent housing.
- 2. Drive gear teeth stripped.
- 3. Side gear or differential pinion broken in either axle or in inter-axle differential.
- Differential spider broken in either axle or in inter-axle differential.

SPECIFICATIONS

IH MODEL	RA-472		RA-474	
IH CODE	14472		14474	
LOAD RATING	Metric	U.S	Metric	U.S.
	17.3 T	38000 lbs	20 T	44000 lbs
PINION:				
Nominal Dimension	95.745 mm	3.7695 in	108.826 mm 4.2845 in	
SE-1065 Disc	0(2)		M(2)
(Pinion Setting Gauge)				
Pinion Bearing Preload	1.4-3.6 Kg	3-8 lbs	1.4-3.6 Kg	3-8 lbs
(Cage Rotating Torque)				
DIFFERENTIAL: Bearing				
Preload	4.4/0	0.11.7.1	1.1/2	NI 4 I
	1 1/2 - 3 Notches 1 1/2 - 3 Notch			
		l both sides)	(Total both sides)	
Drive Gear to Pinion	0.25 mm	0.010 in	0.25 mm	0.010 in
Backlash Drive Gear Rivet Pressures	41-45 Tonnes	45-50 Tons	41-45 Tonnes 45-50 Ton:	
POWER DIVIDER:	41-45 1011165	40-00 10118	41-45 Tolliles	45-50 10115
Idler Gear Bearing End	0.00-0.08 mm	0.000-0.003 in	0.00-0.08 mm	0.000-0.003 in
Play	0.00-0.06 111111	0.000-0.003 111	0.00-0.06 111111	0.000-0.003 111
Inter-Axle Diff End Play	0.00-0.12 mm	0.000-0.005 in	0.00-0.12 mm	0.000-0.005 in
Input Gear Bearing End	0.03-0.08 mm	0.001-0.003 in	0.03-0.08 in mm	0.001-0.003 in
Play				
HOUSING:				
Lube Capacity:				
Forward Rear Axle	12.3 Liter *	26 Pints *	21.8 Liter *	46 Pints*
Rear Rear Axle	11.4 Liter *	24 Pints *	18.5 Liter *	39 Pints *
SERIAL NUMBER			of Differentials	
LOCATION				

^{*} Pour 0.5 Liter (1 pint) of total through filler hole in top of nose cone on forward axle or top of pinion on rear rear axle.

SPECIAL TOOLS				
SE- 1065-A	Pinion Gauge			
SE-1065-64	Pinion Gauge Discs			
SE- 1905	Remover and Installer Set			
SE-1933	Torque Multiplier Wrench			
SE-2222	Riveting Fixture			



TORQUE CHART

IH CODE	D	A 472	DΛ	474
IH MODEL	RA-472 14472		RA-474 14474	
IN WODEL				
	N-m	Ft. Lbs.	N-m	FtLbs.
Input Shaft End Nut	675-800	1 3/4-12	675-800	1 3/4-12
(Fwd. Rear Axle)		500-600	22.11-	500-600
Inter-Axle Differential Case	100-115	1/2-13	96-115	1/2-13
Bolts		75-85		70-85
Inter-Axle Differential Cover	96-115	1/2-13	96-115	1/2-13
Bolts (Nylok)		70-85		70-85
Idler Shaft Nut	675-800	1 1/4-18	675-800	1 1/4-18
		500-600		500-600
Power Divider Intermediate	96-115	1/2-13	96-115	1/2-13
Case-To-Differential Carrier		70-85		70-85
Bolts (Nylok)				
Pinion End Nut	1200-1625	1 3/4-12	1200-1625	1 3/4-12
		900-1200		900-1200
Pinion Cage-To-Carrier Bolts	155-170	9/16-12	155-170	9/16-12
		115-125		115-125
Differential Carrier-To-Axle	217-240	5/8-18	217-240	5/8-18
Housing Bolts		160-175		160-175
Differential Case Bolts	162-176	9/16-18	162-176	9/16-18
		120-130		120-130
Differential Bearing Cap-To-	370-405	3/4-10	370-405	3/4-10
Carrier Bolts		275-300		275-300
Axle Flange-To-Wheel Hub	295-326	3/4-16	295-326	3/4-16
Bolts		217-240		217-240
Inter-Axle Lockout Cylinder	41-52	3/8-16	41-52	3/8-16
Bolts (Nylok)		30-38		30-38
Output Shaft Rear Bearing	41-52	3/8-16	41-52	3/8-16
Retainer Bolts	32	30-38	5_	30-38
Output Shaft End Nut	675-800	1 1/2-18	675-800	1 1/2-18
2 3 4 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	3.000	500-600	0.000	500-600
Lockout Cylinder Piston Bolt	20-27	3/8-24	20-27	3/8-24
200.1001 Doit	20 21	15-20	20 2.	15-20
Lockout Cylinder Cover Bolt	10-13	1/4-20	10-13	1/4-20
200.toat Cymraor Cover Bort	10 10	7-9	13 13	7-9
		1 0		1 0

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BODIES - CABS - COWLS



COMFORT CONTROL (BLEND AIR) HEATING AND AIR CONDITIONING SYSTEM

S-SERIES VEHICLES

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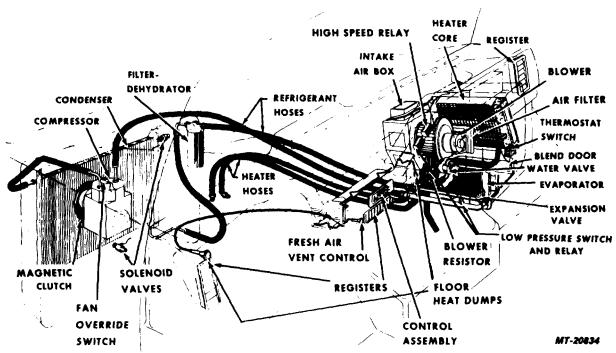


Fig. 1. Comfort Control Heating and Air Conditioning System

DESCRIPTION

The Comfort Control, blend air type heater or combination heater and air conditioner is used in the S-Series medium and medium heavy vehicles.

In the combination system, both the heater core and the air conditioning evaporator are housed in the same unit and utilize the same air ducts, blower and controls. The functions of each system, however, are separate and different. This combination system features compactness, convenience, good air distribution and service accessibility. All components are readily accessible for service resulting in care of maintenance and low service costs.

The heater and air conditioning systems have common distribution ducts with an independently controlled ventilation system. Through control arrangement and common ducting of treated air, the vehicle operator can select any degree of cab interior air temperature in a wide range of cab heating, defrosting, cooling (air conditioning), dehumidification and ventilation modes.

All of the air treated by the heater and air conditioning system comes into the unit through the air intake box. The air intake box has three gravity closed recirculation doors as well as fresh air supply connections to the fresh air chamber which is connected to the fresh air scoop.

From the air intake box, the air goes to the blower and is "pushed" through the evaporator and heater cores. In vehicles with A/C, a replaceable filter is placed ahead of the evaporator to prevent plugging of evaporator with lint or dirt. Once the air goes through the filter and evaporator it can either go through the heater core or bypass the core through the opened blend door. (Hence the term "blend air".) Temperature control is achieved through the blend door and water valve working in combination. Both the water and the air that goes through the heater core is controlled, resulting in a nearly linear temperature response and therefore the best possible cab comfort condition. Once the air leaves the unit, it has been filtered and either cooled, dehumidified or heated depending on operator need.

From the heater/evaporator unit, air enters the duct system where it can be sent to the defroster chamber, various register outlets or the floor heat dumps.

HEATER AND AIR CONDITIONING SYSTEM COMPONENTS

The heater portion of the system employs basic components of any automotive hot water heating system. These include:

- 1. Heater Core.
- 2. Hot Water Flow Control Valve.

- 3. Air Blower. *
- 4. Heater Hoses.
- 5. Hot Water Control Cable.
- 6. Air Ducts* and Defroster Ducts.
- 7. Intake Air Box. *
- * Common with air conditioning system, where equipped.

Major components of the air conditioning system are:

- 1. Compressor and Clutch Assemblies.
- 2. Condenser.
- 3. Filter-Dehydrator (with Sight Glass).
- 4. Evaporator Core.
- 5. Air Filter.
- 6. Expansion Valve.
- 7. Thermostatic Temperature Control Switch.
- 8. Low Pressure Switch.
- 9. Engine Fan Drive Override Switch.
- 10. Fan Drive Solenoid Valve.
- 11. Shutter Override Solenoid Valve.
- 12. Air Blower. **
- 13. Refrigerant Hoses.
- 14. Control Cables. **
- 15. Air Ducts. **
- 16. Intake Air Box. **

** Common with heater system.

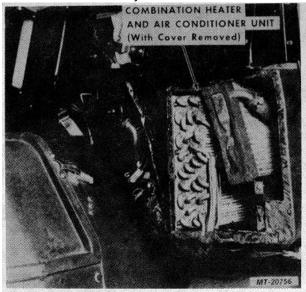


Fig. 2. Combination (Blend Air) Unit

Combination (Blend Air) Unit

The combination heater-air conditioner unit (Fig. 2) is mounted on the dash panel at the right side of the cab.

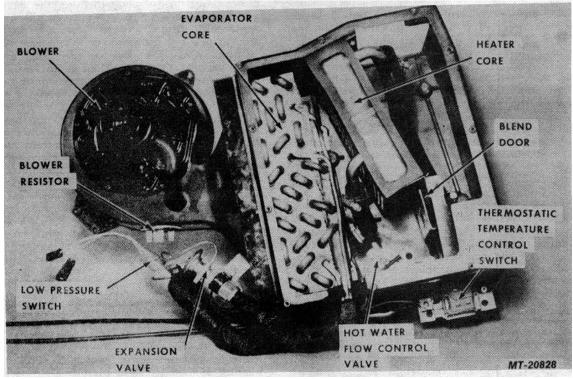


Fig. 3. Components of Combination Unit

Relative positions of heater core, evaporator core, blower fan and motor and other components located in the combination unit are shown in Fig. 3. These components are described in detail later in this section.

Control Panel Assembly

Major functions of the heater and air conditioning systems are controlled from the control panel assembly (Fig. 4). The control panel has three levers (two levers on vehicles with heater only) and a blower switch.

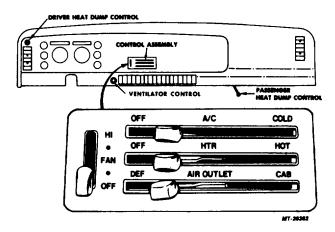


Fig. 4. Control Assembly

The top (A/C) lever operates the air conditioning thermostatic control switch to regulate cab cooling (air conditioning). The center lever (HTR) operates the hot water flow control valve and the blend door to regulate cab heating. The lower (AIR CONTROL) lever divides air flow between DEFROST and CAB AIR outlets.

Separate controls (not in control panel) are provided for operating the fresh air ventilation system and the driver and passenger floor heat dumps.

The three speed blower switch has five terminals. Feed current from a 20 amp fuse enters the switch through terminal "B". Whenever switch lever is moved from the "OFF" position, current is provided through the terminal "A/C" to the thermostat control switch. Terminals "L", "M" and "H" refer to low, medium and high speeds and are energized when the switch lever is moved to their corresponding positions. On vehicles with heater only, the "L", "M" and "H" terminals are wired to the resistor terminals "4", "3" and "1" respectively. On vehicles with air conditioning, the "H" terminal is wired to terminal "4" of the high speed relay. (See wiring circuit diagrams, Figs. 16 and 17.)

The ventilation system is controlled by rotating the "VENT" knob located just to the left of the center instrument panel air outlets. The driver floor heat dump is cable operated from a push-pull control located at the upper left hand corner of the instrument panel. The passenger floor heat dump is operated by a hand lever located under the instrument panel.

Heater Core

The heater core (Fig. 3) is mounted in the combination unit housing. The core is of honeycomb construction. Engine coolant is circulated through the core water passages and heat from the coolant is dissipated to air circulated through the core fins.

Hot Water Flow Control Valve

The hot water flow control valve regulates the flow of hot engine coolant through the heater core. The control valve operates in conjunction with the blend door (Fig. 3).

This arrangement is controlled through cable connected to the second (HTR) lever on the control panel assembly. In the "OFF" position, no coolant is allowed to flow through the heater core and the blend door is in the full open position, bypassing air around the heater core. As the lever moves toward the maximum heat position, the flow of coolant through the core is increased and the air bypassing the core is reduced until at maximum lever travel (HOT) all air flows through the core.

Blower

The blower fan (Fig. 5) provides air circulation through the heater and evaporator cores and delivers the treated air to the cab interior.

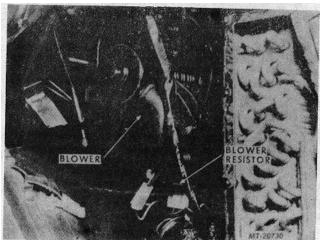


Fig. 5. Air Blower and Resistor

Vehicles with air conditioning have a powerful permanent magnet type blower motor which utilizes a vent tube for efficient motor cooling. On vehicles with heater only, a smaller permanent magnet type motor is used.

A resistor assembly is used in the blower motor circuit to provide three speed settings, "LOW", "MEDIUM" and "HIGH". The resistors are located in the blower air stream to prevent overheating.

On vehicles with air conditioning, a high speed relay is used to accommodate the high current demand of the larger blower motor. This avoids a high current flow through the switch during high speed operation. When the blower is operated on "LOW" or "MEDIUM" speed, current flows from terminal "2" of the resistor assembly to terminal "2" of the relay and out through terminal "1" of the relay to the motor. When the switch is turned to "HIGH", relay terminal "4" is energized, allowing current to flow from a 30 amp fuse to terminal "3" of the relay and out through terminal "1" to the motor. (See wiring circuit diagram, Fig. 17.)

Refrigerant Compressor

The compressor (Fig. 6) is a two-cylinder reciprocating type unit. It is mounted on the engine and belt driven through an electromagnetic clutch mounted on the compressor crankshaft. The compressor compresses and superheats refrigerant gas received from the evaporator and propels the refrigerant through the system.

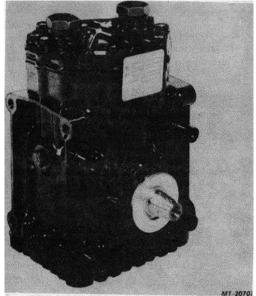


Fig. 6. Refrigerant Compressor Magnetic Clutch

The electro-magnetic clutch (Fig. 7) is used to couple and uncouple the compressor from the V-belt

drive. It cycles the compressor "ON" or "OFF" in response to signals from the thermostatic temperature control switch. When thermostatic switch demands cooling, the clutch is engaged setting the compressor in motion. When cab interior temperature satisfies thermostatic switch, the clutch field coil is de-energized releasing clutch plate from pulley, ceasing compressor operation. Use of a cycling clutch system reduces engine load, maximizes compressor life and enhances fuel economy.

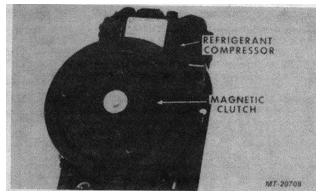


Fig. 7. Magnetic Clutch

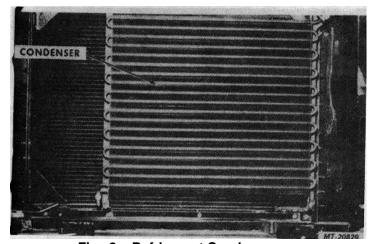


Fig. 8. Refrigerant Condenser

Condenser

The refrigerant condenser (Fig. 8) is mounted at the front of the vehicle between engine cooling system radiator and grille. As refrigerant passes through the condenser, heat that was picked up in the evaporator and during compression is given up to the cooler air flowing through the condenser fins. Refrigerant condenses from a high pressure gas to a high pressure liquid.

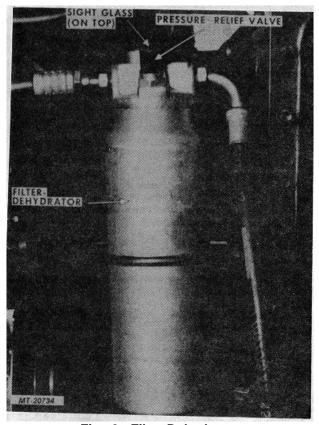


Fig. 9. Filter Dehydrator

Filter-Dehydrator

The filter-dehydrator (Fig. 9) receives the high pressure liquid refrigerant from the condenser and removes any foreign material or moisture which may have entered the system. This unit also serves as a reservoir to store liquid refrigerant until it is needed by the evaporator.

The filter-dehydrator unit incorporates a pressure relief valve which discharges refrigerant into the atmosphere if pressure exceeds 3100 kPa (450 psi). The valve reseals itself automatically when pressure drops below 2750 kPa (400 psi) and does not expel the entire refrigerant charge.

A sight glass used to determine need for adding refrigerant is located at the top of the filter-dehydrator.

Expansion Valve

The expansion valve (Fig. 10) is located between the filter-dehydrator and the evaporator and regulates the flow of refrigerant entering the evaporator.

Leaving the expansion valve, the refrigerant starts to evaporate and expand entering the evaporator as a low pressure liquid-gas mixture.

Attached to the top of the expansion valve is a capillary tube with a feeler bulb which is clamped to the outlet (suction) pipe of the evaporator. The sealed bulb and tube are filled with gas which expands and contracts according to temperature surrounding the bulb. The feeler bulb senses temperature of refrigerant leaving the evaporator. A second capillary tube is attached under the valve diaphragm and is connected to the evaporator outlet (suction) pipe. This is an equalizer line which senses suction pressure. Together, they regulate the amount of refrigerant entering the evaporator.

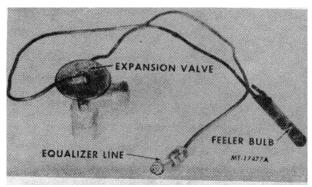


Fig. 10. Expansion Valve

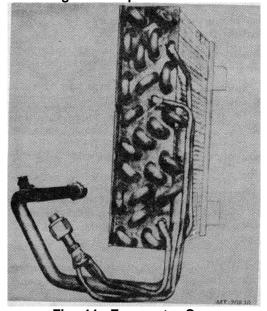


Fig. 11. Evaporator Core

Evaporator

The evaporator core (Fig. 11), mounted in the combination heater-evaporator-blower unit,

is of fin-tube construction. Refrigerant entering the evaporator through the expansion valve vaporizes and absorbs heat from the walls of the evaporator tubes and fins which, in turn, draw heat from the air forced through the evaporator by the blower. This absorbing of heat by the refrigerant results in a flow of cool air from the system. Moisture from the air condensing on the evaporator is drained to the exterior of the vehicle via a drain tube.

Air Filter

On vehicles equipped with air conditioning, a replaceable air filter is located between the blower and the evaporator to keep the evaporator fins clean to assure efficient. heat transfer.

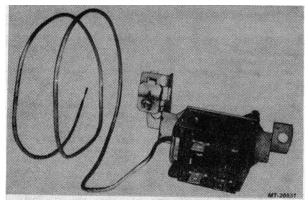


Fig. 12. Thermostatic Temperature Control Switch Thermostatic Temperature Control Switch

The thermostatic temperature control switch (Fig. 12) is located in the bottom of the combination unit. This switch performs these functions:

- 1. Turns air conditioning system "ON" and "OFF".
- Engages and disengages magnetic clutch to start and stop operation of the refrigerant compressor as needed to maintain desired cab cooling.
- Overrides the engine's radiator shutter control to open the shutters whenever air conditioning system is turned on.
- 4. Supplies current to the engine fan drive override switch (where equipped).

The thermostatic switch is controlled through a cable connected to the top (A/C) lever of the control

panel assembly. With the control lever in the "OFF" position, the magnetic clutch will not engage (air conditioning system will not operate).

As the lever moves from the "OFF" position, two sets of contacts close. The smaller set of contacts, which remain closed through all remaining lever travel, connect feed terminal "2" to terminal "3" supplying current to the shutter override solenoid valve and the fan drive override switch (where equipped). (See wiring circuit diagram, Fig. 17.) The larger set of contacts connect feed terminal "2" to terminal "1" to supply current, via terminals "1" and "2" of the low pressure switch relay, to engage the magnetic clutch. (See Fig. 17.) Compressor cycling (engaging and disengaging the magnetic clutch) is accomplished by making and breaking the larger set of contacts.

Cycling temperature setting is determined by position of the air conditioning control (A/C) lever. Moving the lever to the right decreases the control temperature with maximum cooling obtained when lever is in "COLD" position.

Making and breaking of the larger set of contacts (to engage and disengage the magnetic clutch) is controlled by a bellows connected to a capillary tube filled with refrigerant.

The other end of the capillary tube is located in evaporator core where it senses evaporator fin temperature.

When the fin temperature in the evaporator is higher than the control temperature setting, the refrigerant in the capillary tube expands moving the bellows, overcoming spring pressure and closes the contacts to engage the clutch (operate the compressor). When temperature of the air flow is decreased sufficiently the refrigerant in the capillary tube contracts allowing spring pressure to open the contacts and disengage the clutch.

This compressor on-compressor off cycle repeats as often as necessary to maintain the desired cab temperature.

Low Pressure Switch

A low pressure switch (Fig. 13), located in the evaporator outlet tube, is used to protect the refrigerant compressor from damage in the event of refrigerant loss or if ambient temperature is too low to provide sufficient evaporation of refrigerant.

Insufficient evaporation could result in "slugging" -drawing of liquid refrigerant into the compressor. Also an insufficient flow of refrigerant does not provide adequate compressor lubrication.

If evaporator outlet pressure drops to approximately 34 kPa (5 psi) the low pressure switch closes, throwing the low pressure switch relay, to break the feed circuit to the magnetic clutch and disengage the clutch. (See wiring circuit diagram, Fig. 17.)

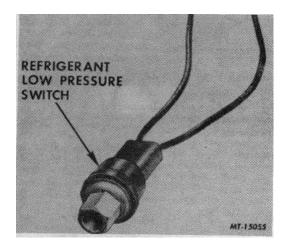


Fig. 13. Low Pressure Switch

Fan Drive Override Switch

Vehicles equipped with an engine cooling fan clutch have a fan drive override switch located in the refrigerant compressor discharge service port.

If compressor discharge pressure exceeds approximately 2070 kPa (300 psi), this switch engages the engine fan drive clutch to provide maximum air flow through the condenser.

The fan drive override switch is similar in appearance to the low pressure switch illustrated in Fig. 13.

Solenoid Control Valves

Two identical solenoid operated control valves (Fig. 14) may be used in conjunction with the air conditioning system to assure that there is sufficient air flowing through the condenser to prevent excessive refrigerant compressor head (discharge) pressure.

The shutter control valve, activated by the thermostatic temperature control switch, opens the radiator shutter and keeps it open (overriding the engine's shutter control) while the air conditioning system is "ON".

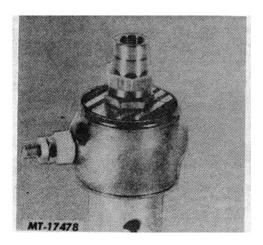


Fig. 14. Solenoid Valve

On engines equipped with an engine cooling fan clutch, the fan drive solenoid valve, responding to activation by the fan drive override switch, engages the fan clutch whenever compressor discharge pressure becomes excessive.

Refrigerant Hoses

Hoses and tubing are used to carry the refrigerant from the compressor to the various components of the air conditioning system and back to the compressor. The hoses (Fig. 15) must withstand certain temperatures and pressures. Therefore it is very important that only hoses of the correct sizes and types be used in the air conditioning system.

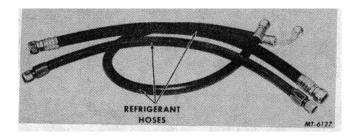


Fig. 15. Refrigerant Hoses

Refrigerant

The refrigerant is the substance which absorbs and removes the heat from the cab. It must be a substance that can be easily converter from a liquid to a vapor and back to a liquid at reasonable temperatures. In other words, it must vaporize at normal ambient temperatures s(that it can absorb the heat while passing through the evaporator.

The type of refrigerant used in IH air conditioning systems is R-12.

Wiring Circuit Diagrams

Heater and air conditioning system wiring circuit diagrams are illustrated in Figs. 16 and 17.

For complete vehicle wiring circuit diagrams, refer to ELECTRICAL, Section CTS-2719 of the Truck Service Manual.

COMPONENT IDENTIFICATION CODE (For Figures 16 and 17)

Key	<u>Component</u>	<u>Key</u>	<u>Componen</u> t
		J	Bulkhead Connector
AA	Heater and A/C Connector	L	Fuse Block
AB	A/C Relays	Q	Instrument Panel Connector
AC	Blower Motor	R	Key Switch
AD	Thermostatic Temperature Control Switch	V	Feed Stud
ΑE	Blower Switch		

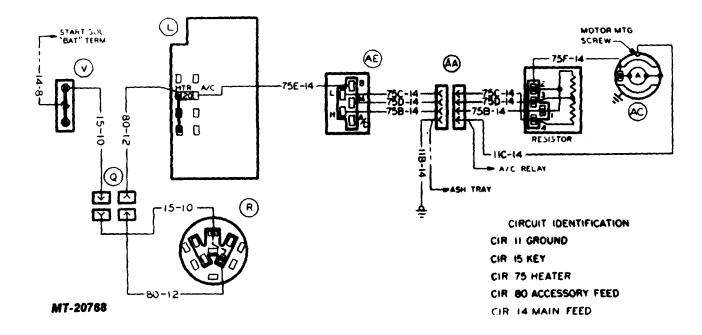


Fig. 16. Heater Wiring Diagram

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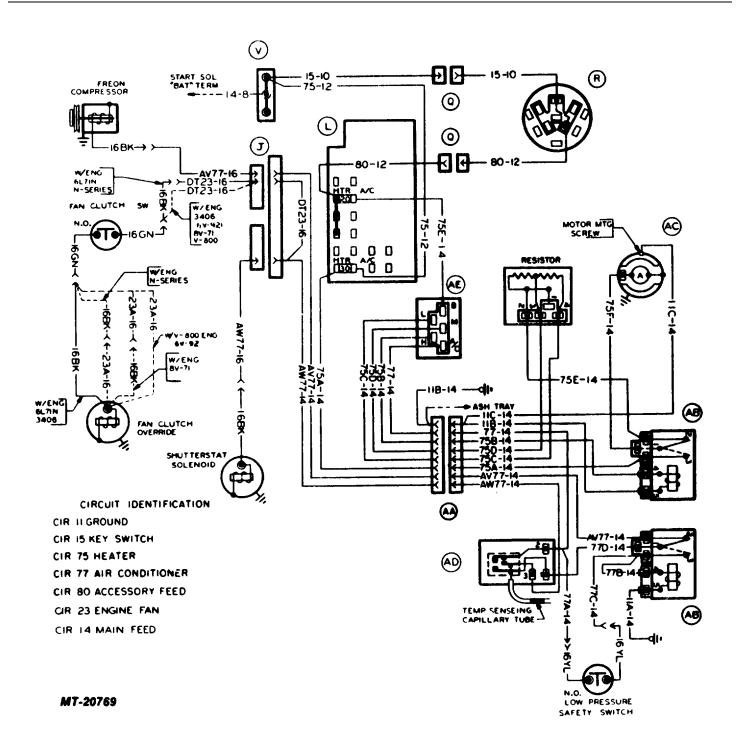


Fig. 17. Heater and Air Conditioner Wiring Diagram

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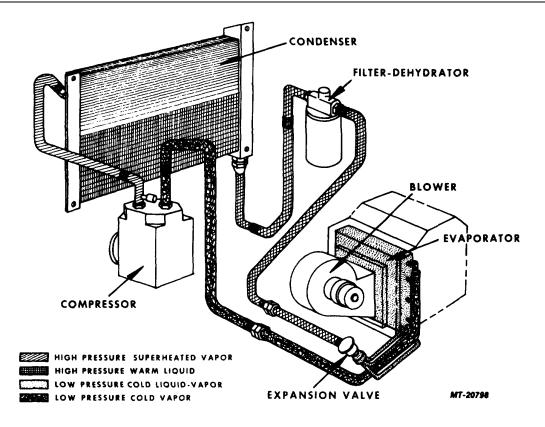


Fig. 18. Refrigerant Flow Through Air Conditioning System

AIR CONDITIONING PROCESS

Operation of the cab air conditioner is basically the same as any mechanical refrigeration system, such as the familiar home refrigerator.

The air conditioning process is a cycle in which the refrigerant (heat absorbing agent) is propelled through a closed system to an area where is absorbs heat from the cab and is then carried to a point where the heat is dissipated to the atmosphere. Let's follow the course of the refrigerant through the various components of the air conditioning system (Fig. 18).

The compressor draws refrigerant vapor from the evaporator and compresses it to high pressure. The temperature of the vapor is increased considerably (superheated) by the compression process. Compressing the refrigerant raises the temperature at which it will condense to liquid. In fact it is raised so high that the vapor under pressure can be cooled sufficiently to condense by a flow of air at normal outside temperatures.

The compressed and superheated vapor flows into the condenser. The air blowing across the

condenser fins removes the heat from the refrigerant causing it to condense back to liquid.

Upon leaving the condenser, the liquid refrigerant, under high pressure, is forced into the filter-dehydrator where the drier agent removes any moisture from the refrigerant.

The expansion valve controls the flow of liquid refrigerant into the evaporator. As the refrigerant passes the expansion valve, pressure is reduced suddenly and it vaporizes and expands.

The expansion valve is controlled by a temperature sensing bulb and capillary tube attached to the outlet of the evaporator. If the temperature of the vapor leaving the evaporator becomes too low, the gas in the bulb contracts. This lowers the pressure on the diaphragm and allows spring pressure to close the valve, reducing the flow of refrigerant into the evaporator. If the temperature of the vapor leaving the evaporator increases, the gas within the bulb expands and increases the pressure above the diaphragm in the expansion valve. This action opens the valve to admit more refrigerant into the evaporator and increases the cooling effect.

The refrigerant entering the evaporator expands and begins to vaporize. Complete vaporization requires heat. The refrigerant absorbs heat from the air surrounding the evaporator coils and fins. As heat is absorbed the refrigerant vaporizes.

The blower draws warm air from the cab and circulates it past the evaporator where the heat is absorbed by the refrigerant. Air exhausted by the blower is cool because the heat has been removed.

From the evaporator, the refrigerant is drawn by suction into the compressor. This completes the refrigerant cycle which is repeated continuously until the temperature of the cab interior is lowered to the desired temperature.

Cab interior temperature is controlled by the thermostatic control switch. This control is adjustable to permit the vehicle operator to select the temperature level desired in the cab. The blower has a multi-speed control which permits the vehicle operator to regulate the amount of air circulation.

OPERATION

HEATING

For proper cold weather operation the heat should be directed toward the floor level; therefore, close all instrument panel outlets and fully open both floor dump outlets.

Adjust the temperature "HTR" (heat) lever as required to give the desired degree of heat. The full right "HOT" position provides the maximum heat. Move the "AIR OUTLETS" control lever either to the full cab position or to any of the other three detented positions in order to obtain the desired air flow distribution between cab heat and defrost requirements. For the maximum air flow, move the fan switch to the "HI" position. The heater will also operate with the fan motor in the "OFF" position due to the ram air introduced during vehicle operation.

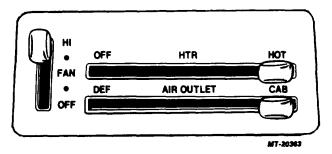


Fig. 19. Heater Controls Set for Maximum Heat

DEFROSTING

To obtain maximum defrosting, move the "HTR" lever to the "HOT" position and place the "AIR OUTLETS" lever on "DEF". Adjust the fan speed to provide the desired air flow.

To clear system of humid air, operate blowers for 30 seconds at "HI" speed before moving the "AIR OUTLETS" lever to the "DEF" position. This will minimize rapid fogging of glass, which can occur if humid air is blown onto a cool windshield.

To improve defroster efficiency, remove ice and/or snow from glass area.

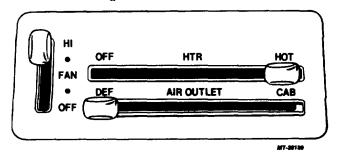


Fig. 20. Heater Controls Set for Defrosting

FRESH AIR VENTILATION

Fresh air enters the cab through either an independent ventilation system or through the heater system itself.

When the "VENT" knob is turned counterclockwise, air enters the cab from the hood scoop and flows through the instrument panel outlets and floor dumps. Except for the ventilation mode, the knob should be rotated to its full clockwise position (vent door closed) for all other modes of operation.

To increase the quantity of air entering the cab in the ventilation mode, the fan may be used to power ventilate. Adjust the fan speed and air outlets for the desired air flow.

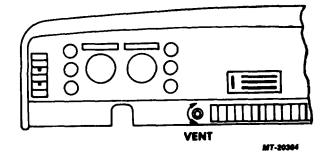


Fig. 21. Ventilator Control

AIR CONDITIONING

To properly air condition your cab in warm weather close both the driver and passenger floor heat dumps and open the instrument panel outlets. Close all windows and ensure the vent knob is turned to its full clockwise position (vent door closed). Set the "HTR" lever on the "OFF" position and "A/C" lever on "COLD". For maximum cooling move the "FAN" switch to the "HI" position. (The fan must be on for A/C operation.) Place the "AIR OUTLETS" lever on the "CAB" position, then adjust the instrument panel outlets to evenly distribute the air around the occupants' head, chest and belt areas. If foot areas feel warm, partially open heat dumps to achieve desired comfort level.

Initial Cooling Always park in the shade when possible. But if your vehicle has been parked in open sun with the windows up, remove overheated air inside by driving with the windows down for one or two city blocks. You can turn on the air conditioner controls at the time you start the vehicle engine. After a short distance with the windows down, roll them up again -all the way -adjust air flow and temperature to your liking.

<u>Stale Air and Smoke</u> To remove stale air or smoke while air conditioner is operating, you may want to open a window vent slightly for a short period of time.

Small amounts of water draining out of air conditioner's drain tube is normal. This is condensed moisture which has been removed from the air inside your vehicle.

The air conditioning system incorporates a low pressure switch which throws a relay to disengage the compressor clutch if evaporator outlet pressure falls below a certain level. To restart the air conditioning after an automatic shut-down has occurred, the operator must do one of the following:

 Place "A/C" lever in "OFF" position and then back "ON",

OR

2. Place blower switch in "OFF" position and then back "ON".

If system continues to shut down automatically, it will be necessary to diagnose the system for the cause of low pressure.

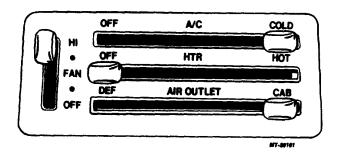


Fig. 22. Air Conditioning Controls Set for Maximum Cooling

DEHUMIDIFICATION

The heater-defroster systems can be operated simultaneously with the air conditioner during mild weather and high humidity conditions for dehumidification of the moist air. To obtain maximum dehumidification, set the "A/C" lever to "COLD", place the fan switch on "HI" and move the "HTR" lever towards "HOT" until a comfortable temperature is maintained. The air conditioner will remove the humidity while the heater keeps the cab comfortable.

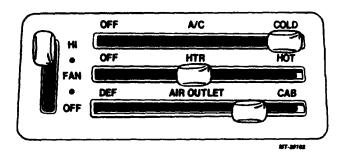


Fig. 23. Controls Set for Dehumidification of Cab

PERIODIC MAINTENANCE

To assure optimum operating efficiency, heating and air conditioning systems must be properly maintained. (See MAINTENANCE OPERATIONS.)



SAFETY PRECAUTIONS

Refrigerant 12 is classified as a safe refrigerant; however, certain precautions must be observed to protect the parts involved and to prevent personal injury to the serviceman.

One of the most important safety measures to be taken while servicing the air conditioning system is adequate and constant protection of the eyes. Safety goggles or other adequate eye protection must be worn. The temperature of liquid refrigerant is a -29.5 deg. C (-21.7 deg. F). Serious injury or blindness could result from refrigerant contacting the eyes.

If refrigerant should contact the eyes, DO NOT rub them. Splash the eyes with cold water to gradually get the temperature above the freezing point. Consult a doctor or eye specialist immediately.

Should liquid refrigerant come in contact with the skin, the resulting injury should be treated the same as though the skin has been frostbitten or frozen.

Liquid refrigerant evaporates so rapidly that the resulting gas may displace the oxygen surrounding the work area, especially if that area is relatively small and enclosed.

To prevent possible suffocation in an enclosed area, always discharge the refrigerant from the air

conditioning system out-of-doors or into an exhaust collector system. Be certain that good ventilation is always maintained around the work area when discharging the system.

<u>Do not smoke</u> or allow any type of fire or flame in the immediate area while servicing the refrigeration system. Refrigerant 12 is not combustible; however, in the presence of fire it changes to a highly poisonous and deadly phosgene gas. This gas will also tarnish bright metal surfaces.

Never weld, solder, steam clean or use any excessive amount of heat on any of the refrigerant lines or components of refrigeration system while the system is charged. Heat applied to any part would cause the pressure of the refrigerant within the closed system to become excessive.

Be certain that pressurized refrigerant containers are never exposed to open flame or temperatures above 51 deg. C (125 deg. F). Do not discard empty refrigerant containers where they are likely to be subjected to the heat of trash burners, etc.

Always use correct refrigerant hoses (freon type) when replacing them. Do not use hoses other than those specified for refrigeration use.

SPECIAL SERVICE TOOLS

Servicing the air conditioning system effectually requires proper tools and equipment especially designed for this work. Recommended tool equipment is shown below.

For further information and sources of this equipment refer to Service Tool Manual, CTS-1147.

High Vacuum Pump

The SE-2446 High Vacuum Pump (Fig. 24) is used to evacuate air and moisture from the air conditioning system prior to charging the system with refrigerant. This pump is capable of removing all moisture and non-condensable gases from the system.

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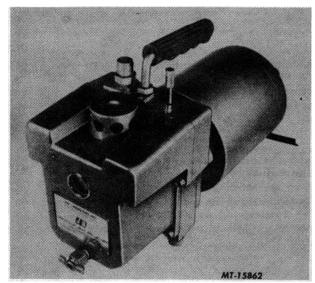


Fig. 24. High Vacuum Pump (SE-2446)

High Vacuum Meter Kit

The SE-2447 High Vacuum Meter Kit (Fig. 25) is used in conjunction with the high vacuum pump. This meter provides a continuous visual monitor on the evacuating operation and serves as a guarantee that the air conditioning system is adequately dehydrated (moisture removed), degassed (non-condensable gases removed) and free from leaks.

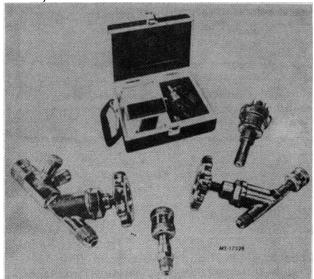


Fig. 25. High Vacuum Meter Kit (SE-2447)

Manifold and Gauge Set

The SE-2444 manifold and gauge set (Fig. 26) incorporates the necessary pressure and

vacuum gauges, control valves and fittings for evacuating, charging and testing the air conditioning system.

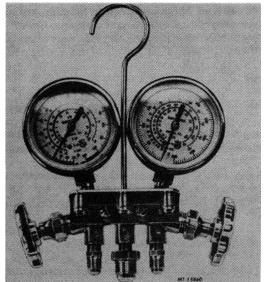


Fig. 26. Manifold and Gauge Set (SE-2444)

Service Hose Set

The SE-2445 service hose set (Fig. 27) is used to connect the manifold and gauge set, vacuum pump and refrigerant containers (or charging cylinder) to vehicle air conditioning system service ports.

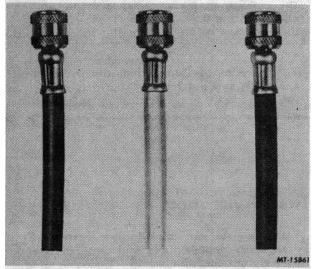


Fig. 27. Service Hose Set (SE-2445)

Heated Charging Cylinder

The SE-2448 Heated Charging Cylinder (Fig. 28) heats the refrigerant to permit quicker

charging of the air conditioning system. Use of this tool also permits purchase of refrigerant in large economical drum containers.

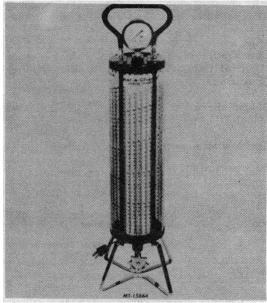


Fig. 28. Heated Charging Cylinder (SE-2448)

Electronic Refrigerant Leak Detector (Audible Type)

The SE-2449 Refrigerant Leak Detector (Fig. 29) is used to check for refrigerant leaks throughout the entire air conditioning system. When this detector senses a refrigerant leak, an audible signal (sound) is emitted.



Fig. 29. Electronic Refrigerant Leak Detector Audible Type (SE-2449)

Electronic Refrigerant Leak Detector (Visual Type)

The SE-2272 Refrigerant Leak Detector (Fig. 30) has the leak sensor and a neon signal light mounted in a probe. When the probe encounters a refrigerant leak, the signal light blacks-out. The neon lamp glows steadily if a leak is not present.



Fig. 30. Electronic Refrigerant Leak Detector Visual Type (SE-2272)

Refrigerant Can Adapter Valve

The SE-2450 Refrigerant Can Adapter Valve (Fig. 31) is used to connect either flat top or screw top type one-pound refrigerant containers to the manifold and gauge set for charging or adding refrigerant to the air conditioning system.

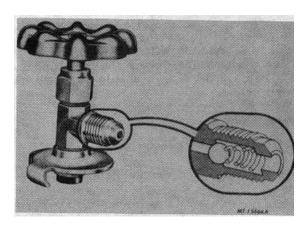


Fig. 31. Refrigerant Can Adapter (SE-2450)

Portable Air Conditioning Service Station

The SE-2443 Portable Air Conditioning Service Station (Fig. 32) consists of Manifold Gauge Set (SE-2444), Service Hose Set (SE-2445), High Vacuum Pump (SE-2446) and High Vacuum Meter Kit (SE-2447) mounted on a convenient cart. Space is also provided for mounting the Heated Charging Cylinder (SE-2448).

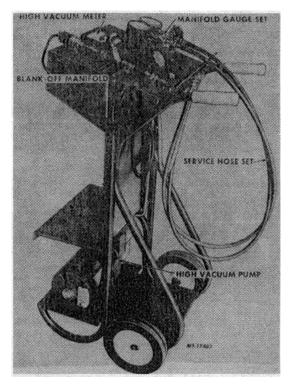


Fig. 32. Portable Air Conditioning Service Station (SE-2443)

MAINTENANCE OPERATIONS

PRE-SEASON CHECKS

Experience has shown that many problems incurred with heating and air conditioning systems result from lack of regular maintenance. Complete pre-season check outs of heating and air conditioning systems will aid in obtaining satisfactory performance during the operating seasons. Pre-season checks should be performed as outlined below.

With Heater Only:

- 1. Check unit mountings for looseness.
- 2. Check condition and tension of all drive belts.

- 3. Check cleanliness of coolant. Clean cooling system if necessary and add new coolant.
- 4. Check to see that radiator core fins are not plugged with bugs or leaves, etc.
- Check heater core fins for lint or other material that could restrict air flow.
- 6. Check adjustment of control cables. (See "Control Cable Adjustment" under Service Operations.)
- Check operation of blowers. Clean blower wheels if necessary.
- 8. Check water control valve adjustment.
- 9. Check cooling system shutter operation (where equipped).
- 10. Check condition of heater hoses and engine cooling system hoses. Replace if necessary.

With Heater and Air Conditioner:

- Perform pre--season check of heater portion of system as outlined above under "With Heater Only".
- 2. Check compressor belt alignment and tension. (See "Compressor Belt Tension Check".)
- Check condition of refrigerant hoses and tubing.
 Look for cracks, chafing or other damage and replace
 as needed. Inspect all tubing and hose connections.
 All connections must be clean and tight.
- 4. Install new air filter. (See "Air Filter Replacement".)
- 5. Clean condenser, radiator, evaporator core and blowers of all dirt, lint or other foreign material. Cleanliness of these components cannot be overemphasized. Lack of proper attention in this area is one of the major causes of unsatisfactory unit operation. As often as necessary, squirt water through condenser towards radiator and through radiator towards condenser to flush debris out of fins. Do not cover the condenser with a screen wire.
- 6. Operate air conditioning system with controls set for maximum cooling (A/C lever on "COLD", blower switch on "HIGH") for about five (5) minutes.

With system operating:

- a. Determine that system is operating properly. (See "Physical Checks" under SERVICE OPERATIONS.)
- b. Observe sight glass for bubbles (Fig. 33). Sight glass should appear clear (no bubbles).
 Bubbles indicate a low refrigerant charge. Add refrigerant. (See "Adding Refrigerant to System" under SERVICE OPERATIONS.)

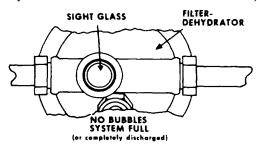




Fig. 33. Sight Glass Indications

7. Shut off engine and check air conditioning system for refrigerant leaks using an electronic leak detector. Follow equipment manufacturer's instructions.

OFF SEASON CARE

Heater

It is a good practice to operate the heater occasionally during the summer season. This will circulate coolant through the heater core to remove any trapped air and flush out possible accumulations of sediment.

Air Conditioner

An important facet of off-season care of the air conditioning system is periodic operation of the unit. Operating the unit for five minutes twice a month after engine warm-up keeps the compressor seals lubricated. If the seals dry out, they may crack and leak.

Also, if the system is not operated periodically, clutch and compressor bearings could become brinnelled.

This is caused by the continual hammering effect on the bearing surface in the same spot from normal vibration during vehicle operation. Do not remove the compressor drive belt during the off-season.

In general, the system will function with less trouble if it is not permitted to remain idle over long periods.

AIR FILTER REPLACEMENT

The air conditioning system air filter element should be replaced every year at the beginning of the operating season. More frequent replacement may be required on vehicles operated in dusty areas.

Replace air filter as follows:

- 1. Remove cover from right side of instrument panel.
- 2. Remove cover from heater/evaporator unit.
- 3. Remove seal mounting strip (with seal) from blower housing (Fig. 34).
- 4. Remove old filter element.

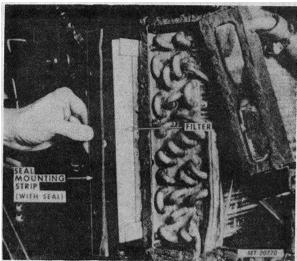


Fig. 34. Replacing Air Filter

- Install new filter element. Be sure arrow on element frame points in direction of air flow (away from blower).
- 6. Inspect seal and replace if damaged. Attach new seal to mounting strip with weather strip adhesive.
- 7. Install seal mounting strip (with seal) on blower housing.

8. Install covers on heater/evaporator unit and instrument panel.

COMPRESSOR DRIVE BELT ALIGNMENT AND TENSION CHECK

Air conditioning (freon) compressor drive belt alignment and tension should be checked prior to the air conditioning season and at least three or four times during the year.

- 1. Inspect drive belt(s) and replace if worn or damaged.
- 2. Check belt and pulley alignment and make any necessary corrections.
- 3. Using belt tension gauge, check belt tension mid-way between the compressor pulley and driving pulley. For specified belt tension, see SPECIFICATIONS.

Belt tension adjustment procedures vary between engine models. Some installations require movement of the compressor on its mounting to adjust belt tensions. Some have adjustment screws to manipulate the compressor for belt adjustment. Others require movement of the alternator.

SERVICE OPERATIONS

IMPORTANT

Certain precautions must be observed when servicing the air conditioning system. (See SAFETY PRECAUTIONS and also "Service Hints" under COMPONENT REMOVAL AND INSTALLATION.)

PHYSICAL CHECKS

Heater and Defroster

- With heater control (HTR) lever and blower switch "OFF", operate engine until normal operating temperature is obtained.
- With engine warmed up, heater inlet hose should feel hot to the touch and heater outlet hose should feel cool (or only slightly warm). If both hoses are hot, check for a faulty or misadjusted heater control cable or a faulty water flow control valve.
- 3. Set heater controls for maximum heat (HTR lever on "HOT", blower switch on "HIGH") and operate engine

and heater for a few minutes to permit system to normalize. Both inlet and outlet heater hoses should flow from heater outlets. If neither hose feels hot or if only the inlet hose is hot, refer to "No Heat" in TROUBLE SHOOTING GUIDE.

4. Manipulate AIR CONTROL lever between "DEF" and "CAB" positions and check for warm air flow from defroster and heater outlets. If air flow is not correct in relation to lever position, check for faulty or misadjusted control cables or faulty air door seals.

Air Conditioning System

 With air conditioning controls set for maximum cooling, (A/C lever on "COLD", blower switch on "HIGH"), operate engine and air conditioning system for about five (5) minutes or until initial heat has been removed from cab and an average flow of cold air is achieved.

If system does not cool, refer to "No Cooling" in TROUBLE SHOOTING GUIDE.

With system operating, feel all air conditioning system components and refrigerant lines for proper operating temperatures.

From the discharge side of compressor along high pressure line, through condenser, filter-dehydrator tank and up to expansion valve, everything should be hot or warm to the touch. The expansion valve, evaporator and all of the lines on the low pressure side leading back to the compressor should be cool to the touch. Any deviation from the above conditions indicates a malfunction in the system.

A stoppage or severe restriction in the refrigerant system can be located in this manner. Malfunctions or stoppages may be indicated by extreme cold or frosted areas (e.g., a cold filter-dehydrator tank frosted part way up indicates a stoppage or serious restriction in the tank).

CAUTION

Avoid contact with moving belts, pulleys and fan when making this check. Beware of extremely high temperatures at compressor outlet (discharge) hoses and tubing.

AIR CONDITIONING PERFORMANCE CHECK (PRESSURE TEST)

This performance test can be used to determine if the air conditioning system is properly charged and functioning correctly.

The procedure for making the performance check utilizing the SE-2443 Portable Service Station is outlined below.

- 1. Park vehicle in an area with low air movement. Place transmission in neutral and apply brake.
- Open cab doors. Close all cab ventilators. Raise hood.
- 3. Connect SE-2443 Service Station to air conditioning system service ports as follows: (See Fig. 35)
 - Close manifold suction and pressure gauge valves. (Turn fully clockwise.)
 - b. Remove cap from compressor suction service port. Connect manifold suction gauge hose to compressor suction service port.
 - c. Remove cap or engine fan drive override switch (if equipped) from compressor discharge service port.

Connect manifold discharge gauge hose to compressor discharge service port.

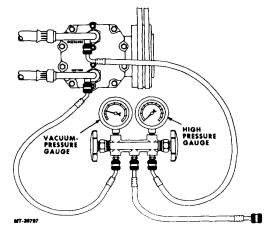


Fig. 35. Manifold and Garage Set Connected to Compressor Service Port

4. Position a thermometer about 305-610 mm (12-24") in front of vehicle grille to measure ambient temperature of air entering condenser.

- 5. Insert another thermometer through center of passenger air conditioning air outlet. Do not let thermometer touch side of air duct.
- 6. Set air conditioning controls for maximum cooling (A/C lever at "COLD", blower switch on "HIGH").
- 7. Operate engine at RPM specified in "Engine Speed Chart" under SPECIFICATIONS for about ten (10) minutes. Then:
- a. Observe and record ambient temperature of air centering vehicle grille.
- b. Observe and record cool air outlet temperature.
- c. Observe and record discharge and suction pressure gauge readings.
- To evaluate air conditioning system performance, compare readings obtained in Step 7 with those listed in the "Operating Pressure Test Chart" under SPECIFICATIONS.

If readings obtained from vehicle are not within limits specified in the chart, refer to TROUBLE SHOOTING GUIDE for causes of abnormal pressures. Make necessary repairs.

 After pressure test is completed disconnect manifold and gauge set hoses from compressor service ports. Install cap on compressor suction service port. Install cap or fan drive override switch (if equipped) on compressor discharge service port.

IMPORTANT

To keep foreign material out of manifold and gauge set hoses, always attach ends of hoses to bracket on service station when not in use.

- 10. Check air conditioning system for refrigerant leaks using an electronic leak detector. Follow equipment manufacturer's instructions.
- 11. Close hood and cab doors.

DISCHARGING THE AIR CONDITIONING SYSTEM

Whenever it becomes necessary to open the air conditioning refrigerant system to remove or service components, the refrigerant charge must be removed from the system.

To discharge the system, utilizing the SE-2443 Portable Service Station, proceed as outlined below:

- 1. Raise hood.
- 2. Connect SE-2443 Service Station to air conditioning system service ports as follows:
 - Close manifold suction and discharge gauge valves (turn fully clockwise).
 - Remove cap from compressor suction service port. Connect manifold suction gauge hose to compressor suction service port.
 - Remove cap or engine fan drive override switch (if equipped) from compressor discharge service port. Connect manifold discharge gauge hose to compressor discharge service port.
 - Route the service hose from the center manifold fitting into the shop exhaust removal system or out of doors.
- 3. Open the manifold gauge valves a slight amount and allow refrigerant to discharge SLOWLY.

<u>Do not allow refrigerant vapor to discharge too</u> rapidly as it will carry out the compressor oil as well.

When refrigerant has been discharged, both manifold gauges will read zero.

4. After refrigerant has been removed, air conditioning system components can be removed for service.

CHECKING COMPRESSOR OIL LEVEL

The compressor is designed to provide a pressurized oiling system where required, without the use of a mechanical pump. As long as a refrigerant flow is maintained, a certain amount of oil will circulate with the refrigerant through the system. When the compressor is operating, there is a pressure difference between the top of the cylinder and the crankcase. This pressure difference causes some oil to be forced down the cylinder wall, thus lubricating some of the compressor parts.

Since some of the oil from the compressor pump is picked up and circulated through the system with the refrigerant, it is very important that the compressor oil level be checked whenever the system is opened for service.

To check compressor oil level, proceed as follows:

 Discharge refrigerant from system. (See "Discharging the Air Conditioning System".) Remove oil fill plug from side of compressor (Fig. 36).

In some cases it may be necessary to remove compressor from engine to gain access to oil fill plug.



Fig. 36. Compressor Oil Fill Plug

3. Insert dipstick through oil fill hole until it bottoms in compressor crankcase.

It may be necessary to rotate compressor crankshaft slightly to permit entrance of dipstick. Be certain that dipstick is bottomed in crankcase.

Dipstick can be made locally from a 3.175 mm (1/8") diameter steel rod as shown in Fig. 37, or is available under service tool number SE-2392-3.

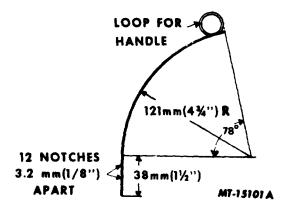


Fig. 37. Dimensions for Making Oil Level Dipstick

 Remove dipstick and measure wetted portion to determine oil level in compressor. Compare oil level reading with specified oil level listed in SPECIFICATIONS.

If necessary, add refrigeration oil to obtain specified level. (Refer to SPECIFICATIONS for oil type.) If oil level is higher than specified, draw out excess oil to obtain correct level.

After establishing correct oil level, reinstall oil fill plug and gasket. Tighten plug to torque value listed in TORQUE CHART Reinstall compressor on engine, if removed.

EVACUATING THE AIR CONDITIONING SYSTEM

Whenever the air conditioning refrigerant system has been opened, it is necessary that the system be completely evacuated of air and moisture before being recharged.

Outlined below is the procedure for evacuating the system using the SE-2443 Portable Service Station.

- 1. Connect SE-2443 Service Station to air conditioning system service ports as follows:
- a. Close all valves on service station (turn fully clockwise).
- b. Connect suction gauge hose to compressor suction service port.
- c. Connect discharge gauge hose to compressor discharge service port.
- d. Connect hose from center fitting on manifold to vacuum pump suction fitting on service station.
- e. Open manifold suction and discharge gauge valves (turn fully counterclockwise).
- Start vacuum pump and SLOWLY open pump blank off valve.
- 3. After suction gauge on manifold shows that vacuum is being established in the system, open vacuum gauge valve on service station and continue to operate vacuum pump for ten (10) minutes.
- 4. Close pump blank off valve and observe electronic vacuum gauge for one (1) minute. The meter should not indicate a rise of more than 5 millimeters of mercury. If gauge rises more than 5 millimeters of mercury in one (1) minute, system has a leak which must be repaired.
- 5. Open pump blank off valve and continue to operate vacuum pump for an additional twenty (20) minutes.

- Then close pump blank off valve and observe electronic vacuum gauge. If meter reading stays below 4 millimeters of mercury for two (2) minutes, system is ready to be charged.
- 6. With vacuum pump still operating, close both manifold gauge valves, pump blank off valve and vacuum meter valve. Turn off vacuum pump.

<u>Do not</u> disconnect manifold gauge hoses from compressor service ports prior to charging the system.

CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE)

In preparation for charging, the air conditioning system must be evacuated of all air and moisture and be completely leak free. (See "Evacuating the Air Conditioning System".)

To charge the system, utilizing the SE-2443 Portable Service Station and SE-2448 Heated Charging Cylinder, proceed as follows:

- Manifold suction and discharge gauge hoses remain connected to compressor service ports from evacuating operation.
- Fill SE-2448 Charging Cylinder with 2.25 kg (5 lbs.) of refrigerant. (Follow equipment manufacturer's instructions.) Make sure all valves on charging cylinder are closed after filling.
- 3. Connect service hose from center manifold fitting to bottom valve on charring cylinder.
- 4. Open bottom valve on charging cylinder and loosen center hose connection at manifold for 10 seconds, or until hose fitting becomes cold, to purge air from hose; then tighten hose connection.
- 5. With the engine shut off, open manifold discharge gauge valve and fill air conditioning system with 2 kg (4.5 lbs.) of refrigerant. (Follow charging cylinder manufacturer's instructions.)
 - <u>DO NOT</u> overcharge the system. Excessively high head pressures during operation will result from overcharging.
- When system is fully charged, close manifold discharge valve and bottom valve on charging cylinder. Slowly loosen hose connection at bottom valve on charging cylinder and allow refrigerant pressure to bleed off; then disconnect hose from valve.

- Pressure test air conditioning system to check performance. (See "Air Conditioning Performance Check".)
- After pressure test is completed disconnect manifold gauge hoses from compressor service ports. Install cap on compressor suction service port. Install cap or fan drive override switch (if equipped) on compressor discharge service port.
- 9. Close hood and cab doors.

ADDING REFRIGERANT TO AIR CONDITIONING SYSTEM

When the air conditioning system is low on refrigerant, it can be refilled using the SE-2443 Portable Service Station and SE-2448 Heated Charging Cylinder as outlined below.

- 1. Raise hood.
- 2. Connect SE-2443 Service Station to air conditioning system service ports as follows:
 - a. Close manifold suction and discharge valves (turn fully clockwise).
 - Remove cap from compressor suction service port. Connect manifold suction gauge hose to compressor suction service port.
 - c. Remove cap or engine fan drive override switch (if equipped) from compressor discharge service port. Connect manifold discharge gauge hose to compressor discharge service port.
- Fill SE-2448 Charging Cylinder with 2.5 kg (5 lbs.) of refrigerant. (Follow equipment manufacturer's instructions.) Make sure all valves on charging cylinder are closed after filling.
- 4. Connect service hose from center manifold fitting to valve on top of charging cylinder.
- 5. Open refrigerant supply valve on top of charging cylinder.
- Loosen service hoses at compressor service ports.
 Open gauge valves and allow refrigerant to escape for 10 seconds to purge air from hoses. Tighten hose connections. Close gauge valves.
- Set air conditioning controls for maximum cooling (A/C lever at "COLD", blower switch on "HIGH").
 Open both cab doors.

- 8. Operate engine at RPM specified in "Engine Speed Chart" under SPECIFICATIONS.
- SLOWLY open suction gauge valve to add refrigerant to system. Do not allow liquid refrigerant to enter compressor. Observe sight glass and add refrigerant until no frothing or bubbles appear in sight glass.

Continue adding refrigerant until .5 kg (1.1 lbs.) has been added to system after sight glass has cleared. Do not overcharge system.

- 10. Close suction gauge valve and close refrigerant supply valve on top of charging cylinder.
- 11. Pressure test air conditioning system. (see "Air Conditioning Performance Check".)
- After pressure test is completed, disconnect manifold gauge hoses from compressor service ports. Install cap on compressor suction service port. Install cap or fan drive override switch (if equipped) on compressor discharge service port.
- 13. Check air conditioning system for refrigerant leaks using an electronic leak detector. Follow equipment manufacturer's instructions.
- 14. Close hood and cab doors.

COMPONENT REMOVAL AND INSTALLATION

IMPORTANT

Certain precautions must be observed when servicing the air conditioning system. (See SAFETY PRECAUTIONS and also "Service Hints" below.)

SERVICE HINTS

Special attention to the following items while performing component removal, installation and service operations will aid in avoiding unnecessary and time consuming problems.

 Note control cable routings during removal and reroute cables carefully in the same path when installing.

Where necessary cables should make gradual, sweeping curves. Sharp directional turns tend to increase resistance to bowden wire movement and sometimes cause kinks which render the cable inoperative.

Make sure control cables are properly adjusted. (See control cable adjustment instructions outlined elsewhere in this section.)

- It is most important that all refrigerant fittings and "O" rings be lubricated with refrigeration oil to allow the connections to seat squarely and to be tightened evenly to the specified torque. It is nearly impossible to attain the correct torque with a dry fitting.
 - <u>Do</u> <u>not</u> attempt to disconnect or reconnect refrigerant fittings with only one wrench. Always use a back-up wrench when loosening or tightening fittings to prevent damage to hoses, lines or components.
 - When tightening refrigerant connections, use only a torque wrench known to be accurate. It should be noted that torque values specified in the "Torque Chart" are for original components with fittings manufactured from specific materials; i.e. brass, aluminum, etc. These torque values may not be correct for substitute components. Use only genuine IH replacement parts.
- 3. Be certain that the evaporator core temperature control sensing bulb is properly inserted into the evaporator core.
- 4. The expansion valve refrigerant temperature sensing tube must be securely attached to the evaporator refrigerant outlet tube. Also, the temperature sensing tube and expansion valve must be tightly wrapped with insulating tape to prevent the ambient temperature from affecting correct sensing of the temperature of the refrigerant leaving the evaporator.
- All refrigerant hose and tubing support clamps and strap locks must be reinstalled in their original positions.
- The freon compressor oil level must be maintained as specified. (See SPECIFICATIONS and "Checking Compressor Oil Level" under SERVICE OPERATIONS.)
- Last but certainly not least is cleanliness. When removing components of the air conditioning system, all openings should be immediately covered or plugged during removal and remain so until reinstallation to prevent the entry of dirt, moisture or other foreign material.
- **BLOWER MOTOR AND FAN**
- Removal:

- 1. Make sure key and blower fan switches are "OFF".
- 2. Remove cover from right side of instrument panel.
- 3. Remove cover from heater/evaporator unit.
- 4. Disconnect blower motor wiring connector and ground wire.
- 5. Disconnect motor cooling air hose from blower housing (where equipped).
- Remove mounting screws and remove motor/fan assembly from blower housing (Fig. 38).
- 7. Remove fan from motor shaft as follows:
 - a. Remove fan lock nut.
 - b. Remove fan from motor shaft.
 - c. Pry metal spacer from motor side of fan.

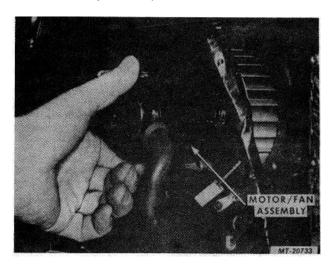


Fig. 38. Blower Motor/Fan Removal Installation:

- 1. Install fan on motor shaft as follows:
 - a. Position metal spacer in shaft hole (motor side) of fan.
 - b. Position fan on motor shaft.
 - c. Install fan lock nut and tighten to 1.4 to 1.7 N.m (12-15 in. lbs.).
- 2. Install motor/fan assembly on blower housing and install mounting screws.
- 3. Connect motor cooling air hose to outlet on blower housing (where equipped).
- Connect blower wiring connector and ground wire.

- Turn key and blower fan switches "ON" and check motor operation. Turn switches "OFF" after operation check.
- Install covers on heater/evaporator unit and instrument panel.

BLOWER RESISTOR

Removal:

- 1. On vehicles equipped with air conditioning:
 - Remove cover from right side of instrument panel.
 - Remove cover from heater/evaporator unit.

Cover removal is not required on vehicles with heater only.

- Disconnect wiring harness connector from resistor.
- 3. Remove resistor mounting screws and remove resistor from blower housing (Fig. 39).

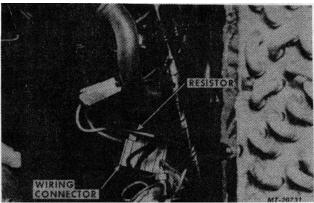


Fig. 39. Blower Resistor Removal

Installation:

- Position resistor in blower housing. Make sure resistor terminal locations correspond with wiring harness terminals. Install mounting screws.
- 2. Connect wiring harness connector to resistor.
- 3. Turn key switch "ON". Operate blower switch and check resistor operation. Turn key switch "OFF" after operation check.

4. Install covers on heater/evaporator unit and instrument panel.

BLOWER SWITCH

Removal:

- 1. Make sure key switch is "OFF".
- 2. Pull knob from blower switch lever (Fig. 40).
- Remove control assembly mounting screws. Remove control assembly trim plate. Pull control assembly outward. (It may be necessary to remove ash tray to allow movement of control assembly.).
- Disconnect wiring harness connector from blower switch.
- 5. Remove blower switch mounting screws and remove switch from control assembly.

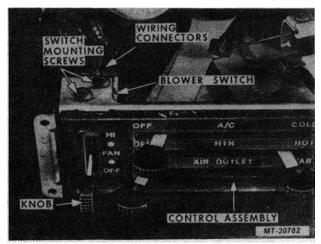


Fig. 40. Blower Switch

Installation:

- Position blower switch on control assembly and install switch mounting screws.
- 2. Connect wiring harness connector to blower switch.
- Position control assembly in instrument panel and install trim plate and mounting screws.
- 4. Push knob onto blower switch lever.
- Turn key switch "ON" and check operation of blower switch. Turn key switch "OFF" after operation test.

COMPRESSOR

IMPORTANT

Compressor removal and installation procedures vary between engine and vehicle models. General instructions are outlined below.

Removal:

- 1. Raise hood and fender assembly.
- 2. Discharge air conditioning system as outlined under SERVICE OPERATIONS.
- 3. Remove drive belt(s).
- 4. Disconnect magnetic clutch feed wire from engine wiring harness.
- Disconnect inlet and outlet hoses from compressor. Cap or tape compressor and hose openings to prevent entry of foreign material.
- 6. Remove bolts securing compressor to mounting bracket(s).
- 7. Remove compressor from mounting bracket.

IMPORTANT

For compressor service instructions, refer to Body and Cabs, Section CTS2577 of the Truck Service Manual.

Installation:

- Check oil level in compressor as outlined under SERVICE OPERATIONS.
- Position compressor on mounting bracket(s) and install mounting bolts. (Do not tighten mounting bolts.)
- 3. Install drive belt(s).
- 4. Check drive belt alignment and tighten compressor mounting bolts.
- Adjust drive belt(s) to specified tension (see SPECIFICATIONS).
- 6. Lubricate fittings with refrigerant oil and connect inlet and outlet hoses to compressor.
- 7. Connect magnetic clutch feed wire to engine wiring harness.

- 8. Evacuate and charge air conditioning system as outlined under SERVICE OPERATIONS.
- 9. Lower hood and fender assembly.

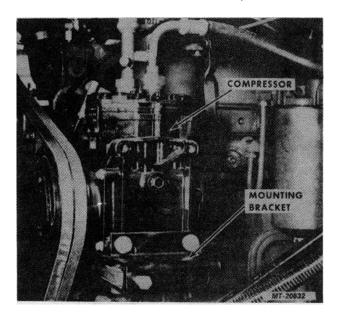


Fig. 41. Compressor Mounting (Typical)

COMPRESSOR MAGNETIC CLUTCH

On most applications the magnetic clutch can be removed for service without discharging the system or removing the compressor from the engine.

- 1. Make sure key switch and A/C lever are "OFF".
- Disconnect clutch feed wire from engine wiring harness.
- 3. Loosen compressor drive belt tension and remove belt(s) from clutch pulley.
 - Inspect drive belt(s) and replace if worn or damaged.
- 4. Using spanner wrench (SE-2392-4) to hold clutch hub, remove clutch retainer bolt (Fig. 42).
- Thread 5/8-11 remover bolt (SE-2392-5) into clutch drive hub. Tighten remover bolt against end of compressor crankshaft to loosen clutch. Remove clutch assembly and drive key from crankshaft.
- Remove mounting bolts and remove field coil assembly (or stationary brush assembly) from compressor body.

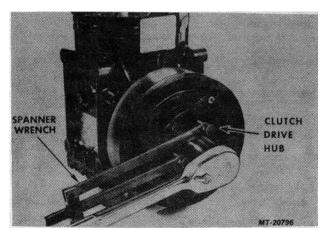


Fig. 42. Removing Magnetic Clutch

IMPORTANT

For clutch service instructions, refer to Body and Cabs, Section CTS-2577 of the Truck Service Manual.

Installation:

- 1. Install field coil assembly (or stationary brush assembly) on compressor body. Tighten mounting bolts finger tight only.
- Position drive key in slot of compressor crankshaft. Position clutch assembly on crankshaft and install clutch retainer bolt.
- 3. Using spanner wrench (SE-2392-4) to hold clutch hub, tighten clutch retainer bolt to specified torque (see Bolt Torque Chart).
- 4. Rotate pulley by hand and check for interference between pulley and field coil assembly (or stationary brush assembly). Interference is indicated by a rubbing noise heard when pulley rotates. If necessary, adjust position of field coil (or stationary brush assembly) to avoid interference. Tighten mounting bolts.
- 5. Install compressor drive belt(s).
- Check pulley alignment and adjust drive belt(s) to specified belt tension (see SPECIFICATIONS).
- 7. Connect clutch feed wire to engine wiring harness.
- 8. Operate engine and check magnetic clutch operation.

CONDENSER

Removal:

- 1. Remove radiator grille.
- 2. Raise hood and fender assembly.
- 3. Discharge air conditioning system as outlined under SERVICE OPERATIONS.
- Disconnect inlet and outlet hoses from condenser. Install caps or tape on hose and condenser openings to prevent entry of foreign material.
- 5. Remove condenser mounting bolts (Fig. 43) and remove condenser from radiator support.

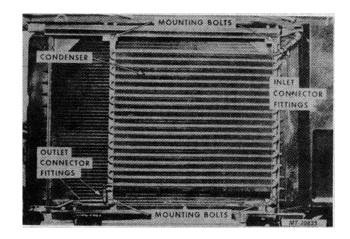


Fig. 43. Condenser Mounting (Typical) Installation:

- 1. Position condenser on radiator support and install mounting bolts.
- 2. Remove caps or tape from condenser and refrigerant hose openings.
- 3. Lubricate hose fittings with refrigerant oil and connect refrigerant hoses to condenser.
- 4. Replace filter-dehydrator.
- 5. Evacuate and charge air conditioning system as outlined under SERVICE OPERATIONS.
- 6. Lower hood and fender assembly.
- 7. Reinstall radiator grille.

CONTROL ASSEMBLY

Removal:

1. Make sure key switch is "OFF".

- Remove control assembly mounting screws. Remove control assembly trim plate. Pull control assembly outward (Fig. 44). It may be necessary to remove ash tray to allow movement of control assembly.
- Disconnect wiring harness connector from blower switch.
- 4. Disconnect instrument panel lamp socket from control assembly as follows:
 - a. Rotate lamp socket clockwise (as viewed from rear of vehicle).
 - b. Pull lamp socket (with bulb) from control assembly.
- Remove control cable to control lever retaining clips. Remove control cable mounting screws and disconnect control cables from control levers.
- 6. Remove control assembly.

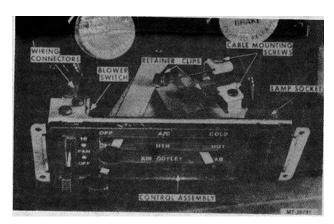


Fig. 44. Removing Control Assembly

Installation:

- 1. Connect control cables to control assembly levers as follows:
 - a. Cable with red mounting tab to upper (A/C) lever.
 - b. Cable with white mounting tab to center (HTR) lever.
 - c. Cable with black mounting tab to lower (AIR OUTLET) lever.

Install control cable mounting screws and cable retaining clips.

2. Connect instrument panel lamp socket to control assembly.

- Connect wiring harness connector to blower switch.
- 4. Position control assembly in instrument panel and install trim plate and mounting screws.
- Check operation and adjustment of control cables as outlined under "Control Cable Adjustment".

CONTROL CABLE REPLACEMENT

Removal:

- 1. Disconnect battery cable from battery.
- 2. Remove cover from right side of instrument panel.
- 3. Remove cover from heater/evaporator unit.
- 4. Remove control assembly mounting screws. Remove control assembly trim plate. Pull control assembly outward. (It may be necessary to remove ash tray to allow movement of control assembly.) 5. Remove control cable-to-control lever retaining clips. Remove control cable mounting screws and disconnect cable(s) from control lever(s)(Fig. 44) cables can be identified by the colored cable mounting tabs:

Air Conditioning (A/C) Cable Red Tab Heater (HTR) Cable White Tab Air Control Cable Black Tab

6. Disconnect opposite end of cable(s) as follows:

Air Conditioning (A/C) Cable

- a. Remove cable mounting screw from thermostatic control switch bracket (Fig. 45).
- b. Remove thermostatic control switch mounting switch from bracket.
- c. Remove retainer clip and disconnect cable from switch lever.

Heater (HTR) Cable

- a. Remove control cable mounting screw from cable mounting bracket (Fig. 45).
- b. Disconnect cable from blend air door.
- c. Withdraw end of cable through hole in heater/evaporator unit housing.

Air Control Cable

- a. Remove control cable mounting screw from mounting bracket (Fig. 45).
- b. Remove retainer clip and disconnect cable from defrost door crank.
- 7. Note cable routing and withdraw cable(s) from under instrument panel.

Installation:

- 1. Route cable(s) under instrument panel.
- Connect cable(s) to control lever(s) of control assembly and install retainer clip(s).
 - Install cable(s) with longest end from adjuster toward control assembly.
 - Follow cable color code listed above, under Step 5 of Removal Procedure.
- 3. Install cable mounting screw(s).
- 4. Position control assembly in instrument panel and install trim plate and mounting screws.
- Connect opposite end of cable(s) as follows: (Follow color code.) Air Conditioning (A/C) Cable a. Connect cable to switch lever and install retainer clip.

- Position switch on bracket and install mounting screws.
- c. Position cable mounting tab on switch bracket and install mounting screw.

Heater (HTR) Cable

- a. Insert cable through hole in heater/ evaporator unit housing.
- b. Connect cable to blend air door.
- Position cable mounting tab on cable mounting bracket and install mounting screw.
- d. Seal cable hole in heater/evaporator unit housing with body sealer after adjusting cable, Step 6.

Air Control Cable

- a. Connect cable to defrost door crank and install retainer clip.
- b. Position cable mounting tab on mounting bracket and install mounting screw.

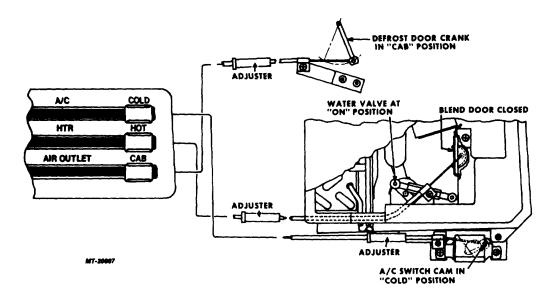


Fig. 45. Control Cable Adjustment Positions

- 6. Adjust control cable(s) as outlined under "Control Cable Adjustment".
- 7. Install covers on heater/evaporator unit and instrument panel.
- 8. Connect battery cable to battery.

CONTROL CABLE ADJUSTMENT (Refer to Figure 45)

- 1. Remove cover from right side of instrument panel.
- 2. Remove cover from heater/evaporator unit.
- 3. Set control panel assembly levers to the extreme right:
 - a. A/C lever at "COLD".
 - b. HTR lever at "HOT" and in detent.
 - c. AIR OUTLET lever at "CAB" and in detent.

IMPORTANT

These lever positions must be maintained during adjustment.

- 4. Rotate cable adjusters (expand cables) to obtain mid-travel position of:
 - a. Thermostatic temperature control switch.
 - b. Blend air door.
 - c. Defrost door crank.
- Rotate cable adjusters (shorten cables) as needed to obtain the following settings with cables free from binding:
 - a. Thermostatic temperature control switch at "COLD" position.
 - b. Blend air door closed about 20 percent compression of door seal and hot water flow control valve in "ON" position.
 - c. Defrost door crank at "CAB" position.
- Operate control panel levers several times and check to assure that proper adjustment is maintained.
 - If necessary, repeat Steps 3, 4 and 5 to obtain proper adjustment.
- 7. Install covers on heater/evaporator unit and instrument panel.

Removal:

- 1. Raise hood and fender assembly.
- Discharge air conditioning system as outlined under SERVICE OPERATIONS.
- 3. Remove cover from right side of instrument panel.
- 4. Remove cover from heater/evaporator unit.
- 5. Remove dash panel seal retainers and seals surrounding evaporator unit inlet and outlet tubes (Fig. 46).
- 6. Disconnect inlet and outlet hoses from evaporator unit inlet and outlet tubes (Fig. 46).

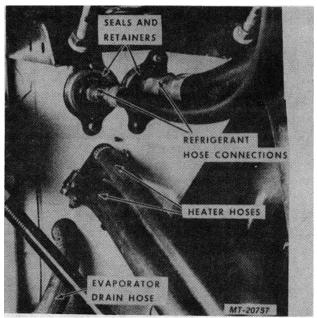


Fig. 46. Evaporator Dash Panel Connections

- 7. Disconnect low pressure switch wires from wiring harness.
- 8. Remove bolt and nut from clamp securing expansion valve to bracket on blower housing.
- 9. Remove air filter seal mounting strip and air filter from blower housing (Fig. 34).
- Remove heater core mounting screws. (Do not disconnect hoses from heater core.) Pull heater core outward to disengage mounting slot. Move heater core down and to the right.

EVAPORATOR CORE

This will permit access to front evaporator core mounting screws and permit withdrawal of thermostatic temperature control switch capillary tube from evaporator core.)(See Figure 57.)

- 11. Withdraw thermostatic temperature control switch capillary tube from evaporator core.
- 12. Remove evaporator core mounting screws (Fig. 47).
- Remove evaporator core from unit housing (Fig. 48).
- 14. Remove low pressure switch and expansion valve from evaporator core.

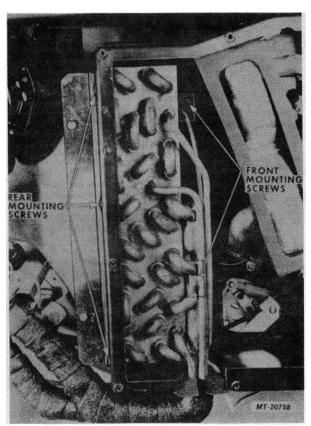


Fig. 47. Evaporator Core Mounting Screws

Installation:

 Install expansion valve and low pressure switch on evaporator core. (Refer to "Expansion Valve" and "Low Pressure Switch".)

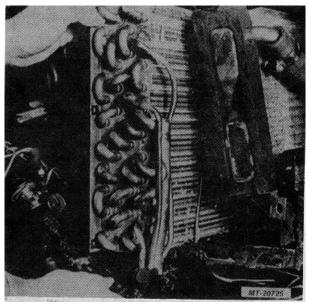


Fig. 48. Removing Evaporator Core

- Position evaporator core in unit housing.
 Replace seal surrounding evaporator inlet and outlet pipes in bottom of unit housing if damaged.
- 3. Install evaporator core mounting screws.
- 4. Position thermostatic temperature control switch capillary tube in evaporator core. (Refer to "Thermostatic Temperature Control Switch".)
- 5. Install heater core as follows:
 - Make sure gaskets are on ends of heater core.
 - b. Align slot in heater core fume with rivet at front of housing and push core into position.
 - c. Install heater core mounting screws.
- 6. Install air filter and seal mounting strip on blower housing.
- 7. Install clamp, bolt and nut to secure expansion valve to bracket on blower housing.
- 8. Connect low pressure switch wires to wiring harness
- Lubricate threads with refrigerant oil and connect inlet and outlet hoses to evaporator unit inlet and outlet tubes.

- 10. Install dash panel seals and retainers surrounding evaporator inlet and outlet tubes.
- 11. Evacuate and charge air conditioning system as outlined under SERVICE OPERATIONS.
- 12. Install covers on heater/evaporator unit and instrument panel.
- 13. Lower hood and fender assembly.

EXPANSION VALVE

Removal:

- 1. Make sure key switch is "OFF".
- 2. Raise hood and fender assembly.
- Discharge air conditioning system as outlined under SERVICE OPERATIONS.
- 4. Remove cover from right side of instrument panel.
- 5. Remove cover from heater/evaporator unit.
- 6. Disconnect wiring harness connector from blower resistor located on bottom of blower housing.
- 7. Remove insulated tape from expansion valve and evaporator inlet and outlet tubes.
- Disconnect expansion valve equalizer line from fitting on evaporator outlet tube (Fig. 49)
- 9. Remove screw and clamp securing expansion valve feeler bulb to evaporator outlet tube.
- 10. Disconnect expansion valve inlet tube from expansion valve.
- 11. Remove bolt, nut and clamp securing expansion valve to bracket on blower housing.
- 12. Using two wrenches, disconnect expansion valve from evaporator core inlet tube. Remove expansion valve.

Installation:

- 1. Lubricate threads with refrigerant oil and connect expansion valve to evaporator core inlet tube. Tighten fitting using two wrenches.
- 2. Install clamp, bolt and nut securing expansion valve to bracket on blower housing.
- Lubricate threads with refrigerant oil and connect expansion valve inlet tube to expansion valve. Tighten nut to 11-14 N.m (15-20 ft.lbs.).

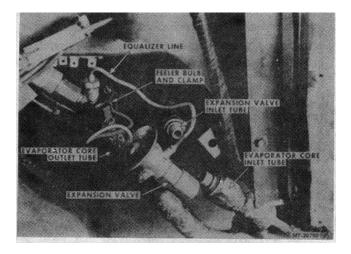


Fig. 49. Removing Expansion Valve

- Position expansion valve feeler bulb on evaporator core outlet tube and secure with clamp and screw.
- Lubricate threads with refrigerant oil and connect expansion valve equalizer line to fitting in evaporator outlet tube. Using two wrenches tighten fittings to 7-11 N.m (10-15 ft. lbs.) torque.
- 6. Wrap expansion valve and evaporator inlet and outlet tubes with insulated tape.
- Connect wiring harness connector to blower resistor.
- 8. Evacuate and charge air conditioning system as outlined under SERVICE OPERATIONS.
- 9. Install covers on heater/evaporator unit and instrument panel.
- 10. Lower hood and fender assembly.

FAN DRIVE OVERRIDE SWITCH

The fan drive override switch can be replaced without discharging the refrigerant from the air conditioning system. A spring-loaded valve in the compressor discharge service port prevents loss of refrigerant when switch is removed.

- 1. Raise hood and fender assembly.
- 2. Make sure key switch is "OFF".
- 3. Disconnect fan drive override switch wires from engine wiring harness.

4. Using two wrenches, remove fan drive override switch from compressor discharge service port.

CAUTION

A small amount of refrigerant may escape from service port valve while switch is being removed.

Installation:

- Lubricate threads of fan drive override switch and position switch on compressor discharge service port.
- 2. Using two wrenches, tighten fan drive override switch.
- 3. Connect switch wires to engine wiring harness.
- 4. Lower hood and fender assembly.

FAN DRIVE OR SHUTTER CONTROL SOLENOID VALVE

Removal:

- 1. Make sure key switch is "OFF".
- 2. Raise hood and fender assembly.
- 3. Bleed pressure from vehicle's air system.
- 4. Disconnect solenoid feed wire from solenoid valve
- 5. Disconnect air hoses from solenoid valve.
- 6. Remove mounting screws and remove solenoid valve from mounting bracket.
- 7. Remove air pipe fittings from solenoid valve.

Installation:

- 1. Install air pipe fittings in solenoid valve.
- 2. Position solenoid valve on mounting bracket and install mounting screws.
- Connect air hoses to solenoid valve.
- 4. Connect feed wire to solenoid valve.
- 5. Lower hood and fender assembly.

FILTER-DEHYDRATOR

IMPORTANT

Filter-dehydrator should be replaced whenever air conditioning system is opened to service components.

System must be discharged before removing filter-dehydrator.

Removal:

- 1. Disconnect inlet and outlet hoses from filter dehydrator. Cap or tape hoses openings to prevent entry of foreign material.
- 2. Loosen U-bolt and remove filter-dehydrator from mounting bracket (Fig. 50).

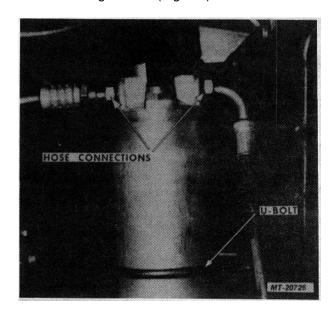


Fig. 50. Filter-Dehydrator Mounting

Installation:

- Position filter-dehydrator in mounting bracket.
 Make sure inlet and outlet openings index and align with their corresponding hoses.
- Tighten mounting U-bolt to 15-18 N.m (11-14 ft.lbs.).
- Remove plug from inlet opening of filterdehydrator. Remove cap or tape from inlet hose. Lubricate threads with refrigerant oil and connect inlet hose to filter-dehydrator.

 Remove plug from outlet opening of filter dehydrator. Remove cap or tape from outlet hose. Lubricate threads with refrigerant oil and connect outlet hose to filter-dehydrator.

IMPORTANT

To avoid contamination, do not uncover filter-dehydrator openings longer than necessary to make connections.

Evacuate and charge air conditioning system as outlined under SERVICE OPERATIONS.

HEATER CORE

Removal:

- 1. Raise hood and fender assembly.
- 2. Drain engine cooling system.
- 3. Remove cover from right side of instrument panel.
- 4. Remove cover from heater/evaporator unit.
- 5. Loosen hose clamps at heater core.
- 6. Open blend air door.
- Remove heater core mounting screws (Fig. 51)
- 8. Disconnect hoses from heater core and pull core outward (toward rear of vehicle) to remove.
- 9. Remove gaskets from ends of heater core.
- 10. Inspect hoses and gaskets and replace if damaged or deteriorated.

Installation:

- 1. Position gaskets on ends of heater core.
- 2. Open blend air door.
- 3. Position heater core into housing. Align slot in heater core frame with rivet at front of housing and push heater core into position.
- 4. Install heater core mounting screws.
- 5. Connect hoses to heater core and tighten hose clamps.
- 6. Refill engine cooling system.

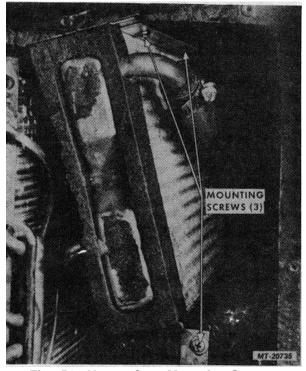


Fig. 51. Heater Core Mounting Screws

- Set heater (HTR) control lever at "HOT".
 Operate engine. Check for coolant leaks and coolant flow through heater core.
- 8. Install covers on heater/evaporator unit and instrument panel.
- 9. Lower hood and fender assembly.

HIGH SPEED AND LOW PRESSURE SWITCH RELAYS

Relays are mounted on defroster duct and are located in front of instrument panel and above blower motor.

- 1. Disconnect battery cable.
- 2. Remove cover from right side of instrument panel.
- If relays are accessible, proceed to Step 4.
 If relays cannot be reached, remove radio/ ash tray panel, as follows, to gain access to relays.
 - a. Remove radio/ash tray panel mounting screws and pull panel outward.

- Disconnect radio power feed wire, speaker leads and antenna lead from radio.
- If necessary, disconnect hourmeter, front wheel drive warning light, engine oil temperature gauge and transmission oil temperature gauge wiring.
- d. Disconnect ash tray light from ash tray frame.
- e. Remove radio/ash tray panel.
- 4. Using offset screwdriver or screwdriver socket, remove relay mounting screws and remove relay(s) from air duct (Fig. 52).
- 5. Disconnect wiring harness connectors from relay(s).



Fig. 52. Removing Relay

Installation:

- 1. Connect wiring harness connectors to relay (s).
- Position relay(s) on air duct and install mounting screws. Use offset screwdriver or screwdriver socket to tighten screws.
- 3. Reinstall radio/ash tray panel and related parts (if removed).
 - 4. Reconnect battery cables.
 - Turn key switch "ON" and check operation of relay(s). Turn key switch "OFF" after operation check.

6. Install instrument panel cover.

HOT WATER FLOW CONTROL VALVE

- 1. Raise hood and fender assembly.
- 2. Drain engine cooling system.
- 3. Remove cover from right side of instrument panel.
- 4. Remove cover from heater/evaporator unit.
- 5. Remove heater core as follows:
 - a. Loosen hose clamps at heater core.
 - b. Open blend air door.
 - c. Remove heater core mounting screws.
 - d. Disconnect hoses from heater core and pull core outward to remove.
- Remove control cable mounting screw from mounting bracket (Fig. 53). Disconnect control cable from blend air door.

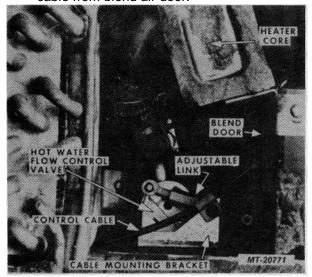


Fig. 53. Hot Water Flow Control Valve Connection Details

- Loosen hose clamp and disconnect inlet hose (located beneath heater/evaporator unit housing) from neck of flow control valve
- 8. Remove flow control valve mounting screws. (Screw heads are located on bottom of heater/ evaporator unit housing.)

- 9. Remove control cable mounting bracket.
- Disconnect adjustable link from blend air door.
- 11. Rotate control valve assembly as necessary to withdraw lower neck of valve through grommet in bottom of heater/evaporator unit housing. Remove valve (Fig. 54).

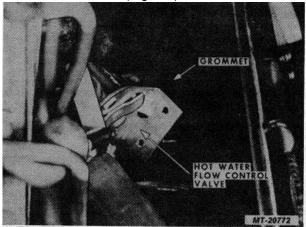


Fig. 54. Removing Hot Water Flow Control Valve from Unit Housing

- 12. Disconnect hose clamp and remove valve-to heater core hose from valve.
- Inspect all hoses and control valve inlet neck grommet in bottom of unit housing. Replace if damaged or deteriorated.

Installation:

- 1. Position control valve-to-heater cover hose on valve and tighten hose clamp.
- Insert lower neck of flow control valve through grommet in bottom of heater/evaporator unit housing and rotate valve assembly into position.
- 3. Connect adjustable link to blend air door.
- 4. Position flange of control cable mounting bracket under mounting flange of control valve.
- 5. Install and tighten valve mounting screws.

- Connect inlet hose to lower neck of flow control valve and tighten hose clamp.
- 7. Install heater core as follows:
 - Make sure gaskets are in position on ends of heater core.
 - b. Open blend air door.
 - c. Position heater core into housing. Align slot in heater core frame with rivet at front of housing and push core into position.
 - d. Install heater core mounting screws.
 - e. Connect hoses to heater core and tighten hose clamps.
- 8. Connect control cable to blend air door and install cable mounting screw.
- 9. Adjust control cable as outlined under "Control Cable Adjustment".
- 10. Refill engine cooling system.
- 11. Set heater (HTR) control at "HOT". Operate engine and check for coolant leaks and for proper operation of flow control valve.
- 12. Install covers on heater/evaporator unit and instrument panel.
- 13. Lower hood and fender assembly.

LOW PRESSURE SWITCH

The low pressure switch can be replaced without discharging the refrigerant from the air conditioning system. A spring-loaded valve in the switch mounting adapter on the evaporator outlet pipe prevents loss of refrigerant when switch is removed.

- 1. Make sure key switch is "OFF".
- 2. Remove cover from right side of instrument panel.
- 3. Remove cover from heater/evaporator unit.
- 4. Disconnect low pressure switch wires from wiring harness.
- 5. Using two wrenches, remove low pressure switch from adapter on evaporator outlet pipe (Fig. 55).

CAUTION

A small amount of refrigerant may escape from adapter while low pressure switch is being removed.

Installation:

- 1. Lubricate threads of low pressure switch with refrigerant oil and position switch on adapter.
- 2. Using two wrenches, tighten low pressure switch.
- 3. Connect low pressure switch wires to wiring harness.
- 4. Install covers on heater/evaporator unit and instrument panel.

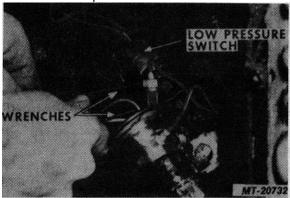


Fig. 55. Removing Low Pressure Switch
THERMOSTATIC TEMPERATURE CONTROL
SWITCH

Removal:

- 1. Make sure key switch and A/C lever are "OFF".
- 2. Remove cover from right side of instrument panel.
- 3. Remove cover from heater/evaporator unit.
- 4. Disconnect wiring connectors (3) from thermostatic control switch.

IMPORTANT

Before disconnecting wires, note circuit number locations to assure correct reassembly.

- 5. Remove control cable mounting screw (Fig. 56).
- 6. Remove thermostatic control switch mounting screws and remove switch from bracket (Fig. 56).

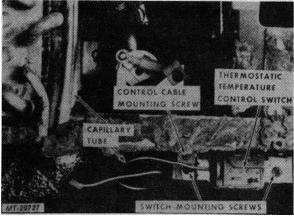


Fig. 56. Thermostatic Control Switch Mounting
Details

- 7. Remove retainer clip and disconnect control cable from switch lever.
- 8. Remove heater core mounting screws. (Do not disconnect hoses from heater core.) Pull heater core outward to disengage mounting slot. Move heater core down and to the right. (This will permit withdrawal of thermostatic control switch capillary tube from evaporator core.
- 9. Withdraw thermostatic control switch capillary tube from evaporator core (Fig. 57).

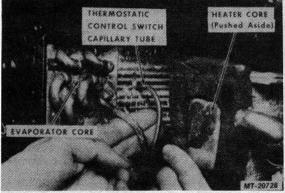


Fig. 57. Withdrawing Thermostatic Control Switch Capillary Tube from Evaporator Core

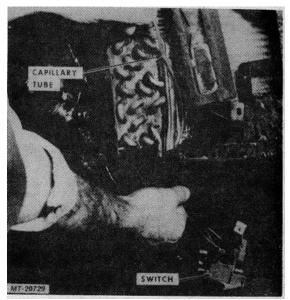


Fig. 58. Withdrawing Thermostatic Control Switch Capillary Tube from Housing

Installation:

- 1. Insert thermostatic temperature control switch capillary tube through hole in seal at bottom of heater/evaporator unit housing.
- Insert end of capillary tube into evaporator core at location shown in Figure 59. (Remove air filter seal strip and air filter to check position of end of capillary tube.)
 Connect control cable to switch lever and install retainer clip.
- 4. Position switch on bracket and install switch mounting screws.
- 5. Position cable mounting ta on switch bracket and install mounting screw.
- 6. Check control cable adjustment as outlined under "Control Cable Adjustment".
- 7. Install heater core as follows:
 - Make sure gaskets are in place on ends of heater core.
 - b. Align slot in heater core frame with rivet at front of housing and push core into position.
 - c. Install heater core mounting screws.

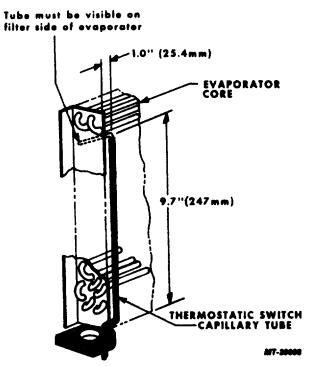


Fig. 59. Capillary Tube Location in Evaporator

8. Connect wiring connectors to thermostatic control switch. Make sure connectors are located properly (Fig. 60).

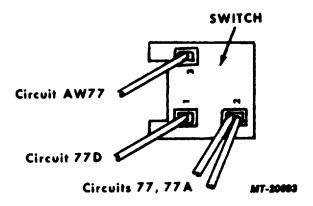


Fig. 60. Thermostatic Control Switch Wiring Connector Locations

- 9. Check operation of thermostatic control switch.
- 10. Install covers on heater/evaporator unit and instrument panel.

COMPONENT PROBLEM ANALYSIS

COMPRESSOR

Some possible failings of the compressor include:

- Leaking Front Seal This allows refrigerant and lubricating oil to escape from system in loss of cooling and damage to compressor.
- Bearing Failure Usually the result of material wear but can result from excessive drive belt tension or pulley misalignment.
- Burned-Up Compressor Caused by lack of lubricating oil. This emphasizes the need for checking the oil level in the compressor at the time of system service.

In the event that compressor failure is severe enough to form metal particles, purge compressor discharge-to-filter dehydrator lines with 4.5 kg (1 lb.) of refrigerant and replace the filter-dehydrator.

For compressor service procedures, refer to Bodies and Cabs, Section CTS-2577 of the Truck Service Manual

MAGNETIC CLUTCH

The two most common clutch failures are:

- 1. Burned-Out Facings.
- 2. Broken Torque Springs.

Both of these failings are usually symptomatic of troubles somewhere else in the system. (Example: A restriction in the condenser will cause excessive head pressures, which in turn will overwork the compressor and clutch, eventually causing failure of one or both.)

For clutch service procedures, refer to Bodies and Cabs, Section CTS-2577 of the Truck Service Manual.

THERMOSTATIC TEMPERATURE CONTROL SWITCH

The thermostatic temperature control switch is relatively trouble free; however, should it fail, it must be replaced. If the clutch remains engaged continually, check the sensing tube of the control switch to see that it has not been pulled out of the evaporator core. The sensing tube should be located in the evaporator core as shown in Figure 59.

Also, make sure air conditioning (A/C) control cable is properly adjusted.

CONDENSER

Possible problems with the condenser include:

- 1. A leak in the condenser.
- A stoppage or restriction of refrigerant flow through the condenser. This could result from some foreign material inside the core or by a sharp bend or dent in the condenser tubing or in the hoses leading into or out of the condenser.
 (Make a visual check to make sure this has not
 - (Make a visual check to make sure this has not occurred.)
- 3. A restriction of air flow through the condenser. This is the most common problem and results from dirt, leaves, etc. collecting on the front area. A stoppage or restriction of refrigerant flow or air flow through the condenser will be indicated by a high discharge pressure reading on the test gauge.

Restriction of refrigerant flow will show a lower than normal suction pressure on the test gauge. Restricted air flow will build high discharge and suction pressures.

In some instances tubing may be replaced or leaks may be repaired by silver soldering if the spot is accessible, however, a stopped-up or internally restricted core must be replaced.

CAUTION

Never weld, solder, steam clean or use any excessive amount of heat on any of the refrigerant lines or components of the refrigeration system while the system is charged. Heat applied to any part would cause the pressure of the refrigerant within the closed system to become excessive.

EXPANSION VALVE

Possible problems at the expansion valve include:

- 1. Stoppage Stoppage in the system tends to occur at the valve or at the filter-dehydrator tank.
- 2. Valve Sticking The valve tends to stick closed cutting off the refrigerant supply to the evaporator and stopping all cooling from the air conditioner.



- 3. Ruptured Sensing Bulb If the sensing tube ruptures, the valve will remain closed.
- 4. Sensing Bulb Loose If the sensing bulb works loose from its proper location on the evaporator output line, the valve will remain open and flood the evaporator with refrigerant.

If it is determined that the valve is faulty, it must be replaced with another valve of exactly the same capacity and type. It requires no adjustment.

EVAPORATOR CORE

This unit is very similar to the condenser, both in type of construction and in its trouble-free operating characteristics. When checking this component, make sure that:

The air flow through the core is in no way obstructed by dirt, etc. clogging the fins of the core.

The sensing tube of the thermostatic control switch is in its proper place inside the evaporator core.

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TROUBLE SHOOTING GUIDE

Outlined below are possible causes of problems most frequently experienced with the heating/air conditioning system.

When analyzing air conditioning operational problems, it is required that the manifold gauge set be connected to the compressor service ports and that the system be operated for a sufficient period to normalize (e.g. to have removed the initial heat from the cab and settled to an average flow rate and pressure). See Performance Checks under SERVICE OPERATIONS.

Problem	Possible Cause
No Heat.	 Kinked or obstructed heater hoses. Faulty blower motor, resistor assembly or switch. Plugged or defective heater core. Faulty water flow control valve. Faulty control assembly or cables.
Insufficient Heat.	 Kinked or obstructed heater hoses. Faulty blower motor, resistor assembly or switch. Faulty water flow control valve. Obstructed heater core. Faulty control assembly or cables. Poor sealing around vent door, blend door or other cab areas.
Too Much Heat (Heater won't regulate).	 Blend door cable disengaged or misadjusted. Faulty water control valve.
All Air Flow Coming from Defroster Outlets.	 Faulty control assembly. Control cable defective or disengaged from defrost door.
No Cooling.	 Loss of Refrigerant. Broken or slipping compressor drive belt. Inoperative Compressor Clutch. Frozen or faulty expansion valve. Faulty thermostat control. Faulty compressor. Broken refrigerant line.
Insufficient Cooling.	 Low refrigerant charge. Clogged air filter. Obstructed air passages. Slipping compressor drive belt. Inoperative or faulty blower or switch. Faulty thermostatic control switch. Faulty expansion valve. Faulty compressor.



TROUBLE SHOOTING GUIDE (Continued)

Problem	Possible Cause
Compressor Noise and Vibration.	 Worn, loose or misaligned compressor drive belt. Loose compressor clutch. Foreign material or damaged parts in compressor. Damaged clutch. Loose or broken mounting bracket. Excessive refrigerant charge. Compressor oil level below minimum.
Engine Overheating.	 Low radiator coolant level. Clogged engine cooling system. Debris-laden condenser and radiator. Inadequate engine cooling system. Excessive refrigerant charge. Broken or slipping fan belt. Faulty engine thermostat. Radiator shutters stuck shut. Faulty water pump. Collapsing or obstructed radiator hoses. Faulty fan drive system.
Excessive Compressor Drive Belt Wear.	 Incorrect belt tension. Incorrect belt alignment. Slippage due to excessive refrigerant charge. Cord fracture due to forcing belt into place. Broken or nicked pulley. Excessive oil on belt.
Compressor Clutch Inoperative.	 Blown fuse. Loose connection or broken wire. Faulty field coil. Faulty thermostatic control switch. Broken drive belt.
Clutch Slippage	 Excessive head pressure. Loose pulley. Oily drive belt. Worn drive belt.
Unit Blower Motor Inoperative or Operate Slow.	 Blown fuse. Loose connection. Broken wire. Defective switch. Faulty resistor. Motor shaft bound.



TROUBLE SHOOTING GUIDE (Continued)

Problem	Possible Cause
High Head Pressures. (Discharge Side)	 Excessive refrigerant charge. Air in system. Engine overheated. Condenser air flow restricted. Flooded evaporator (indicated by heavy frosting of suction line). Kinked lines. Defective fan drive or fan drive switch.
Low Head Pressure (Discharge Side)	 Insufficient refrigerant charge. Defective compressor valves.
High Suction Pressure (Suction Side)	 Expansion valve sensing tube not tightly secured to evaporator discharge line (compressor suction line). Leaking or broken compressor valves. Compressor drive belt slipping. Magnetic clutch slipping. Expansion valve not closing. Faulty expansion valve.
Low Suction Pressure (Suction Side)	 Insufficient refrigerant. Restriction at filter-dehydrator or in lines. Expansion valve feeler bulb charge low. Expansion valve capillary tube broken or charge lost. Expansion valve blocked. Moisture freezing in expansion valve. Expansion valve sticking. Moisture-saturated filter-dehydrator unit.
Automatic System Shutdown.	 Defective low pressure switch. Low refrigerant charge. Excessive discharge pressure. Ambient temperature too low. Blown fuse.

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SPECIFICATIONS

Refrigerant Type R- 12

Refrigerant Quantity (Full Charge) 2 kg. (4.5 lbs.)

Compressor Oil Type Texaco "Capella E, Dual Inhibited"

or Equivalent

Compressor Oil Level 25.4 mm Min. to 34.9 mm Max.

(Vertical Mounting) (1" Min. to 1 3/8" Max.)

Compressor Oil Quantity (After Rebuild 340 g (12 oz.)

Compressor Drive Belt Tension:

Initial Tension (New Belt) 445 N (100 lbs.) Normal Tension (Used Belt) 311 N (70 lbs.)

Low Pressure Switch:

Opens at 14-69 kPa (2-10 psi) Closes at 179-234 kPa (26-34 psi)

Fan Drive Override Switch:

Opens at 1379-1517 kPa (200-220 psi) Closes at 999-2137 kPa (290-310 psi)

ENGINE SPEED CHART

(For Air Conditioning System Pressure Test)

Engine Model	RPM		
	Direct Drive	Fan Drive	
VS	2300		
DT-466	1750		
V-800	1800	1750	
6-71	1850		
8V-71, 6V92TT	2000		
NYC	2100		
3208	2100		
3406	2000	1750	

SPECIFICATIONS (Continued)

OPERATING PRESSURE TEST CHART

A properly charged and functioning air conditioning system should indicate the readings shown below with the engine operating at the speed shown in ENGINE SPEED CHART, blower on "HIGH" speed, control lever on "COLD" and both cab doors open.

RELATIVE HUMIDITY BELOW 30%

	nbient erature (F)	Average Compressor Refrigerant Pressures			Passenger Inboard Outlet Air Temperature	
		HEAD	SUC	CTION	С	(F)
20 25 30 35 40	(68)* (77)* (86) (95) (104)	880-1080 kPa (125-155 psi) 1130-1330 kPa (160-190 psi) 1380-1580 kPa (200-230 psi) 1630-1830 kPa (235-265 psi) 1790-1890 kPa (260-290 psi)	61-89 kPa 67-95 kPa 76-104 kPa 104-132 kPa 134-162 kPa	(9-13 psi) (10-14 psi) (11-15 psi) (15-19 psi) (19-23 psi)	5-6 5-6 5-6 7-9 10-13	(41-43) (41-43) (41-43) (45-48) (50-55)

RELATIVE HUMIDITY ABOVE 30%

	mbient perature (F)		Average Compressor Refrigerant Pressures			Passenger Inboard Outlet Air Temperature	
		HEA	D	SUC	CTION	С	(F)
20 25	(68)* (77)*	1115-1315 kPa 1360-1560 kPa	(160-190 psi) (195-225 psi)	84-112 kPa 108-136 kPa	(12-16 psi) (16-20 psi)	5-6 7-9	(41-43) (45-48)
30	(86)	1600-1800 kPa	(230-260 psi)	132-160 kPa	(19-23 psi)	11-13	(52-55)
35	(95)	1850-2050 kPa	(270-300 psi)	178-206 kPa	(26-30 psi)	14-17	(57-63)
40	(104)	2090-2290 kPa	(300-330 psi)	236-264 kPa	(34-38 psi)	18-21	(64-70)

^{*} System may cycle at these ambient temperatures. Test readings listed are those that will occur just prior to compressor cycling off

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TORQUE CHART

IMPORTANT

All refrigerant fittings must be lubricated with refrigerant oil prior to tightening. <u>Do not</u> exceed specified torque. Use two wrenches where applicable.

	THREAD		
LOCATION	SIZE	TORQL	JE
Condenser Inlet	3/4-16	30-35 N.m	22-26 ft.lbs.
Condenser Outlet	5/8-18	20-26 N.m	15-19 ft.lbs.
Filter-Dehydrator Inlet	11/16-16	15-20 N.m	11-15 ft.lbs.
Filter-Dehydrator Outlet	5/8-18	15-20 N.m	11-15 ft.lbs.
Compressor Suction Line	1-14	54-60 N.m	40-44 ft.lbs.
Compressor Discharge Line	1-14	54-60 N.m	40-44 ft.lbs.
Fan Drive Override Switch	7/16-20	9-15 N.m	7-11 ft.lbs.
Refrigerant Supply Line to Heater-A/C			
(Evaporator) Unit	5/8-18	20-26 N.m	15-19 ft.lbs.
Refrigerant Return Line from Heater-A/C			
(Evaporator) Unit	1 1/16-14	89-95 N.m	66-70 ft.lbs.
Expansion Valve Inlet	5/8-18	20-27 N.m	15-20 ft.lbs.
Expansion Valve Outlet	3/4-16	20-27 N.m	15-20 ft.lbs.
Expansion Valve Equalizer Line	7/16-24	14-20 N.m	10-15 ft.lbs.
Low Pressure Switch	7/16-20	9.5-20 N.m	7-15 ft.lbs.
Heater-Evaporator-Blower Unit Mounting Nuts	1/4-20	8-11 N.m	6-8 ft.lbs.
Condenser Mounting Bolts	5/16-18	15-19 N.m	11-14 ft.lbs.
Filter-Dehydrator Mounting Clamp	5/16-18	15-19 N.m	11-14 ft.lbs.
Clutch Retainer Bolt	5/16-24	20-27 N.m	15-20 ft.lbs.
Compressor Oil Level Plug		5-15 N.m	4-11 ft.lbs.
Compressor-to-Mounting Bracket Bolts:			
w/CAT 3208 Engine	3/8-16	24-27 N.m	18-20 ft.lbs.
All Other Engines	3/8-16	26-31 N.m	19-23 ft.lbs.
Compressor Mounting Bracket-to-Engine			
Bolts	3/8-16	41-51 N.m	30-38 ft.lbs.
	3/8-24	41-51 N.m	30-38 ft.lbs.
	7/16-14	68-81 N.m	50-60 ft.lbs.
	1/2-13	95-115 N.m	70-85 ft.lbs.

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AIR CONDITIONING COMPRESSOR AND MAGNETIC DRIVE CLUTCH

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SPECIFICATIONS

Two-Cylinder Reciprocating 168.8 cm³ (10.3 Cu. In.) Compressor Type Displacement..... Refrigerant Type..... Freon R-12 Refrigerant Oil Type..... Texaco "Cappella E Dual-Inhibited" or Equivalent Suniso No. 5 or Equivalent Compressor Oil Capacity: Vertical Mounting..... 25.4 mm (1") Min. - 34.9 mm (1-3/8") Max. 25.4 mm (1") Min. - 36.5 mm (1-7/16") Max. Horizontal Mounting..... Compressor Belt Tension..... Use SE-2312 Belt Tension Gauge

TORQUE CHART

		Torque		
Application	Size	(Ft. Lbs.)	N-m	
Base Plate	1/4-20	12-18	16-24	
Connecting Rod Bearing Cap	1/4-20	12-16	16-22	
Rear Bearing Housing	1/4-20	9-17	12-23	
Cylinder Head	5/16-18	15-23	20-31	
Crankshaft Seal Plate	No. 10-24	5-7	7-9	
Service Valve Rotalock Nut	1-14	30-35	41-47	
Compressor Mounting	3/8-16	20-25	27-34	
Oil Fill Plug	3/8-24	4-11	5-15	
Drive Clutch Retaining Bolt	5/16-24	15-20	20-27	
Clutch Brush Mounting Bracket (Eaton Clutch)	1/4-20	7-10	9-14	
Field Coil Mounting Bracket (Warner Clutch)	1/4-20	7-10	9-14	
Service Valve Port Cap	1/4 Tube	15-23	20-31	

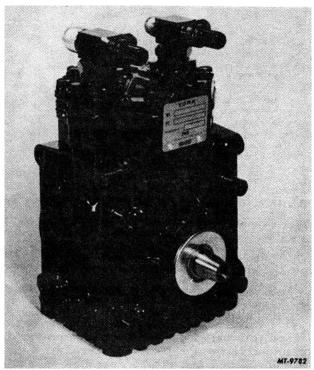


Fig. 1. A/C Compressor DESCRIPTION AND OPERATION

Air Conditioning Compressor

The compressor, Figs. 1 and 2, used on air conditioned International vehicles is a two-cylinder reciprocating unit. It is belt driven through a magnetic clutch located on compressor crankshaft.

Compressor crankcase, cylinder head, pistons, connecting rods, bearing housing, valve plate and base plate are die-cast aluminum. Crankshaft is cast iron as are the cylinder liners which are permanently cast into the crankcase.

The compressor can be operated in any position from horizontal left to horizontal right. It can be operated clockwise or counterclockwise.

The lubrication system utilizes the existing pressure differential between the suction intake and crankcase to provide lubricating oil to bearings and internal components. An oil plug on each side of crankcase permits oil checking regardless of compressor mounting.

The primary functions of the compressor are to propel the refrigerant through the system and compress and superheat the heat-saturated refrigerant vapor it pulls from the evaporator.

Compressor Magnetic Clutch

The compressor magnetic clutch, Figs. 3 and 4, is secured to compressor crankshaft. The purpose of the clutch is to

couple and uncouple Fig. 2 A/C Compressor (Cutaway) compressor from V-belt drive as necessary to maintain desired cab interior temperature. Two types of clutches are used on IH trucks.

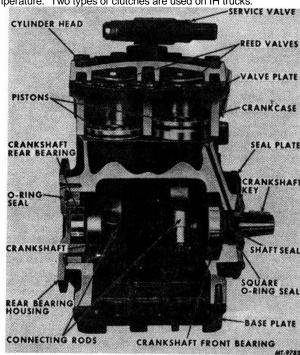


Fig. 2. A/C Compressor (Cutaway)

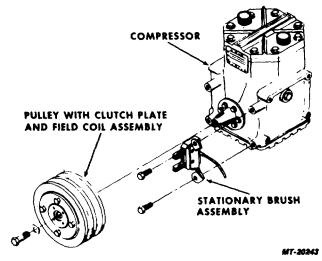


Fig. 3. Compressor Magnetic Clutch (Eaton)

Rotating Field Coil Type (Eaton)

The primary components of the Eaton electric clutch are: The pulley assembly, field coil, bearing, slip ring and clutch plate (drive hub) mounted on compressor shaft, and brush' assembly, mounted on compressor housing.

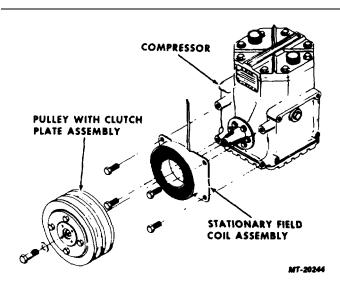


Fig. 4. Compressor Magnetic Clutch (Warner)
Stationary Field Coil Type (Warner)

The primary components of the Warner electric clutch are: the pulley assembly containing the clutch disc and bearing mounted on compressor shaft, and the stationary field coil mounted on compressor housing (Fig. 4).

During operation electrical current flows into the field coil. The energized field coil, acting as an electromagnet, holds clutch plate in contact with pulley, setting compressor in motion.

When desired cab interior temperature is reached, the field coil is de-energized, clutch plate is released from pulley and compressor operation ceases.

REMOVAL

Compressor

The compressor can be removed from the vehicle without discharging the system. It should be noted, however, that the need for compressor service will most often dictate whether it is advisable to save the charge. If the compressor damage is such that refrigerant contamination is likely, completely discharge system.

To isolate the compressor to retain the A/C system charge, turn both the suction and discharge service valves to the extreme clockwise position, Fig. 5. Loosen the port cap on the discharge service valve fitting and allow the refrigerant gas to slowly escape until the compressor is relieved of pressure.

CAUTION: Loosen port cap only a small amount. Do not remove cap until pressure within compressor is completely removed. Be certain to wear adequate eye protection when servicing the air conditioning system.

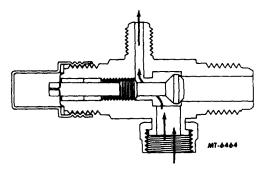


Fig. 5. Service Valve Positioned to Close Refrigerant Line and Discharge Compressor Only

To discharge the system remove the caps from the compressor service valve ports. Obtain an SE-2444 Manifold and Gauge Set and an SE-2445 Charging' Lines Set. Connect the manifold suction gauge hose to the compressor suction service valve port. Connect the hose from the manifold discharge gauge to the compressor discharge service valve port. Be certain that the manifold suction and discharge gauge valves are closed.

Open the compressor discharge service valve port by turning the valve stem clockwise one-half turn, Fig. 6. Connect hose to center fitting on manifold and position opposite end of hose in a garage exhaust collector.

Open the manifold discharge gauge valve a slight amount and allow the refrigerant gas to discharge slowly.

CAUTION: Be certain that discharged refrigerant is not inhaled. If refrigerant is not discharged into an exhaust collector, be certain adequate ventilation is present -- preferably out of doors.

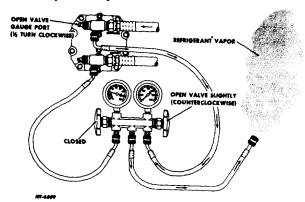


Fig. 6. Service Valves Positioned to Discharge System

Whether discharging the entire system or only the compressor, do not allow the refrigerant gas to be discharged too rapidly, as it will carry out the compressor oil as well.

After the refrigerant has been discharged, the compressor can be removed for repair or replacement.

When removing the compressor, be certain to seal all openings to prevent the entry of dirt or moisture into the system.

NOTE: <u>DO</u> <u>NOT</u> invert the compressor beyond a horizontal position during compressor removal or installation as refrigerant oil may be transferred from the crankcase to the suction cavity. If this happens, the piston may draw the oil into the cylinder, and since a liquid cannot be compressed, possible compressor destruction will occur during initial compressor operation following installation.

Compressor mounting brackets will vary from one engine to another; however, the compressor has a four-bolt mounting in all cases with a supporting brace in most installations.

Remove the compressor mounting bolts, compressor drive belt and service valves or freon hoses from the service valves. Disconnect electric clutch wire at connector. Remove compressor from vehicle.

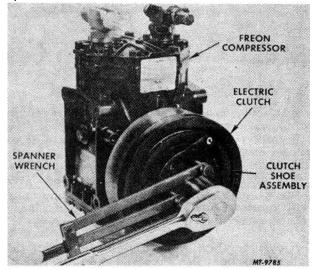


Fig. 7 Removing Electric Clutch Assembly from Compressor

Compressor Drive Clutch

Using an SE-2392-4 spanner wrench to secure clutch pulley, remove retainer bolt, Fig. 7. Install SE-2392-5 (5/8-11) remover bolt into the threaded clutch drive hub and tighten. The pressure of the bolt end against the end of the

compressor crankshaft will force the drive hub loose. Remove clutch pulley assembly from compressor crankshaft. Take key from crankshaft.

Remove capscrews and detach brush assembly for Eaton clutch or the stationary field coil if Warner type.

DISASSEMBLY

Compressor

NOTE: Not all parts of the compressor are provided for service. Before disassembling the compressor, check to see that the expected needed parts are serviced.

Remove the service valves from compressor cylinder head by turning the hex nut counterclockwise, Fig. 8.

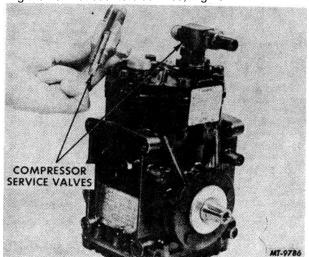


Fig. 8 Removing Compressor Service Valves (Valve Cut Away for Illustrative Purposes)

Remove service valve gaskets, Fig. 9.

Using two screwdrivers or similar tools, pry dust cap off of crankshaft, Fig. 10.

Remove the five capscrews securing the crankshaft seal plate to the crankcase. Remove seal plate and square O-ring seal, Fig. 11.

Using an SE-23921 seal puller tool as shown in Fig. 12, remove crankshaft seal.

Fig. 13 shows how seal puller grasps crankshaft seal. Note how puller legs are under lower edge of seal.

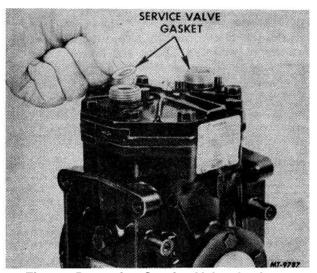


Fig. 9. Removing Service Valve Gaskets

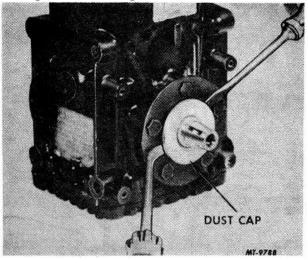


Fig. 10. Prying Dust Cap off of Crankshaft

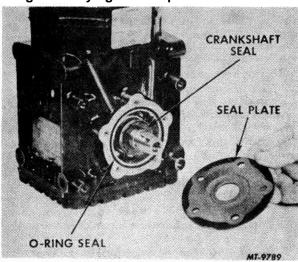


Fig. 11. Removing Crankshaft Seal Plate

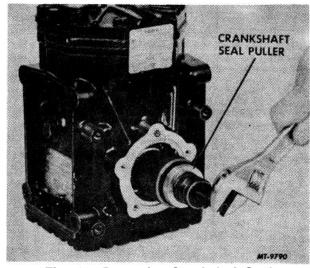


Fig. 12. Removing Crankshaft Seal

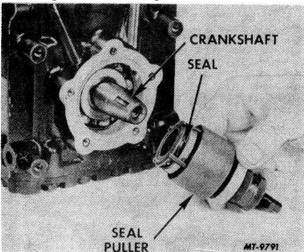


Fig. 13. Crankshaft Seal Removed

Remove the 8 hex head capscrews securing compressor cylinder head to crankcase. Using a 12 point socket, remove the 4 remaining capscrews near the service valve ports.

Remove cylinder head, Fig. 14, and valve plate, Fig. 15, by gently prying or tapping with a soft hammer under the ears which extend from the valve plate.

If cylinder head and valve plate adhere to each other, hold the head and tap the valve plate ears away from the head with a soft hammer. Do not hit or tap the cylinder head to separate it from the valve plate, as damage to the head may result.

Remove the four screws securing the crankshaft rear bearing housing to the crankcase. Using two screwdrivers or similar tools carefully pry the housing out of the crankcase bore,

Fig. 16. Pry in such a manner that the housing is pulled parallel to the bearing surface. Be careful not to damage components during removal.

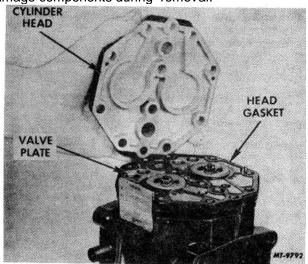


Fig. 14. Removing Cylinder Head from Compressor

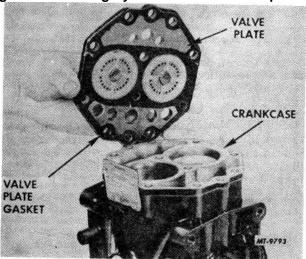


Fig. 15. Removing Valve Plate Remove rear bearing housing and 0-ring seal, Fig. 17.

Remove 14 capscrews and gently pry or tap base plate to loosen gasket. Remove base plate from crankcase, Fig. 18.

Using a 12-point socket, remove connecting rod bearing capscrews. Remove connecting rod bearing caps, Fig. 19. Match mark pistons and respective rod bearing caps and crankshaft throws to be certain they are installed in their original positions during reassembly because of pre-established wear patterns.

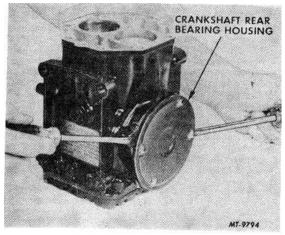


Fig. 16. Removing Crankshaft Rear Bearing Housing

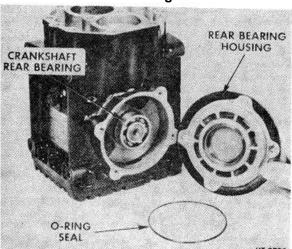


Fig. 17. Crankshaft Rear Bearing Housing and O-Ring Seal Removed

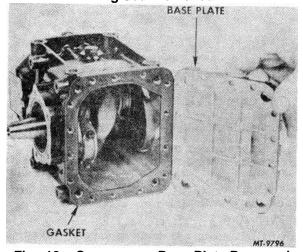


Fig. 18. Compressor Base Plate Removed

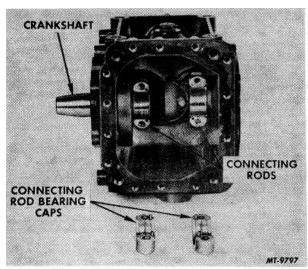


Fig. 19. Connecting Rod Bearing Caps Removed Remove pistons from cylinders, Fig. 20. Note during piston removal that the piston wrist pin roll pin is towards the center of the compressor. If positioned toward the outside during reassembly, the roll pin may contact the crankshaft when the piston is at the bottom of its stroke.

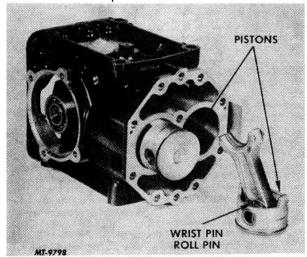


Fig. 20. Removing Pistons from Cylinders
The crankshaft front bearing is a ball type bearing and is a shrink fit in a recess in the compressor crankcase.

The preferred method of front bearing removal is to oven heat the crankcase to 149 deg. C (300 deg. F). NOTE: The complete crankcase must be heated. Localized heating may crack the crankcase.

At 149 deg. C (300 deg. F) the crankshaft and ball bearing assembly can be removed with very little applied pressure.

CAUTION: Insulated gloves or similar protection should be worn to prevent possible burns during handling of the hot crankcase.

Place the crankshaft in a vertical position (keyway end up) in a vise, gripping the shaft at the unmachined area between the throws. Using two large screwdrivers or similar tools as a pry, force the bearing upward and remove it from the shaft. Pry rear bearing off of crankshaft if necessary.

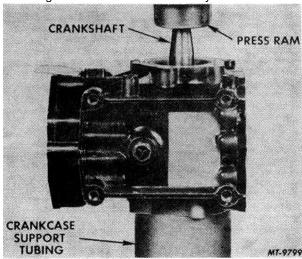


Fig. 21. Removing Compressor Crankshaft
If no oven or means of evenly heating the crankcase is available, the bearing and crankshaft may be pressed in and out of the crankcase.

Support the crankcase in an arbor press as shown in Fig. 21. Press out crankshaft. Should the bearing come out with the crankshaft, remove bearing from shaft as previously described.

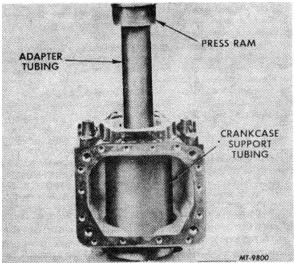


Fig. 22. Removing Crankshaft Front Bearing from Crankcase

Support compressor crankcase in an arbor press shown in Fig. 22 and press bearing out of crankcase.

Compressor Magnetic Clutch

NOTE: Clutch disassembly illustrated is Eaton type. Warner type is similar.

To disassemble the clutch, remove the snap ring securing the drive hub to the pulley.

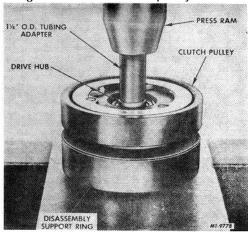


Fig. 23 Removing Clutch Drive Hub from Pulley

Position the clutch assembly on an adaptable disassembly support ring with the slip ring side up. Place the clutch and support ring in an arbor press as shown in Fig. 23. Using a short piece of 1-1/8" O.D. tubing, press the drive hub out of the pulley bearing.

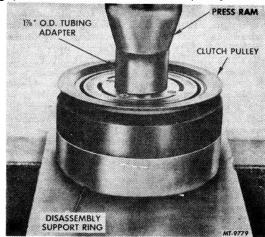


Fig. 24 Removing Clutch Pulley Bearing

Remove snap ring retaining bearing in pulley.

Invert the clutch pulley on the support ring (slip ring side down) and with a 1-7/8" O. D. tubing adapter, press the bearing from the pulley, Fig. 24.

CLEANING, INSPECTION AND REPAIR

Inspect all parts for damage or excessive wear. Clean all old gasket material from mating surfaces being certain not to scratch or nick the machined surfaces.

Use all new gaskets and O-ring seals during reassembly.

REASSEMBLY

Press the rear ball bearing onto the crankshaft by exerting pressure on the inner race of the bearing. Be certain that the shaft, bearing and recess in the crankcase are clean and free of burrs.

Oven heat crankcase to 149 deg. C (300 deg. F). Place the crankshaft front bearing in the crankcase recess. If necessary, apply force to the outer race to be sure that the bearing is seated in the bottom of the recess.

Allow the crankcase to cool. Enter the crankshaft through the rear bearing housing opening and guide the drive clutch end through the ball bearing inner race. Position the crankcase in such a manner that it is completely supported on the ball bearing inner race. Press the crankshaft into place until the cheek of the shaft contacts the bearing inner race.

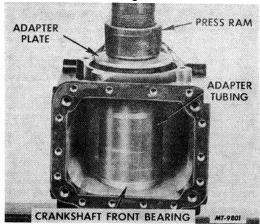


Fig. 25 Pressing Crankshaft Front Bearing into Crankcase Recess

NOTE: If crankcase is not entirely supported by the bearing inner race, bearing may be damaged.

If no means of heating the crankcase is available, press the crankshaft front bearing into the crankcase recess, Fig. 25. NOTE: Press only on bearing outer race. Be sure that bearing is seated squarely against bottom of recess.

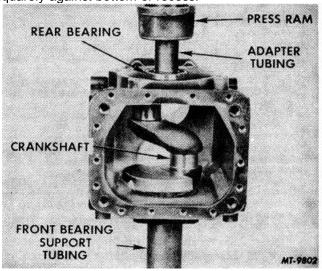


Fig. 26 Pressing Crankshaft into Front Bearing

Support front bearing inner race with a piece of tubing in an arbor press as shown in Fig. 26. Place a piece of tubing on the end of the crankshaft and press shaft into front bearing until the cheek of the shaft contacts the bearing inner race. NOTE: Do not press on rear bearing outer race.

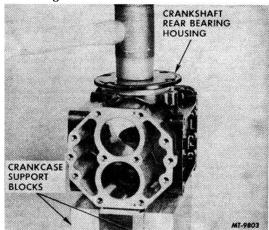


Fig. 27 Installing Crankshaft Rear Bearing Housing

Install a new O-ring seal on crankshaft rear bearing housing. Place rear bearing housing on crankshaft rear bearing and tap housing squarely onto bearing, Fig. 27. Align mounting screw holes and install four screws. Tighten to specified torque and in the sequence shown in Fig. 28.

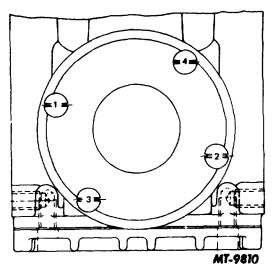


Fig. 28 Rear Bearing Housing Screw Tightening Sequence

Coat connecting rod bearing surfaces with refrigerant oil. NOTE: Always reinstall pistons in cylinders from which they were removed and rod bearing caps to original rods. Enter piston and rod assembly into cylinder with the wrist pin roll pin positioned toward the center of the compressor. If positioned toward the outside, the roll pin may make contact with the crankshaft when the piston is at the bottom of its stroke. Mate the connecting rod and cap match marks made during disassembly. Install caps, indexing dowel pins with holes in connecting rods, Install cap retaining screws and tighten to specified torque.

Before assembly to compressor, all gaskets should be dipped in clean refrigerant oil. Gaskets are made of fibre-neoprene composition and wicking action will result as oil follows the fibre. Do not mistake this wicking action for leaking. Wicking is a normal condition and is to be expected.

Using a new gasket, install and secure base plate to crankcase with 14 capscrews. Tighten to specified torque and in the sequence shown in Fig. 29.

Apply a thin film of clean refrigerant oil on the area of the crankcase to be covered by the

cylinder gasket. place the gasket on the cylinder so the dowel pins in the crankcase go through the dowel pin holes in the cylinder gasket.

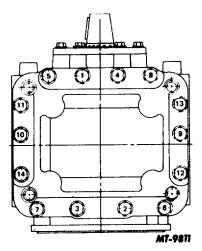


Fig. 29 Base Plate Capscrew Tightening Sequence

Apply a thin film of clean refrigerant oil to the bottom side of the valve plate areas to be covered by the gaskets. Place the valve plate in position on the cylinder gasket so the discharge valve assemblies (i.e. the smaller diameter assemblies with the retainer over the valve reed) are facing up and the locating dowel pins go through the dowel pin holes in the valve plate.

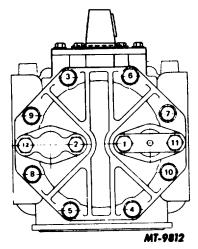


Fig. 30 Cylinder Head Capscrew Tightening Sequence

Place the head gasket on the valve plate so the dowel pins go through the dowel pin holes in the gasket. Place the head on the cylinder head gasket so the dowel pins go into the dowel pin holes in the cylinder head.

Secure cylinder head using 8 hex head capscrews and 4 12-point head capscrews. Tighten to specified torque and in the sequence shown in Fig. 30.

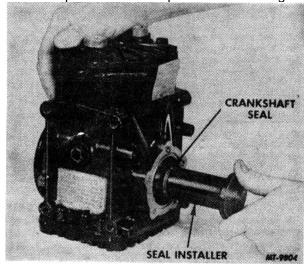


Fig. 31 Installing Crankshaft Seal

Dip seal gland in refrigerant oil. Push seal assembly, less the carbon ring, over the end of the crankshaft with the carbon ring retainer facing out. Using SE-2392-2 seal installer tool, push seal assembly onto shaft as far as possible, Fig. 31.

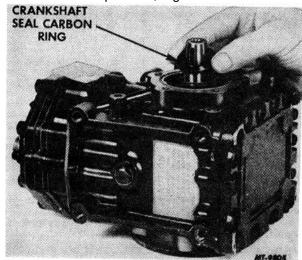


Fig. 32 Installing Shaft Seal Carbon Ring

Place the carbon ring in the ring retainer s the lapped surface is facing outward, Fig. 32. The indentations in the outside edge of the carbon ring must engage the driving lugs and be firmly seated in the retainer.



Fig. 33. Installing Seal Plate

Install new O-ring seal in groove of seal plate. Use refrigerant oil to make seal adhere to plate surface. Start the five capscrews. Place seal installer tool SE-Z392-Z over end of crankshaft with thin flange of tool inserted between shaft and seal plate, Fig. 33. Apply a downward pressure and tighten capscrews to specified torque in the sequence shown in Figs. 34 and 35.

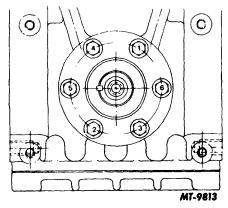


Fig. 34 Crankshaft Seal Plate Capscrew Tightening Sequence 6 Bolt Mounting

Place dust cap, if used, on crankshaft. Compressor drive clutch will correctly position dust cap when it is installed. Install woodruff key in crankshaft.

Using new gaskets install service valves. Position valves and tighten hex nut to specified torque. Install service valve port caps finger tight to prevent the entry of dirt or foreign matter. Install one oil fill plug with new O-ring seal. Tighten to specified torque.

Fig. 35 Crankshaft Seal Plate Capscrew Tightening Sequence 5-Bolt Mounting



Fig. 36 Checking Compressor Oil Level

Place compressor in mounted position. Add refrigerant oil until dipstick reading is as given in specifications, Fig. 36. Use specified refrigerant oil. Install remaining oil fill plug with new 0ring gasket and tighten to specified torque.

A compressor oil level dipstick is available under SE-2392-3.

Compressor Drive Clutch

NOTE: Clutch reassembly illustrated is Eaton type. Warner type is similar

Place clutch pulley on SE-2194 support ring with slip ring facing up. Install clutch bearing using bearing installer tool SE-2393 and an arbor press, Fig. 37. Remove clutch from press.

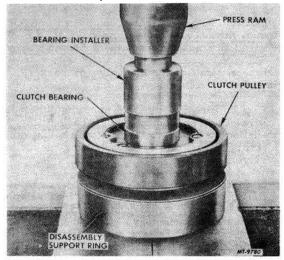


Fig. 37 Installing Compressor Clutch Bearing

Install snap ring retaining bearing in pulley.

Place clutch assembly in an arbor press with the slip ring side down. Position clutch on bearing support tool SE-2393 as shown in Fig. 38.

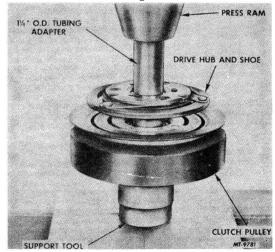


Fig. 38 Installing Drive Hub in Clutch Pulley

Press drive hub into clutch pulley and secure with snap ring. Be certain that slip ring is free of any grease or dirt before clutch installation.

INSTALLATION

Compressor Drive Clutch

Secure brush assembly for Eaton type clutch or stationary field coil for Warner type clutch to compressor with capscrews. Tighten to specified torque.

Install woodruff key in crankshaft and place drive clutch on shaft. Secure clutch to shaft with a new Nylok grade 5 hex head bolt. NOTE: Always use a new retaining bolt to attach clutch to crankshaft. The nylon insert in the bolt is designed to maintain proper torque at first application only. Tighten bolt to specified torque.

Turn pulley by hand to be sure there is no interference between pulley and brush assembly or field coil (depending on type). If interference exists, a rubbing noise can be heard as pulley rotates. Adjust brush or field coil mounting as required.

Compressor

Position compressor on mounting bracket and insert four retaining bolts. Install compressor drive belt. Adjust belt tension to specifications and align drive clutch pulley with accessory drive pulley or water pump pulley. Tighten compressor mounting bolts to specified torque. Install support brace if applicable.

If system charge was not lost, connect service valves to compressor using new gaskets. Tighten hex nut to specified torque. Turn service valve stems counterclockwise as far as possible (valve backseated), Fig. 39. This is the normal operating position. Connect drive clutch wire.

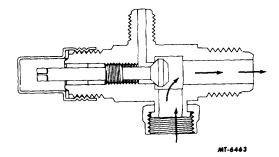


Fig. 39 Service Valve in Normal Operating Position



Operate A/C system and check sight glass for bubbles. If no bubbles can be seen in liquid refrigerant flowing through sight glass, refrigerant supply is adequate. Bubbles or foam showing in sight glass indicates refrigerant supply is low. Add refrigerant if necessary following the instructions given for "Charging the System" in CTS-2441 of BODIES AND CABS in the IH Service Manual.

If the system was discharged, purge, evacuate and charge the system following the instructions given for "Charging the System" in CTS-2441 of BODIES AND CABS in the IH Service Manual. NOTE: For best results the filter-dehydrator should be replaced whenever the system is discharged and recharged.

Refer to CTS-2441 of BODIES AND CABS in the IH Service Manual for air conditioning system general maintenance and service instructions and trouble shooting.

COMPRESSOR REED VALVE AND HEAD GASKET CONDITION TEST

If it is suspected that a compressor head gasket or reed valve is leaking, the following test can easily be performed:

- Connect the hose from an A/C manifold suction gauge to the compressor suction valve service port.
- 2. Remove discharge valve port cap.
- Turn both the suction and discharge valve stems clockwise as far as possible (valve "front seated").

4. Start engine and turn air conditioner "on". Check suction gauge reading. If a vacuum of 381 mm (15 inches) cannot be reached or if it requires considerable time (two or three minutes) to reach 508 mm (20 inches) of vacuum, indication is a leaking suction reed valve or head gasket. Vacuum should reach 508-635 mm (20-25 inches).

NOTE: <u>Do not operate compressor longer than</u> three (3) minutes and only at idle speed during performance of Step 3 above.

Before condemning the valve or gasket, repeat test as follows:

- Stop compressor by disconnecting clutch lead wire. Loosen suction gauge hose fitting at suction valve port. Gauge will return to zero. Tighten gauge hose fitting at suction valve port.
- 6. Connect compressor clutch lead wire to start compressor. In 30 seconds or less vacuum should reach 508-635 mm (20-25 inches). If vacuum is satisfactory, stop compressor. Vacuum should remain steady for 3 to 4 minutes or longer. If vacuum does not hold, it indicates faulty valves, pistons, piston rings or a leaking head gasket.
- 7. Remove compressor and repair or replace as an assembly.

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TROUBLE SHOOTING

PROBLEM	POSSIBLE CAUSE	REMEDY
Compressor Noise and Vibration	Low refrigerant charge.	Add refrigerant.
Vibration	2. Low oil level.	2. Add oil.
	Worn or damaged crankshaft bearings.	3. Replace bearings.
	4. Loose drive clutch.	Remove clutch and check shaft taper and key. Install new clutch retaining bolt.
	Worn or damaged drive clutch bearing.	5. Install new bearing.
	6. Compressor drive belt loose.	6. Tighten drive belt.
	7. Compressor drive clutch pulley misaligned.	7. Align drive clutch pulley.
	Loose or broken compressor mounting bracket.	Tighten or replace mounting bracket.
	Foreign material or damaged parts in compressor.	9. Repair or replace.
_	10. Excessive refrigerant charge.	10. Bleed off excess refrigerant.
Compressor Clutch Inoperative	Incorrect belt tension.	Adjust drive belt tension.
Порогануо	Loose connection or broken wire.	Check connections or replace wire.
	3. Faulty field coil.	Replace field coil or clutch depending on type.
	Faulty thermostatic control switch.	Replace switch.
	5. Broken drive belt.	5. Replace drive belt.
	6. Excessive wear.	6. Replace clutch assembly.
Drive Clutch Slippage	Excessive head pressure.	Determine remedy from CTS-2441, BODIES AND CABS.
	2. Loose drive pulley.	Tighten pulley or replace damaged components.
	3. Oily drive belt.	3. Replace drive belt.
	4. Worn drive belt.	4. Replace drive belt.



PROBLEM	POSSIBLE CAUSE	REMEDY
Compressor Runs But Doesn't Pump	Leaking head gasket.	Replace head gasket.
	Damaged or worn piston or piston ring.	2. Replace compressor.
	3. Damaged or stuck reed valve.	3. Replace valve plate assembly.
	Leaking valve plate gasket.	4. Replace gasket.
Compressor Leaks Refrigerant and/or Oil	Leaks at service valve connections.	Replace service valve gaskets and tighten Rotalock nut to correct torque.
	Worn or damaged crankshaft seal.	2. Replace crankshaft seal.
	3. Head gasket leaks.	3. Replace gasket.
	4. Valve plate gasket leaks.	4. Replace gasket.
	5. Damaged compressor crank case.	5. Replace compressor.
	Crankshaft seal plate 0-ring gasket leaks.	6. Replace O-ring.
	7. Crankshaft rear bearing housing 0-ring gasket leaks.	7. Replace 0-ring.
	Crankcase base plate gasket leaks.	8. Replace gasket.

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BODIES AND CABS

S-SERIES CONVENTIONAL CAB

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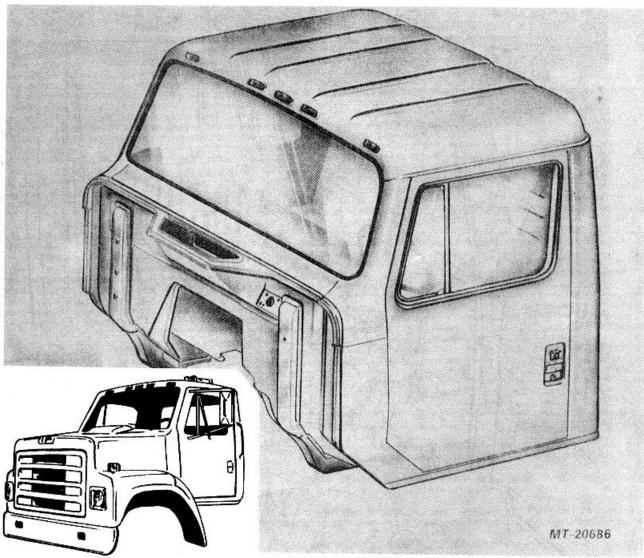


Fig. 1 S-Series Conventional Cab

GENERAL

The S-Series mid-range conventional cab shown here in Figure 1 and covered in this manual is available in either 200 or 230 cm width (80 or 90 inch) and for three different bumper to back of cab (B.B.C.) dimensions.

This manual has been prepared to help servicemen maintain cab in its original condition or restore cabs which may have sustained damage.

CONTROLS INSTRUMENT PANEL

While there is a wide range of optional equipment available on the S-Series models for which this cab is used, all instruments, gauges and driver

controls are located for driver convenience. Fig. 2 shows the cab interior and a typical instrument panel installation. Removable panels provide for easy access to speedometer, cables, gauges, bulbs, wiring, plumbing, switches, valves, etc.

CAUTION

Always disconnect battery ground before servicing or removing instrument panel.

For further information on S-Series instrument panel see INSTRUMENTS CTS-2735.

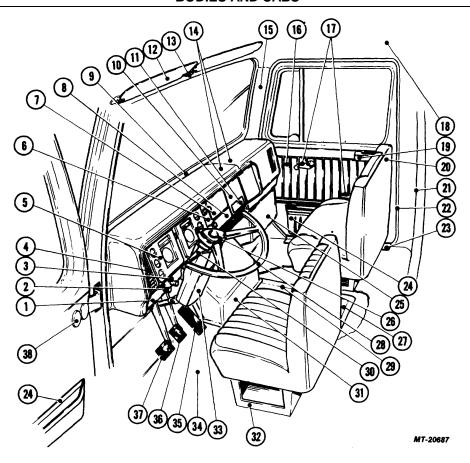


Fig. 2 S-Series Cab Interior View (Typical)

Legend for Figure 2

Key Description	Key Description	Key Description
1 Lower Instrument Panel	14 Instrument Panel Cover	27 Transmission Cover
2 Control Knobs	15 Hinge Pillar Access Cover	28 Steering Wheel
3 Name Plate	16 Door Trim Panel (Custom)	29 Shift Lever
4 Air Conditioning Louver	17 Door Hardware	30 Turn Signal Lever
5 Instrument Cluster	18 Headliner	31 Engine Cover
6 Instrument Panel	19 Arm Rest	32 Seat Riser
7 Air Control Cluster	20 Seat	33 Steering Column
8 Heater/Air Conditioner Control	21 Back Inner Trim Panel	34 Floor Mat
9 Defroster Panel	22 Door Trim Strip	35 Accelerator Pedal
10 Radio Panel	23 Scuff Plate	36 Brake Pedal
11 Ash Tray	24 Manifest Pocket, Vinyl or Metal	37 Clutch Pedal
12 Sun Visor	25 Heater	38 Button Plug, Hinge Cover

26 Horn Button

13 Sun Visor Clip

SERIAL NUMBER LOCATIONS

Serial numbers are necessary if the need for replacement parts should occur. For this reason you will want to know the location for these important numbers. S-Series chassis serial numbers are located on face of cab lock pillar. S-Series <u>cab</u> serial numbers are located at top right of cowl front panel.

MAINTENANCE

Most service requirements, disassembly procedures or adjustments, on this cab and hood can be performed with ordinary mechanic's hand tools. Illustrations and suggested procedures for helping the mechanic are covered in paragraphs which follow.

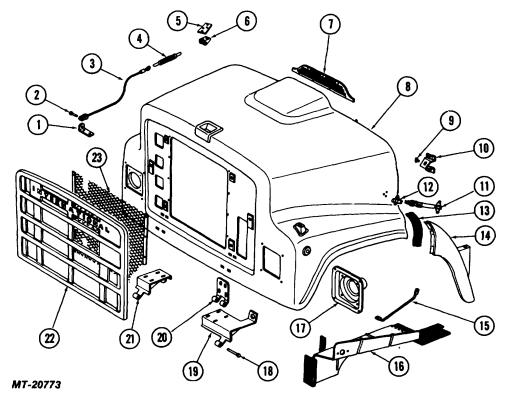


Fig. 3 Hood and Hinge Mounting for S-2200 Cab (230 Cm - 90 Inch Wide)

Legend for Figure 3

<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
1	Bracket, Hood Stop	9	Guide, Hood Locator	17	Shield, Headlight
2	Pin, Cable End	10	Bracket, Locator Guide	18	Pin, Hood Hinge
3	Cable, Assembly, Hood	11	Latch, Hood	19	Hinge, Lower Half Left
4	Spring, Hood Stop	12	Socket, Hood Latch	20	Hinge, Hood Half
5	Reinforcement	13	Seal	21	Hinge, Lower Half Right
6	Bracket, Hood Stop Anchor	14	Fender	22	Grille, Radiator
7	Grille, Fresh Air Intake	15	Brace, Splash Panel	23	Screen, Radiator
8	Hood, Assembly	16	Panel, Fender Splash		

HOOD AND HINGE MOUNTINGS

Tilt type hoods (Figs. 3 & 4) used with S-Series cabs are one-piece molded fiberglass units. While they may vary slightly in size, appearance and hinge mounting, they are similar in servicing as follows:

Hood Opening (Tilting)

The hood assembly is hinged near bumper and can be tilted by releasing hood latches on cowl panels.

Place foot on bumper step, grasp handle recess and pull complete hood, fenders and grille assembly to front. There are two hood stop cables to prevent over-travel of hood.

To lower hood, push the hood towards cab and at the same time hold back at handle recess to ease the hood into traveling position. Secure both hood latches at cowl panels. Do not allow hood to drop into place or damage can result.

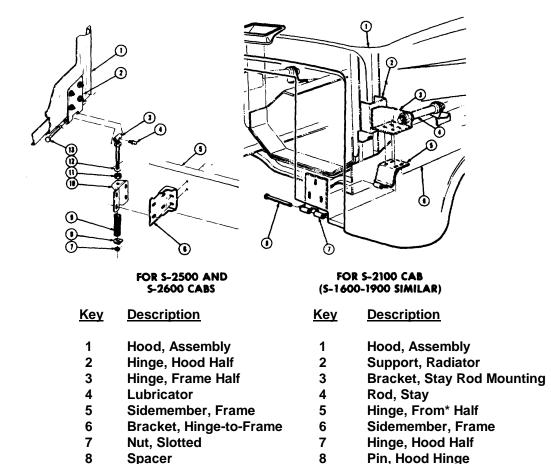


Fig. 4 Hood Hinge Types For 200 Cm (80 Inch) Wide Cabs

Spring, Tension

Pin, Hood Hinge

Bracket, Hinge

Insulator

Washer

9

10 11

12

13

Remove

- Release hood latches on each side of cowl and tilt hood assembly forward.
- Support tilted hood on floor stands or saw horse to relieve tension on hood stop cables. Protect paint from scratches.
- 3. Remove spring type pins and cable end pins (one for each cable) and detach stop cables from hood stop brackets at top of radiator.
- 4. Disconnect headlight wiring harness from connector on underside of hood.
- 5. Remove spring type pin and hinge pin from the two hood hinge assemblies and detach hood from chassis.
- 6. Hood-to-frame hinge mounting details for the various size hoods are shown in Figs. 3 and 4.

Fiberglass Repair

Refer to BODIES AND CABS CTS-2408 for fiberglass repair instructions.

Install

Hood installation is the reverse of the foregoing removal procedure. Before final tightening of hood mounting bolts, check hood adjustment.

Adjust

When making any adjustment to tilt hood, inspect hood alignment and clearance between hood and cowl. Elongated mounting holes in frame half of hood to frame hinges provide for hood adjustment. If adjustment is required, loosen hinge to frame mounting bolts and adjust hood to cowl clearance as necessary. Tighten mounting bolts to specified torque (see Torque Chart) .

CAB DOORS (Fig. 5)

Doors used on the S-Series cab are of all steel-welded construction with access panel and button plug openings for making hinge adjustments or removal as required. The door is mounted on concealed leaf type hinges and door adjustment is provided by elongated holes in hinge leaves. Door stop is integral with upper hinge. Door striker pin is also adjustable on lock pillar. Service on the door and its components is covered in paragraphs which follow.



Fig. 5 Custom Trimmed Door

DOOR HARDWARE AND TRIM (Fig. 6)

Components of door assembly can be removed while door is either on cab or removed. They can also be removed individually without having to remove other components for access. Servicemen should have little difficulty in making a complete door disassembly or a removal of any of its component parts. (Most components do require the prior removal of door hardware and trim.)

Remove

- Remove window regulator handle and door remote control handle by removing socket head screws from handles.
- 2. Remove two screws and detach arm rest.
- 3. Remove door trim screws and detach door trim panel (custom trim model only).

<u>Install</u> <u>IMPORTANT</u>

Door hardware and trim installation is the same as reverse of removal procedures.

Be careful when reinstalling arm rests so as to avoid stripping out mounting screws. Torque for mounting screws is 2.3 N.m (20 in.lbs.).

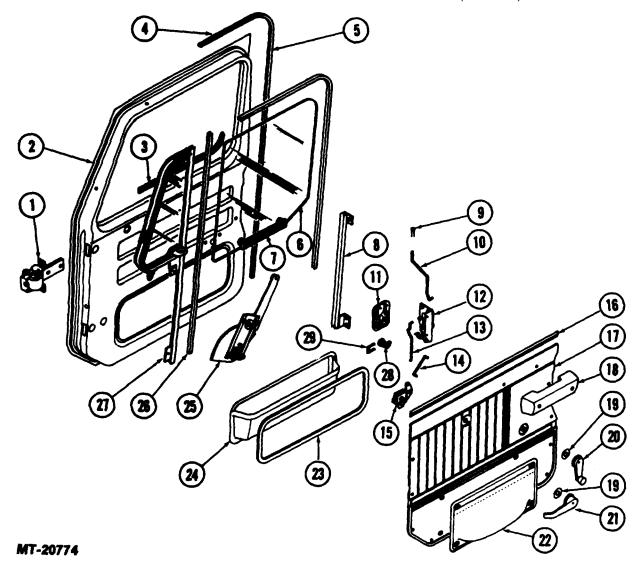


Fig. 6 Door Hardware, Trim and Internal Components - Exploded View

Legend for Figure 6

<u>Key</u>	<u>Description</u>
1	Hinge, Cab Door
2	Door, Assembly, Cab
3	Seal, Door Glass
4	Seal, Door
5	Seal, Door Glass Rear Channel
6	Glass, Door Window
7	Guide, Door Window
8	Channel, Rear Run
9	Knob, Door Lock
10	Rod, Lock Knob to Latch
11	Handle, Assembly Door Outer
12	Latch, Assembly, Door
13	Rod, Remote Control to Latch
14	Rod, Lock Cylinder to Latch

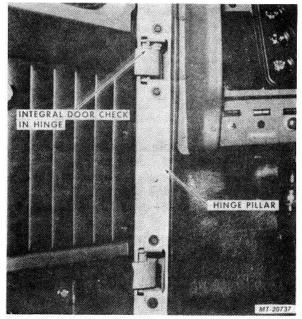
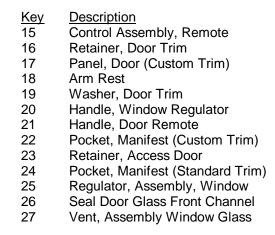


Fig. 7 Door and Hinge Details DOOR HINGES

An integral door check (Fig. 7) is included in the upper hinge used with this door. If door is removed, upper and lower hinges should not be interchanged. There is no disassembly of hinges since they are serviced as a complete unit. It should also be noted that hinge mounting holes are elongated to provide adjustment for positioning cab door in door opening.



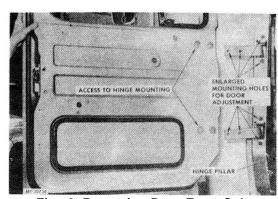


Fig. 8 Removing Door From Cab

Remove

- 1. Remove door hardware and trim as covered previously.
- 2. Using a rope sling (or padded chain) through window opening, attach sling to overhead lift and support door.
- Remove four button plugs for access to hinge bolts.
- 4. Remove the four flange head hinge bolts and lift door assembly from hinges (Fig. 8).
- 5. Place door on saw horses or similar support. Protect paint from scratches.
- 6. To simplify door adjustment on reassembly, mark hinge position on hinge pillar with scratch awl before loosening hinges. Remove the three flange head bolts and detach door hinge from hinge pillar (Fig. 9).

IMPORTANT Flange head bolt inside pillar can best be removed with a flex socket. Also be careful when extracting bolt so as to avoid its loss inside pillar.

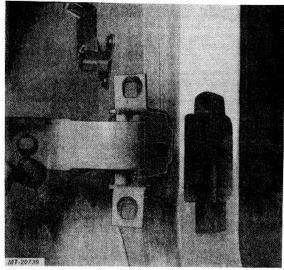


Fig. 9 Removing Cab Door Hinge From Hinge Pillar

Install

Cab hinge and door installation is accomplished by reversing the foregoing removal procedures. Before final tightening hinge mounting bolts, check the door adjustment. See CAB DOOR ADJUSTMENT for complete details.

DOOR GLASS

Remove

- 1. Remove door trim as covered previously.
- Remove rubber insert from around door access cover. Use blunt nose screwdriver or seal tool as shown (Fig. 10). Lift out cover and remove seal from access opening.
- 3. Lower window glass to bottom of its channel.
- Working thru access opening remove two glass fastener screws from window guide and detach guide from glass and window regulator lever (Fig. 11).

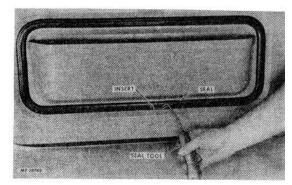


Fig. 10 Removing Access Panel From Door

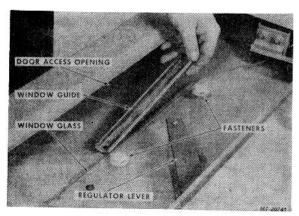


Fig. 11 Removing Window Guide From Window Glass



Fig. 12 Removing Rear Run Channel

- 5. Remove button plug from side of door for access to rear glass run channel upper retaining bolt. Remove bolt.
- Remove two retaining bolts from lower end of glass rear run channel. Remove channel and channel seal (Fig. 12) from glass and lay aside in door.

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- 7. Remove glass from front run channel.
- 8. Pull glass out bottom of access opening (Fig. 13).

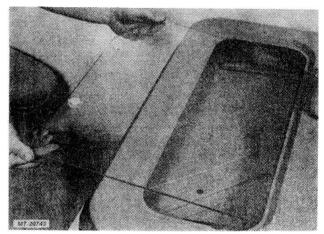


Fig. 13 Removing Or Installing Window Glass

Install

- 1. Insert window glass through access opening (Fig. 13).
- 2. Enter glass into front run channel.
- 3. Slide rear run channel and channel seal onto rear edge of glass.
- 4. Secure rear run channel retainer to upper and lower mounting brackets with bolts and washers.
- When assured that glass will slide easily from top to bottom in window channels, move window to lowered position.

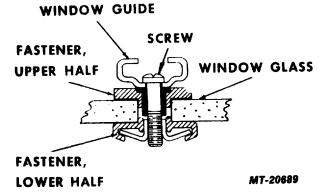


Fig. 14 Window Glass Fastener Cross Section

Temporarily install regulator handle and turn regulator lever to engage with bottom edge of window.

- 7. Install window guide and regulator lever stud to window glass using the two fastener assemblies (Fig. 14) through holes provided in glass.
- 8. Operate regulator handle to make sure all components have been assembled correctly.
- 9. Reinstall access door.

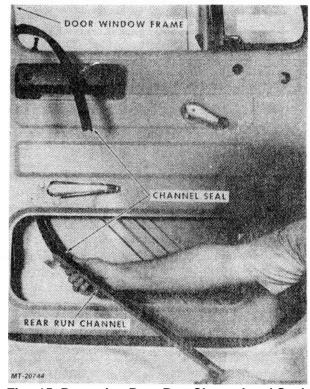


Fig. 15 Removing Rear Run Channel and Seal

DOOR GLASS REAR RUN CHANNEL AND CHANNEL SEAL

The door glass rear channel seal (weather stripping) is moulded for a compression fit in window frame as well as in glass rear run channel. No clips are required to retain it. Channel and seal are removed together.

Remove

 Remove cab door glass as outlined under "DOOR GLASS". Glass may be left in bottom of door or removed through access opening as desired.

- 2. Pry out channel seal from door window frame (Fig. 15).
- Since rear run channel is already loosened as outlined under "DOOR GLASS", remove channel and seal through door access opening (Fig. 15).

Install

- 1. Obtain replacement channel seal and insert lower end in rear run channel.
- 2. Place channel and seal assembly inside door and press upper end of seal into window frame.
- 3. Procedure for mounting rear run channel to door is same as covered under "DOOR GLASS".

DOOR GLASS INNER AND OUTER SEALS

Door glass inner and outer seals are retained in bottom of window frame by clips (Fig. 16).

Remove

- Remove cab door glass as outlined under "DOOR GLASS". Glass may be left in bottom of door or removed through access opening as desired.
- Carefully pry out inner and outer seals from window frame (Fig. 16). Apply pressure at clips to avoid damage. If clips are broken during removal, a replacement seal will be necessary.

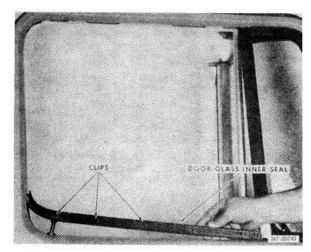


Fig. 16 Door Glass Inner Seal

Install

To install door glass inner and outer seals, simply align seals in place and press clips into openings provided. Avoid damage to seal by applying pressure at clip locations only.

DOOR VENT GLASS AND FRONT RUN CHANNEL

The door vent glass and front run channel (Fig. 17) is serviced as one assembly. It is held in place in door by two pan head screws and two hex head bolts.

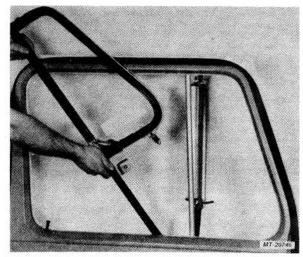


Fig. 17 Removing or Installing Door Vent Glass and Front Run Channel

Remove

- 1. Remove door glass and door glass window seals as outlined previously.
- 2. At the outside of door remove two pan head mounting screws, one from top and one from front edge.
- From inside of door remove two hex head bolts and detach vent glass and front run channel from door.
- 4. Lift out vent glass and front run channel as an assembly through window frame (Fig. 17).

Install

Door vent glass and front run channel installation is accomplished by reversing the foregoing removal procedure.

DOOR GLASS REGULATOR

The cab door glass regulator is serviced as a complete unit with the door glass either in place or removed. If it is not desired or necessary to replace door glass, simply lower glass sufficiently to detach regulator lever from glass and then push glass back up into window frame. Secure glass temporarily to top of door with tape

Remove

- 1. Remove door hardware, trim and access door (same as for removing door glass).
- Lower glass to bottom of door and remove the two glass fastener screws and regulator lever from window guide.
- 3. Remove window guide by sliding it from regulator lever.
- 4. Push door glass up in window frame and secure glass to top of door with tape.

- 5. Remove the four retaining screws which hold regulator assembly in door.
- 6. Push regulator shaft through hole in door inner panel and remove regulator assembly through access opening (Fig. 18).

Fig. 18 Removing or Installing Door Glass Regulator

Install

Cab door glass regulator installation is accomplished by reversing the foregoing removal procedure. See Fig. 19 for door internal component details.

Lubricate

Lubricate cab door glass regulator gear teeth, arm pin and slide at installation. See Lubrication.

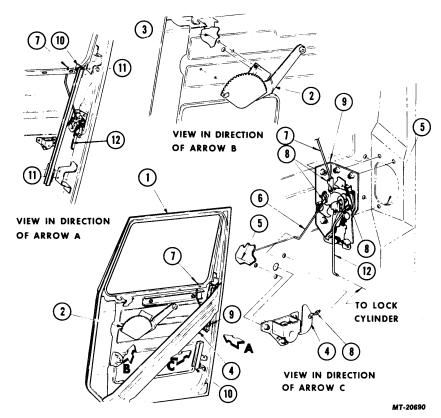


Fig. 19 Door Glass Regulator and Latch Details



Legend for Figure 19

<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
1	Door, Assembly, Cab	7	Rod, Lock Knob to Latch
2	Regulator, Assembly, Window	8	Clip, Rod End
3	Screw, Mounting, Pan Head	9	Latch, Assembly, Door
4	Control Assembly, Remote	10	Retainer, Rear Run Channel
5	Screw, Mounting	11	Bolt, Mounting, Hex Head
6	Rod, Remote Control to Latch	12	Rod, Lock Cylinder to Latch

IMPORTANT Be careful when reinstalling door glass, door glass regulator and related parts to avoid glass breakage. Door glass inner and outer seals, channel seals and glass mounting fasteners have been designed to protect glass through rugged operating conditions. Make sure the reassembly of these parts will maintain this same glass protection.

DOOR LATCH ASSEMBLY AND REMOTE CONTROL

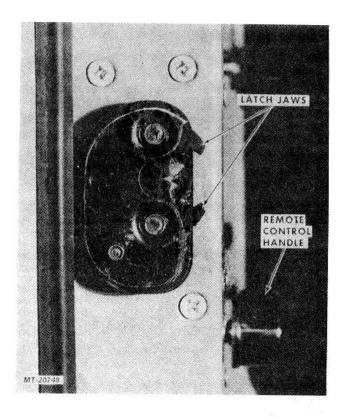
The cab door latch assembly (Figs. 19 and 20) used with this door features positive no-rattle latch jaws which engage with striker pin on cab lock pillar. Latch assembly mounts to a small opening in edge of door and connects to remote control, lock cylinder and lock knob by relay control rods.

Remove

 Remove door hardware, trim and access door (same as for removing door glass).

- 2. Remove lock knob from relay control rod through window frame.
- Unfasten rod end clips and remove relay control rods from remote control assembly and from lock cylinder assembly. Opposite ends of the three relay control rods can remain attached to latch assembly.
- 4. Remove three socket head screws and detach remote control from inside of door (Fig. 21).
- Remove five socket head screws and detach door latch assembly from inside of door frame (Fig. 22). Latch jaws should be closed.

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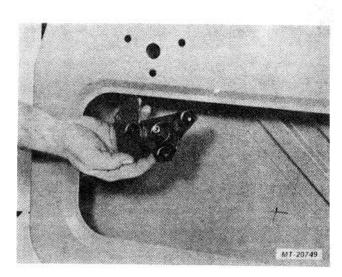


Fig. 21 Removing Remote Control Assembly

Install (Refer to Fig. 19 for Component Details)

 Position latch assembly to inside of door. Latch jaws must be closed and the three relay control rods should be preassembled to latch.

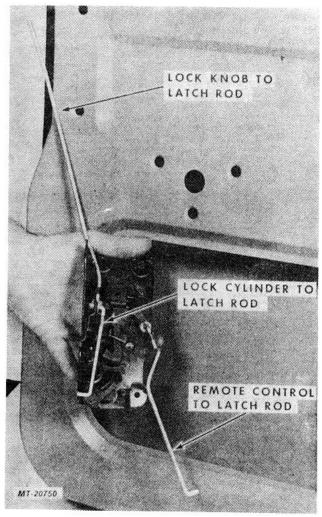


Fig. 22 Removing Latch Assembly

- 2. Pilot threaded end of upper lock knob rod through lock knob hole in window frame while positioning latch. Install lock knob.
- 3. Secure latch assembly in door with five socket head screws.
- 4. Position remote control assembly in door and secure with three socket head screws.
- Connect the two remaining relay control rods to remote control assembly and to lock cylinder lever. Secure rods with rod end clips.
- 6. Operate latch assembly to assure correct assembly.

DOOR OUTER HANDLE

The door outer handle (Fig. 23) is a combination handle and lever operating assembly that connects with the latch assembly mechanism inside door to actuate the latch jaws. Outer handle can be removed without removing latch assembly.

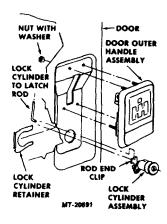


Fig. 23 Door Outer Handle and Lock Cylinder

Remove

- Remove door hardware, trim and access door (same as for removing door glass).
- 2. Remove three hex nuts from studs through door from rear of handle.
- 3. Remove door outer handle from door (Fig. 24).

Install

To install outside door handle, reverse foregoing removal procedure.

DOOR LOCK CYLINDER ASSEMBLY

The door lock cylinder (Fig. 23) is key coded to key switch on instrument panel so that one key operates both. If keys are lost or a replacement of lock cylinder is desired, see special instructions under "KEY SWITCH AND DOOR LOCK CYLINDER REPLACEMENT".

<u>Remove</u>

- Remove door hardware, trim and access door (same as for removing door glass).
- 2. Disconnect rod end clip and detach control rod from door lock cylinder assembly.

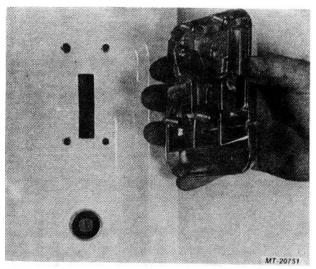


Fig. 24 Removing Door Outer Handle

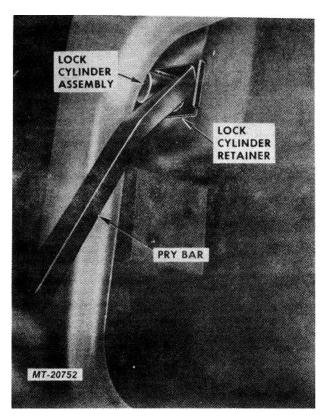


Fig. 25 Removing Lock Cylinder Retainer

IMPORTANT Lock cylinder retainer can be removed without removing glass rear run channel. Channel removed in Fig. 25 for clarity.

- 3. Working through door access opening pry lock retainer from lock cylinder assembly (Fig. 25) with a small pry bar or screwdriver.
- 4. Rotate lock cylinder assembly slightly and remove from door.

Install

To install door lock cylinder assembly, reverse foregoing removal procedure.

KEY SWITCH AND DOOR LOCK CYLINDER REPLACEMENT

The instrument panel mounted key switch and the lock cylinder in the door are coded so that one key operates both. Code number is stamped on key switch body just back of cap nut. Door lock cylinder assembly does not have a code number stamped on body since this cylinder is coded to the key switch.

To locate code number on key switch, remove key switch mounting cap nut and detach key switch from instrument panel.

The key switch cylinder can be replaced providing the regular key is used.

Remove

To remove key switch cylinder from switch body, place key in switch cylinder and insert a piece of stiff wire or rod 1.5 mm (1/16") dia. in the small hole behind cap nut in switch body. Turn key to left (accessory position) and press the cylinder retainer down with the wire. The switch cylinder can then be pulled out of switch body.

Install

To install a new switch cylinder, simply push cylinder into switch body and turn to right ("ON" position) until the cylinder retainer snaps into place.

Door lock cylinder replacement is by the complete assembly. Lock cylinder itself (tumbler unit) is not removable. If door lock replacement is required, lock cylinder assemblies should be replaced in pairs.

If a replacement of key switch cylinder is necessary and the operator wants to use the original key, the tumblers on the new switch cylinder can be coded accordingly.

This is accomplished by inserting original key in new cylinder (cylinder removed from body) and filing off the tumblers that protrude from cylinder. When making this change, be sure no burrs are left on tumblers and all filings are blown out with air. Apply a small quantity of powdered graphite to tumblers and reinsert cylinder in key switch body.

IMPORTANT If keys are lost, switch cylinder must be drilled out using a 7.9 mm (5/16") drill, 12.7-19 mm (1/2-3/4") deep. This will permit tumblers to drop out and free lock.

DOOR WEATHER SEAL

A one piece rubber weather seal is secured to cab door flange with plastic fasteners and provides a weather-tight seal around door when door is closed.

Remove

Pry up old weather seal at fastener locations and remove complete seal from cab door flange.

Install

- 1. Obtain new seal.
 - 2. Be sure all old fasteners have been removed and door flange is free of dirt.
 - 3. Place new weather seal into place on door flange and align fasteners over mounting holes.
 - 4. Apply pressure to each fastener to secure weather seal.

DOOR STRIKER PIN

Door striker pin (Fig. 26) mounted on lock pillar provides for positive engagement with the door latch assembly (Fig. 20). Striker pin removal and installation requires a special driver tool. Enlarged mounting hole in lock pillar permits adjustment.

For complete details on striker pin adjustment, see "CAB DOOR ADJUSTMENT".

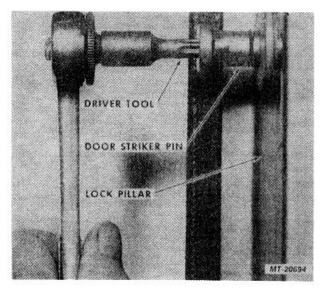


Fig. 26 Removing or Installing Door Striker Pin

CAB DOOR ADJUSTMENT

Getting a good cab door to door opening fit requires a knowledge of where the various adjustments are located and what effect each adjustment has on door fit. These adjustments apply whether door has been removed or door adjustment is simply being changed or improved.

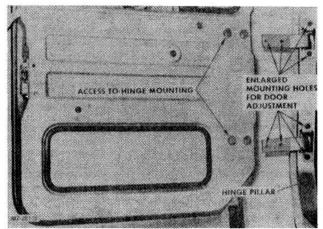


Fig. 27 Location for Door Adjustments at Hinge Pillar

- 1. Adjustment at Hinge Pillar (Fig. 27)
 - a. Fore and aft door adjustment is made at enlarged holes in door half of hinge.

- b. Up and down or in and out door adjustment is made at enlarged holes in pillar half of hinge.
- With mounting bolts slightly loosened, one hinge at a time, adjust door to fit evenly in door opening and snug against door seal. Tighten mounting bolts to specified torque (see Torque Chart).

2. Adjustment at Lock Pillar (Fig. 26)

- Door striker pin or stud is mounted in an enlarged hole in lock pillar. Loosen pin to move pin up or down and in or out as required.
- b. Fore and aft adjustment is by spacer shim between striker pin and pillar.
- Make final adjustment of striker pin and tighten to specifications (See Torque Chart).

When adjusted (1) door weather seal should contact door frame all around with slight pressure but without damage to seal (2) door should latch, lock and release without undue effort, and (3) door should be rattle free when vehicle is in motion.

DRIVER AND PASSENGER SEATS

Seat types available with S-Series cabs are determined by cab width and by the kind of equipment (engine, transmission, auxiliary, etc.) furnished with the truck. Full width bench seat and individual driver and passenger seats are available in the 200 cm (80 inch) wide cab. Individual driver and passenger seats only are available in the 230 cm (90 inch) wide cab. Mechanical and air suspension seats are also available optionally.

FULL WIDTH BENCH SEAT (Fig. 28)

Full width bench seats have fore and aft seat adjustment standard. Adjustable seat backs however, are available only on models having custom trim.

The fore and aft seat adjuster assembly consists of two integral sliding rail assemblies, the upper halves of which are bolted to seat bottom and lower halves to seat risers. Risers are firmly bolted to cab floor.

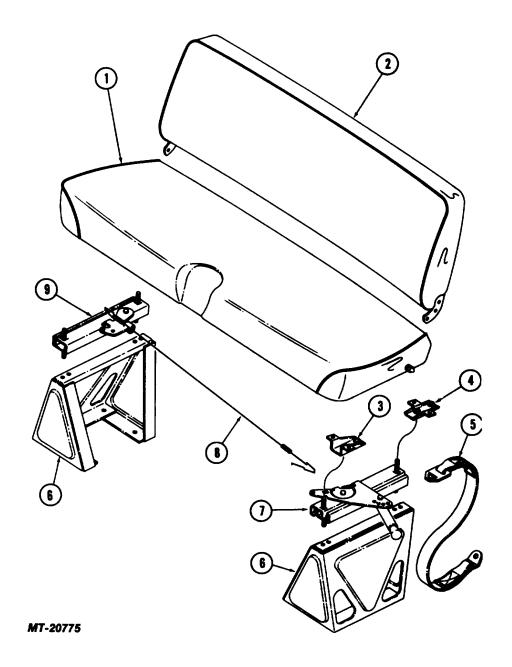


Fig. 28 Full Width Bench Seat - Standard Trim - Exploded View

Legend for Figure 28

Key	Description	Key	Description
1	Cushion, Seat Assembly	2	Cushion, Back with Support
3	Bracket, Seat Adjuster, Front	4	Bracket, Seat Adjuster, Rear
5	Belt, Seat	6	Riser, Seat
7	Adjuster, with Handle, Seat Left	8	Wire, Seat Adjuster
9	Adjuster, Seat, Right		·

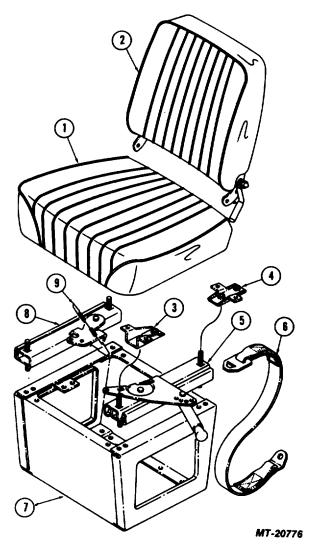


Fig. 29 Individual Drivers Seat - Custom Trim Exploded View

Legend for Figure 29

Kev Description

- 1 Cushion, Seat Assembly
- 2 Cushion, Back with Support
- 3 Bracket, Seat Adjuster Front
- 4 Bracket, Seat Adjuster Rear
- 5 Adjuster with Handle, Seat Left
- 6 Belt, Seat
- 7 Riser, Seat
- 8 Adjuster, Seat, Right
- 9 Wire, Seat Adjuster

INDIVIDUAL DRIVERS SEAT (Fig. 29)

Individual drivers seats are similar in construction to the bench seat and have the same adjustment features and mechanisms. Individual passenger seats however are fixed in one floor position.

Removal and installation procedures which follow apply to both the full width bench seat and the individual drivers seat.

Remove

- Remove the four bolts which secure the upper adjuster rails to seat bottom on right and left side and detach seat and back assembly. Slide seat fore and aft as necessary for access to mounting bolts.
- 2. Unlock seat adjuster wire between the two rails.
- 3. Remove two bolts which secure lower half of each seat adjuster to seat riser and remove right and left seat adjusters.
- Clean seat adjusters as required. Apply a light coat of multipurpose lube (IH 251 HEP) to rails to assure a smooth operation on reassembly. Wipe away excess lube.

Install

Seat installation procedure is the reverse of removal. See Torque Chart for specified mounting torques.

WINDSHIELD

The windshield used with the S-Series cab is either one or two piece flat glass type depending on whether cab is the 200 or 230 cm (80 or 90 inch) width model. A molded weather seal (weather strip) with either an integral or detached insert fits perimeter of glass to retain glass in windshield opening. Seam between halves of two piece windshield is closed with inner and outer division bars and seals. When replacing windshield always use a new weather seal since a used weather seal is likely to be stretched or deteriorated and susceptible to leaks.

Remove

If either windshield or weather seal must be replaced, procedure is as follows:

- Remove washer hose from fittings on top of cowl.
- 2. Remove cap nut and detach windshield wiper arms (Fig. 30).

For further information on S-Series windshield wipers and washers see BODIES AND CABS CTS-2732.

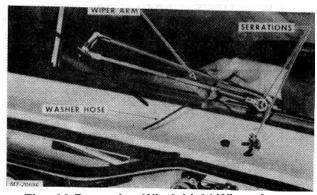


Fig. 30 Removing Windshield Wiper Arms

- 3. Pry integral or detached insert from weather seal with a thin blade screwdriver or seal tool (SE-2442) (Fig. 31) around entire glass.
 - See Fig. 32 for details of weather seal.
- 4. If windshield is two piece type remove inner and outer division bars and seals (Fig. 33).

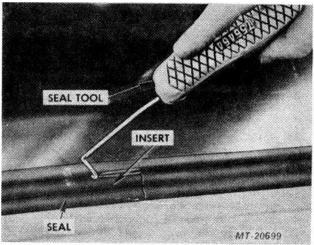


Fig. 31 Removing Windshield Weather seal Insert

- 5. Working with one man outside cab and an assistant inside apply light pressure on windshield from inside of cab to push glass from seal. Be careful during this operation since heavy pressure at any one point can lead to glass breakage.
- 6. Lift glass from opening and peel weather seal from fence (weld flange).

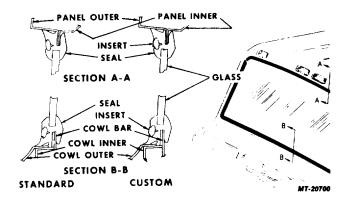


Fig. 32 Windshield Weather seal (Retainer)

Install

IMPORTANT Before installing new weather seal or windshield, clean body flange and glass free of dirt, old sealing compound, wax, etc.

- Coat weather seal with a soapy solution or rubber lubricant for ease of assembly.
- Install weather seal carefully around edge of windshield opening flange. Position splice joint of seal ends at centerline of cab and on lower flange.
- 3. Working from outside the cab, place windshield in channel of weather seal, starting at lower edge of opening.
- 4. For two piece type windshield install inner and outer division bars and seals. Check seal details (Fig. 33).
- Work weather seal insert (Fig. 31) down into groove provided around entire weather seal. Use seal tool or a dull screwdriver to seat insert in groove. A second coat of rubber lubricant in groove will simplify installation.

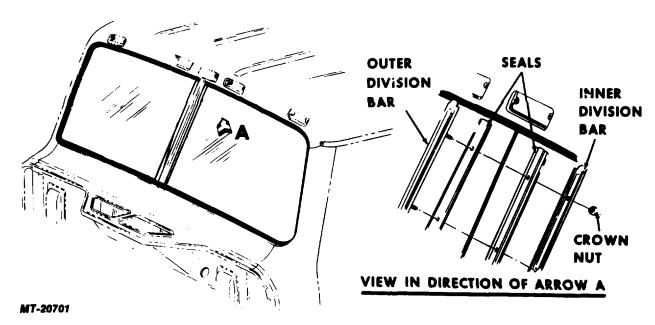


Fig. 33 Details of Windshield Division Bar (230 cm or 90 Inch Cab Only)

REAR WINDOW GLASS

Cab rear window glass (Fig. 34) is secured in cab rear window opening with a molded one piece weather seal with integral insert similar to that used for windshield. The weather seal fits around edge of glass and is so formed, that it retains the glass in window opening by fitting over the window opening flange. Old or deteriorated weather seals should not be reused whenever window glass is replaced.

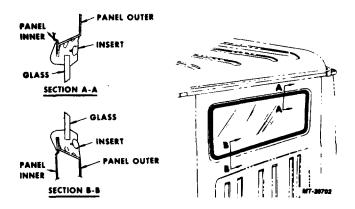


Fig. 34 Cab Rear Window Glass and Weather seal

Remove

- 1. Pry out integral insert of weather seal with seal tool or a thin blade screwdriver around entire perimeter of glass.
- 2. Working with an assistant, one man inside cab and one man outside, gently push glass from inside out.
- 3. Lift glass from opening.

<u>Install</u>

IMPORTANT Before installing new weather seal or window glass, body flange and glass must be cleaned free of dirt, old sealing compound, wax, etc.

- 1. Coat weather seal with a soapy solution or rubber lubricant for ease of assembly.
- 2. Position weather seal carefully around edge of rear window glass opening flange.
- Working from outside the cab place rear window glass in channel of weather seal starting at lower edge of opening.
- 4. With glass completely seated in weather seal channel start working weather seal insert down into groove provided with seal tool or dull screwdriver. A second coat of rubber lubricant will expedite this step.

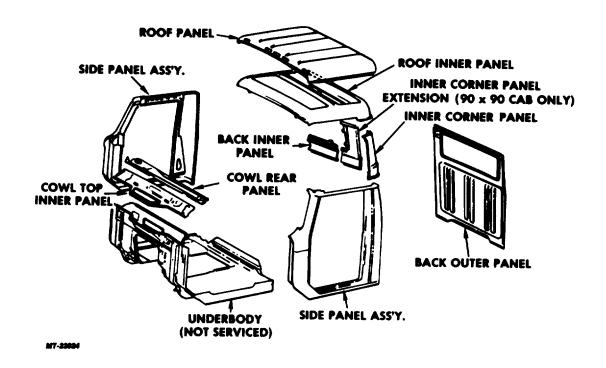


fig. 35 S-Series Cab Panels

SHEET METAL REPAIRS

A special feature of the S-Series Cab is the availability of complete body panels for repairing the cab. The types of panels available are shown in Fig. 35. These panels enable a service man to restore a damaged cab to new condition without the usual problems associated with cab rebuilding. Extensive metal refinishing is not required and most restoration welds are in areas of low stress.

SHEET METAL TOOLS

To perform the necessary cab sheet metal disassembly and rebuild work, the special tools listed here should be on hand. Most of these are common to any cab or body rebuilding shop.

- 1. Electric or pneumatic drill.
- 2. Sheet metal drill bits.
- 3. Pneumatic chisel (SE-2664 or SE-2129).
- 4. An assortment of C-clamps.
- 5. MIG welder (SE-2640).

6. Weld wire Spec. No. E70S-3.

PREPARING CAB FOR PANEL REMOVAL

Before sheet metal repairs to cab can be started some mechanical work must be performed. This will depend on cab damage and which panel is being replaced. Since the side panel (Fig. 36) or door frame is a commonly replaced panel, let us use the left side panel replacement as an example for what mechanical work is required. The following items must be removed:

- 1. Left door, seat and interior trim.
- 2. Dash pad and instrument panel left side mounting.
- 3. Roof and back panel liners.
- 4. Left scuff plate and floor mat.
- 5. Windshield and rear window glass.
- 6. Junction boxes, relays, dimmer switch, wiring harness and brake piping.
- 7. Marker light harness and air horn supply line.
- 8. Fuse block, junction block and starter solenoid.
- 9. Fuel or air tanks.
- 10. Cowl top outer panel.

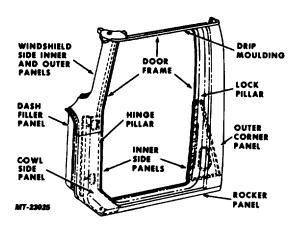


Fig. 36 Components of Side Panel Assembly

REMOVING SPOT WELDS

The actual side panel removal requires the drilling out of spot welds which attach the side panel to other panels of the cab. Sheet metal drill bits should be used. These are drill bits, the ends of which have been ground for this special purpose. An example of a sheet metal drill bit as compared to a regular drill bit is shown in Fig. 37. When spot welds have been removed, a pneumatic chisel is then used to open seams which have been clinched together.

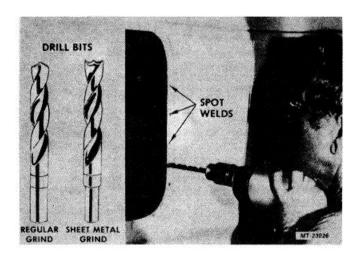


Fig. 37 Removing Cab Inner Corner Panel

SIDE PANEL REMOVAL

- For access to back panel joint, remove cab inner corner panel. Remove trim strip between corner panel and inner roof panel and drill out spot welds (Fig. 37) around panel. Separate corner panel from back panel, inner roof panel and side panel assembly.
- Separate inside panel of side panel assembly from sill side inner panel. Free inside panel of side panel assembly by cutting through MIG weld (Fig. 38) at bottom of panel. (On 80" wide cabs remove spot weld used at cowl side inner panel).
- Drill out spot welds along drip moulding from front to rear and around corner to end of side panel. Separate side panel from outer roof panel (Fig. 39).

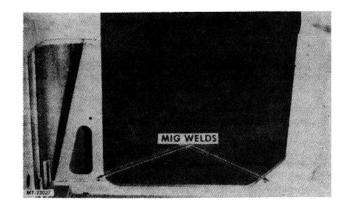


Fig. 38 Location of MIG Weld Seams

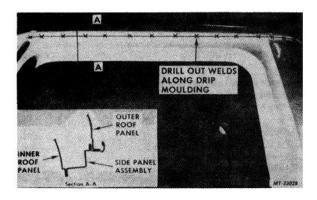


Fig. 39 Side Panel to Outer Roof Panel Spot Welds

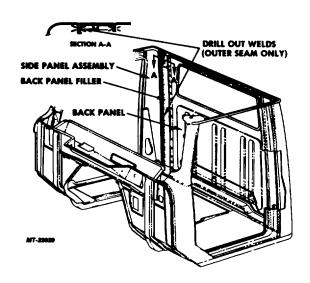


Fig. 40 Side Panel to Back Panel Spot Welds (Right Corner 90" Wide Cab Shown)

- 4. Drill out spot welds along seam between back panel
- 5. Drill out spot welds along seam at bottom of cab and
- 6. Drill out spot welds at seam between dash filler panel
- 7. Drill out five spot welds and separate windshield side

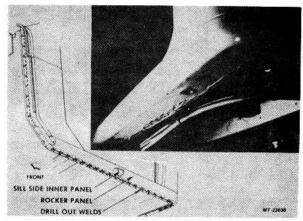


Fig. 41 Rocker Panel to Sill-Side Inner Panel Spot Welds

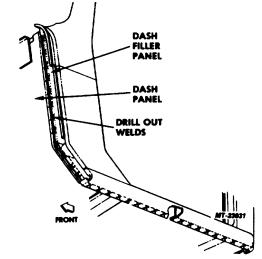


Fig. 42 Filler Panel to Dash Panel Spot Welds

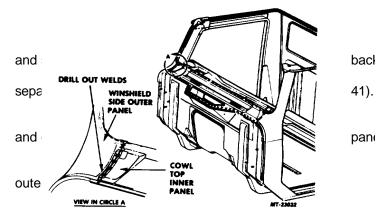


Fig. 43 Windshield Outer Panel to Cowl Inner Panel

8. Drill out six spot welds and separate windshield side

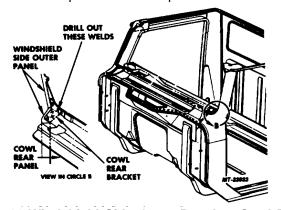


Fig. 44 Windshield Side Outer Panel to Cowl Rear Panel and Bracket Spot Welds

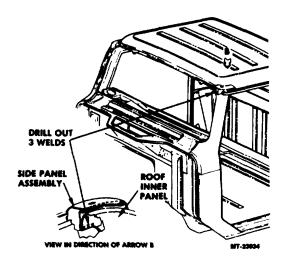


Fig. 45 Side Panel to Roof Outer and Inner Panel Spot Welds (Outer Roof Panel Not Shown)

- 9. Drill out three spot welds and separate side panel
- 10. Drill out fourteen spot welds along top of door

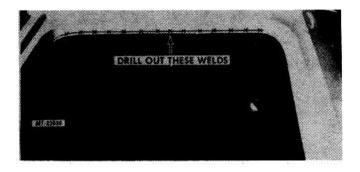


Fig. 46 Side Panel to Roof Inner Panel Spot Welds

- 11. Drill out fifteen spot welds along bottom of door
- 12. Drill out three or four additional welds along top

IMPORTANT

Be careful while removing side panel so from roofstherward damage to roofstherward damage to roofstherward damage.

opening and separate side panel from roof inner

pane

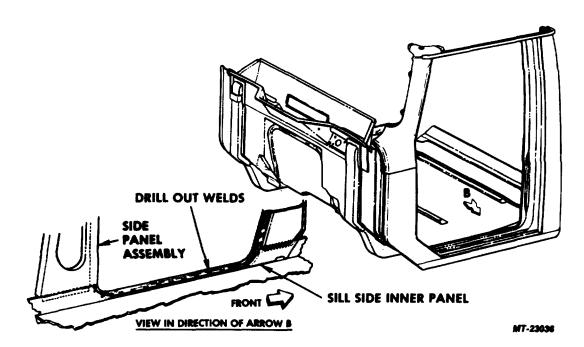


Fig. 47 Side Panel To Sill Side Inner Panel Spot Welds

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INSPECT CAB STRUCTURE FOR DAMAGE

1.

2.

3.

ALIGN NEW SIDE PANEL TO CAB

- 1. Position and clamp new side panel assembly to side
- 2. Raise roof outer panel sufficiently to insert windshield
- 3. Apply heat expanding type sealer (Plastisol or
- 4. Align panels to establish windshield opening and
- 5. Align remaining joints at dash panel, cowl, roof panel

WELDING SIDE PANEL TO CAB

1. Using MIG

CAUTION

Adjust welder so as not to damage or burn sheet metal when performing these welds.

2. Where drilled holes are not accessible such " at

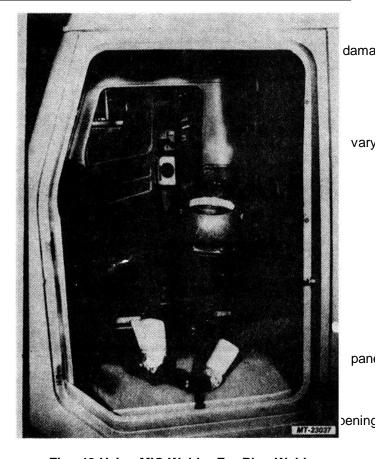


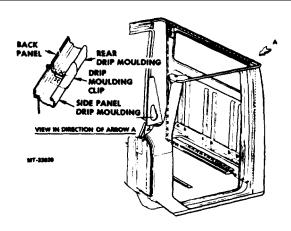
Fig. 48 Using MIG Welder For Plug Welds

3. At inside of cab weld base of inner side panels to sill



Fig. 49 Seam Weld At Inside Of Side Panel

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- 4. Obtain drip moulding clip and position clip so as to
- 5. Clamp outer roof panel to drip moulding of new side
- 6. Plug weld through holes drilled for removing to

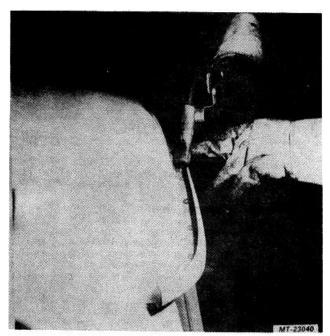


Fig. 51 Fastening Roof Panel To New Side Panel

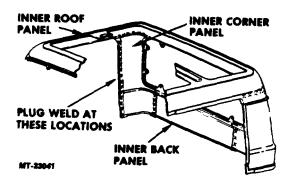


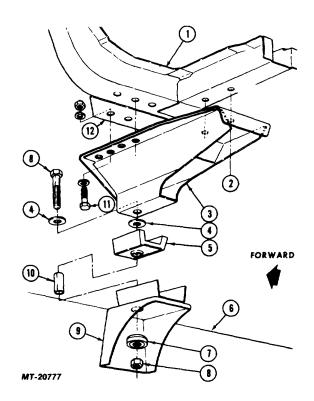
Fig. 52 Installing Inner Corner Panel (Right Side 80" Fig. 50 Securing Drip Moulding Clip

close joint between old drip moulding on back of cab and panel assembly and plug weld roof panel to moulding (Fig 7eparindansendonnalingalments and analyses (Figure 2) or If ne

8. Obtain body sealant (Plastisol Type 1 or equivalent)

9.

OTHER PANEL REPAIRS



Legend for Figure 53

<u>Key</u>	<u>'</u>		
1			
3 4 5 6 7 8			
9 10			
11			
12			

CAB MOUNTING

insulators used are maintenance free.

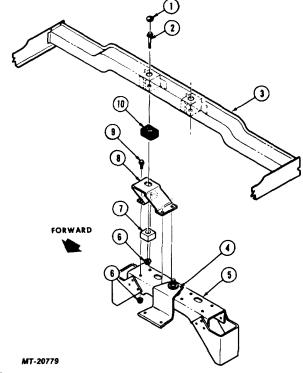


Fig. 33 Cap Front Mounting Bracket (Left Front View)

Legend for Figure 54

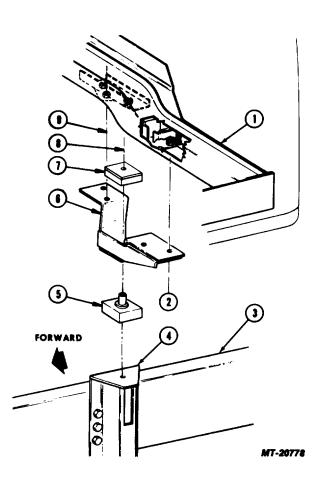
	Description Key
2	Sill, Cab Underbody Bolt, Intermediate Bracket
_	Bracket, Intermediate
	Washer, Flat
	Insulator, Water Type
	Sidemember Frame
	Insulator, Donut Type
	Bolt and Nut (Cab Mounting)
	Sidemember Frame Insulator, Donut Type Bolt and Nut (Cab Mounting) Bracket, Cab Front Mounting
	Busning
	Bolt, Nut and Washer

Cab Front Mounting

Reinforcement

A four point rubber cushioned mounting is used for securing

Cab Rear Mounting



Legend for Figure 55

Cab Stay Rods

The different cab rear mountings used for the 200 and 230 cr

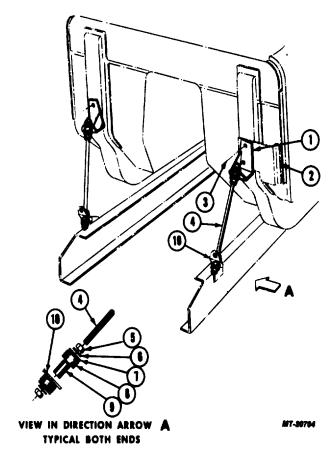


Fig. 55 Cab Rear Mounting (230 cm 90 inch Wide Cab)

Legend for Figure 56

Key

Key Description

- 1 Sill, Cab Underbody
- 2 Bolt
- 3 Sidemember, Frame
- 4 Bracket, Frame
- 5 Insulator, Lower
- 6 Bracket, Intermediate
- 7 Insulator, Upper
- 8 Bolt, Flange Head, Cab Mounting
- 9 Bolt, Hex Head

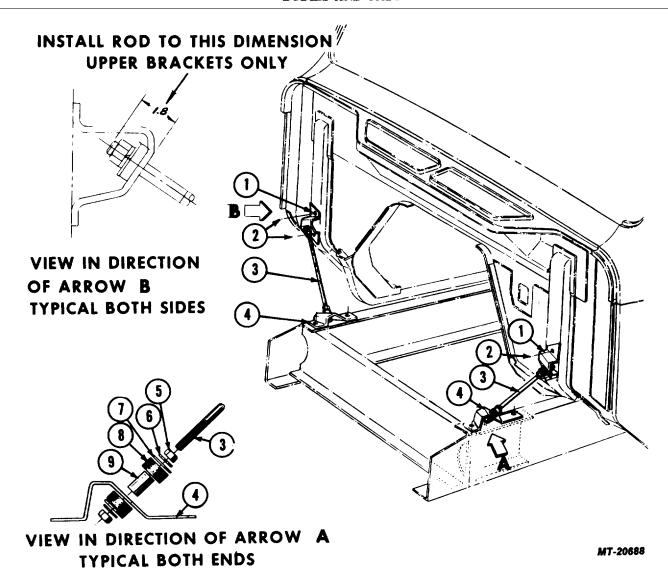


Fig. 57 Stay Rod Details for 230 x 230 cm (90 x 90 inch) Cab

Legend for Figure 57

<u>Key</u>	<u>Description</u>	<u>Key</u>	Desci	<u>ription</u>		
1	Bracket, Cab S	Stay Rod,	Upper	6	Washer, I	_ock
2	Bolt, Bracket N	/lounting	7	Wasl	her, Flat	
3	Rod, Cab Stay	8	Insula	ator, Sta	y Rod	
4	Bracket, Cab S	Stay Rod,	Lower	9	Spacer,	Stay
5	Nut, Hex 5/8-1	1				

Rod

CAB REMOVAL

front and rear locations.

The removal of the S-Series cab from chassis can be perforr

CAUTION

The following steps may be used as a guide.

Inspect all cab to frame attaching points to be

- Block wheelaref triscloand trebease plankings brake.
 result.
- 2. Tilt-or-remove-hood-----
- 3. Disconnect battery ground cable.

CAB INSTALLATION

4. Drain radiator and disconnect heater hose.

5 on Dissolver test elevining shaft lating service.

6UBRICATION accelerator linkage.

7. Disconnect electrical connections and ground

New cabs are lubricated at factory and before they are <code>BelDisconnectculstoh</code> <code>Enkagafter</code> the cab is placed in service, regular lubricating intervals based on type of <code>SerDisconnectd</code> <code>Unrectangle</code> the <code>SerDisconnectd</code> the <code>Sersion</code> at definite intervals adds greatly to cab service life and <code>ReduDisconnectd</code> expense are tachometer drive

- 11. Disconnect air conditioning lines (if so equipped).
- 12. Remove shift lever from transmission.
- 13. Detach exhaust system from cab if system is
- 14. Install cab lifting fixture. Make sure fixture is
- 15. Remove cab to frame stay rods.
- 16. Partially lift cab so cab weight will be supported

wire.

cables.

vertical type.

padded to prevent damage to cab.

on lifting fixture.

TORQUE CHART

Application	Size	N.m	Ft. Lbs.
Door Hinge Mounting Bolts	5/16-18	27-30	20-22
Hood Hinge Mounting Bolts	5/16-18	27-30	20-22
Door Striker Pin	1/2-13	60-80	45-60
Cab to Frame Mounting Bolts (Front)	1/2-13	95-115	70-85
Cab to Frame Mounting Bolts (Rear)	1/2-13	95-115	70-85
Seat Riser to Floor Mounting Bolts	5/16-18	27-30	20-22
Seat Adjuster to Seat Mounting Bolts	5/16-18	27-30	20-22
Seat Belt to Cab Sill Mounting Bolts	1/2-13	95-115	70-85
Arm Rest to Door Mounting Screws	1/4-20	2-2.5	1.5-2
Stay Rod Bracket to Dash hunting	3/8-16	26-37	19-27
Bolt Splash Shield Bracket To Cab Mounting Bolt	5/16-18	18-21	12-16

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FIBERGLASS REPAIR INSTRUCTIONS

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GENERAL

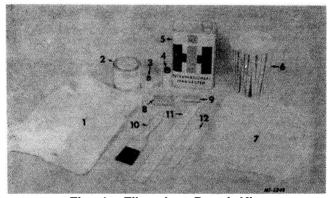


Fig. 1 Fiberglass Repair Kit.

Legend for Fig. 1

mat. The cloth or mat is then saturated with a resin. When the resin cures (hardens) it acts as a binder to Mobile ith ferhibation lass together in this forming assolited passelbeen processes.

Instructions for making fiberglass repairs to sheet metal are a provides the strength in the panel while the resin bonds the beliastastic trouget plass tiac depairphie (Fignly) and is the additional amount of strength. Therefore when repairing the section of the continuous been removed. Always overlap the undamaged portion with fiberglass patches, so that a more continuous sheet of reinforced fiberglass results.

then.

external heat supply. Cooler temperature increases the working time and hardening time.

TOOLS AND EQUIPMENT NEEDED

Key Putty Knife

1 CLOTH Electrical Drill and Bits
2 PLASTIC Fire Portion of Sander
3 PLASTIC FIRE PORTION OF SANDER
4 RESIN ACTIVATOR
5 RESIN FIRE (3)
7 MAT Acetone or Lacquer Thinner
8 SQUEEGEE (1-1/e"1 x 2")
9 SQUEEGEE (1-1/2" x 1")
10 PAINT BRUSH
11 STIRRING STICK
12 STIRRING STICK

DESCRIPTION

Fiberglass is manufactured from filaments of pure glass spur

CTS-2408 Page 2



Scissors
Polyethylene (Plastic Container Bag
Material) or Cellophane Sheets
Assorted Bolts, Nuts and Rivets.

SAFETY PRECAUTIONS

- 1. The Following When Making Repairs With Fiberglass
- Avoid spilling the resin or hardener on skin or clothing, If this occurs, remove with paint thinner or denatured alcohol. Then wash with soap and water. If the mixture contacts the eyes, flush thoroughly with water immediately. Continue flushing for at least 15 minutes and contact physician as soon as possible.
- In some cases, some individuals may have skin sensitivity to the use of these materials. Because of this, protective creams can be applied to the hands to guard against irritation.
- When protective creams are not available, rubber gloves may be used to protect the hands. The gloves can be removed quickly leaving the hands clean for other work.
- 4. When working with fiberglass always work in a well ventilated area. DO NOT SMOKE OR EXPOSE FLAME WHERE KITS ARE BEING USED OR STORED. If possible, obtain a kit of material large enough to accommodate only one or two jobs to avoid storing any quantity of this material. Resin liquid must be kept in a metal container or cabinet when not being used.
- 5. Repairs must be ground or sanded to match surrounding contours. When grinding or sanding, it is advisable to use an approved type respirator during the operation. Suitable respirators are available under equipment number SE-1798 and SE-1799. The ground dust or particles of resin or fiberglass must not be inhaled, otherwise irritation may occur.

REPAIRING FIBERGLASS

Small Holes (Under 3" Diameter):

 Remove damaged material such as loose fiberglass and bevel the edges (approximately 20°). See Fig. 2.



Fig. 2

- Remove paint from outside surface with sandpaper. Clean inner surface (if accessible).
- Cut a piece of cloth and a piece of mat so that the patches will extend past the edges of the hole about 2".
- 4. Coat both inner and outer surfaces with resin mixture and saturate both the mat and cloth.
- When tacky, apply the mat on the inner surface and the cloth to the outer surface. Press the two patches together using polyethylene. A saucerlike depression should be made. See Fig. 3.

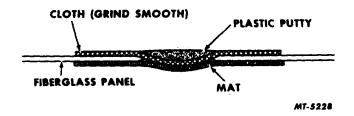


Fig. 3

- 6. Allow the material to cure. This is a chemical action and not a drying action. A hard surface indicates a hard interior. To hasten curing action, heat lamps may be used about 18" from work. Then smooth the outside surface. Additional coats of resin mixture may be added if necessary.
- 7. Apply plastic putty to fill the low spots, allow time for the putty to cure, then smooth the outside surface.

Large Holes (Over 3" Diameter):

- 1. Remove damaged material such as loose fiberglass and bevel the edges (approximately 201). See Fig. 2.
- 2. Remove paint from the outside surface



with sandpaper. -Clean the inner surface also if it is accessible.

- 3. On a piece of polyethylene place a piece of cloth cut larger than hole being repaired. Saturate with resin mixture. Obtain a layer of mat cut larger than the hole being repaired and position it on the cloth. Saturate mat also with the resin mixture.
- 4. Coat the inner surface of area being repaired with the resin mixture. When tacky, apply the patch prepared in item 3. Using the polyethylene sheetpress out air pockets and allow patch to cure.
- 5. On a piece of polyethylene, place another piece of cloth larger than hole being repaired. Saturate with resin mixture. Apply two layers of 4), saturating both with the resin mixture. Coat the outer surface of area being repaired with the resin mixture. When tacky, position the entire patch on the prepared surface and press into position. Allow the patch to cure.

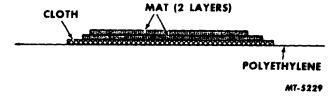


Fig. 4

- 6. After the inner and outer patches have cured, peel off the polyethylene and smooth the outer surface. Any of the polyethylene material left on patch will be removed when sanded.
- 7. In the resulting low spots, apply plastic putty. Then over the putty place another sheet of polyethylene and squeeze well to remove all air. When putty has cured, remove polyethylene and sand down to a feather edge.

Crack or Split:

- 1. Remove loose material and grind to a broad "V" (Fig. 5). Clean inner panel also.
- Align parts. A nut and bolt with large flat washers may be used to. draw parts together. See Fig. 6.
- 3. Cut one or two pieces of mat and apply

to inner surface with resin mixture. (On cracks where excessive stresses may occur, apply two pieces of mat). Apply a piece of cloth with the resin mixture to the inner surface also. Extend patches beyond break about 2". Press the patches firmly into place and allow to cure. NOTE: It is a recommended procedure to leave the washer and nut (if used) in the patch if the mat and cloth were applied over them.

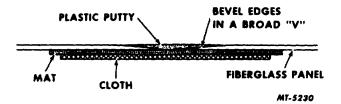


Fig. 5

Mix a fresh supply of plastic putty and apply over the outside surface filling the large "V" like valley (Fig. 5). Before the plastic putty cures, remove the bolt and washer (if used) from the outside and fill the hole with putty and allow to cure.

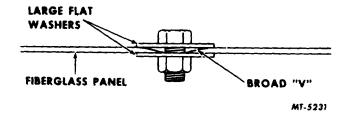


Fig. 6

5. After the putty has cured, sand down to the exposed surface.

Small Scratches or Chipped Area:

(No damage to basic fiberglass structure)

Remove paint from area being repaired and fill damaged area with a plastic putty mixture. After area has cured sand smooth.

FIBERGLASS SERVICE FENDER INSTALLATION (D-400 Series Illustrated)

1. Remove and place hood assembly on level surface or support frame. See Fig. 7.Hood should be blocked so it is horizontal

TRUCK SERVICE MANUAL



- as nearly as possible. See Fig. 8.
- Using service fender for template, scribe line on hood and remove remaining damaged portion of hood assembly as shown in Fig. 7. Maintain a straight cut on all edges. Before making cutout, measure down one inch below scribe line to allow for service fender flange overlap over hood for firm attachment base. See Fig. 8.

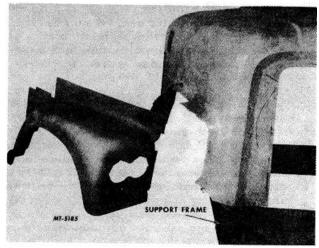


Fig. 7 Service Fender and Damaged Hood Assembly.

 Cut out any remaining portion of hood and fender in damaged area. Maintain 90O angles at corners. See Fig. 8. Recommended cutting tools are disc (carboflex with masonry blade) or sabre saw with steel blade. NOTE: Use of face mask and safety goggles are required as protective equipment.

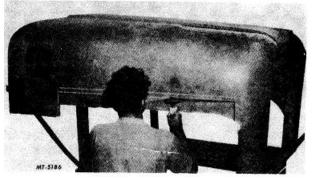


Fig. 8 Service Fender Cutout.

4. Recheck service fender alignment with cutout. Special precautions should be taken to remove all road film or undercoating with acetone. Stiffener surfaces

- must be ground down to service fender thickness to insure proper bonding. Grind all surfaces and edges to be bonded down to mat surface. Use coarse sandpaper (A.L.O. 26, 36 or 50 grit).
- 5. Secure fender to hood with "C" clamps. Locate fender flanges to inside of hood. See Fig. 9.

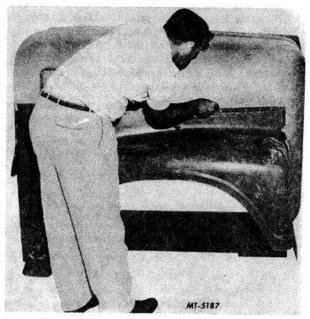


Fig. 9 Service Fender Positioning.

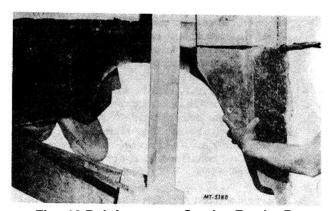


Fig. 10 Reinforcement Service Fender Rear.



- 6. After clamping fender to hood on D-400 series check position of lower corner of inside rear reinforcement channel. In some cases, the rear reinforcement channel corner will not line up with inside hood channel. See Fig. 10. This is due to slight variations of hoods. To position correctly, cut off reinforcement for reinstallation after fender has been attached.
- 7. Drill holes from inside of hood through fender flanges for installation of No. 10 sheet metal screws to hold fender in place. Holes should be spaced 3 to 4" apart. Observe fender alignment to hood. See Fig. 11.

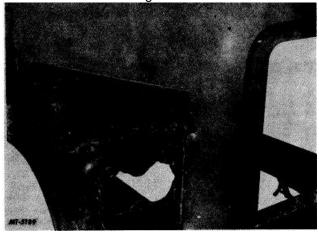


Fig. 11 Service Fender Mounting.

- Grind or buff all joining edges and radius to normal thickness on cowl contours. Blow off all surfaces and corners. Clean with acetone on a soft cloth.
- 9. Cut several four inch strips of mat material (2" each side of seam). Then on a piece of polyethylene position two layers of mat saturated with the resin mixture. Apply resin mixture to the inside of hood where material is being repaired. When tacky, position the strips (2 layers) over seam. Use the polyethylene to press out air bubbles. Allow to cure.. Additional coats of the resin mixture may be applied to the area if desired. NOTE: If holes are left where the new fender may not cover the damaged area, repair these places as outlined in instruction for repairing holes.
- Refer to item 6. If required, remount inside rear channel reinforcement corner. Grind edges and mounting surfaces for proper bonding. Apply saturated sections

- of mat to all edges and seam to hood channel. If corner positions correctly as applied on fender, apply mat required to joining seam only. Brush out air bubbles with a squeegee.
- Before proceeding on outside repairs, allow inside sections to harden. To speed drying or curing time, apply heat with lamps. No further inside refinishing is required. Surfaces may be undersealed.
- 12. Grind off outside screw threads holding fender in place just below seam surface. Take grinder or sander and dish out concave strip approximately one inch wide along hood and fender seams.
- 13. Apply one four inch strip of mat saturated with the resin along concave hood and fender seams. Next apply a four inch strip of cloth saturated with the resin mixture to the fender seams for additional strength. Use a squeegee or polyethylene sheet to force out entrapped air. Allow time for assembly to cure. Trim off any mat overhang at edges.
- Grind or sand all outside hood and fender joined laminated seams. See Fig. 12



Fig. 12 Service Fender and Hood Refinishing.

- 15. With plastic putty fill any existing low spots or surface cracks with plastic putty.
- 16. Sand the entire exterior smooth, using a #400 grit paper. See Fig. 12. Clean surface with acetone or laquer thinner. Apply prime coat and follow with standard automotive refinishing procedures. See Fig. 13.

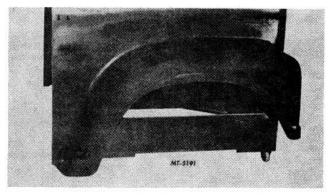


Fig. 13 Repaired Hood and Fender Assembly.

REPAIRING SHEET METAL WITH FIBERGLASS

Small Holes (Under 3" Diameter):

Repair on sheet metal as well as fiberglass can be made with the fiberglass reinforced plastic repair kit. It can be used to repair torn holes, rust holes and damaged surfaces which are difficult to refinish with the usual sheet metal repair procedures.

- Clean metal to bare surface with No. 16 or 24 grit sandpaper approximately 6" beyond area being repaired.
- 2. Indent area being repaired about 2" beyond damaged area.
- Cut a piece of mat about 1" larger than the surface being repaired, then a piece of cloth (two or three pieces of mat may be used to fill the indented area).
- Brush the resin mixture on the damaged area and then saturate the layers of mat and cloth being used. Allow the resin mixture to get tacky.
- 5. Apply the mat and cloth patches, pressing the laminations down tightly with a sheet of polyethylene to produce a tight bond. (The cloth patch is installed last). See Fig. 14.

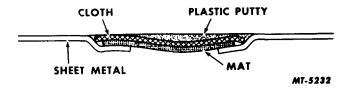


Fig. 14

6. Allow material to cure.

- 7. Sand and file surface after patches have cured.
- 8. Mix up a plastic putty mixture and fill low areas.
- 9. Allow the putty to cure, then sand smooth.

Large Holes (Over 3" Diameter):

- Clean metal to bare surface and dent in surface being repaired as in items 1 and 2 for "Small Holes".
- On a piece of polyethylene position a piece of cloth larger than hole being repaired. Saturate with resin mixture. Apply two layers of mat (Fig. 4) saturating both with the resin mixture. Now place the entire patch on the prepared surface and press on to metal. See Fig. 15. Allow the patch to cure, then peel off polyethylene.

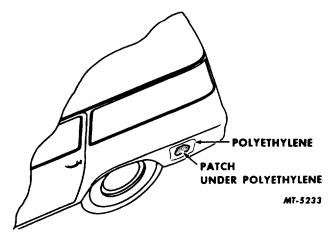
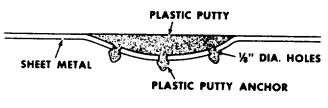


Fig. 15

3. In the resulting low spots, apply plastic putty. Then over the putty position another sheet of polyethylene and squeeze well to remove all air. When putty has cured, remove polyethylene and sand down to a feather edge.

Dents:

- 1. Clean metal to bare surface.
- 2. Drill or punch 1/8" holes in the dent to assure a good anchor for patch. See Fig. 16.
- If the dent is over 1", cover dent with piece of cloth and saturate with resin mixture. Allow to cure.



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Fig. 16

- 4. Force plastic putty in dent with a stiff brush to break air bubbles.
- 5. After putty cures and if any air bubbles appear, open them with a knife and apply more putty.
- 6. Sand to feather edge.



AIR SUSPENSION SEAT

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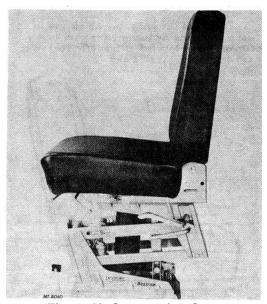


Fig. 1 Air Suspension Seat

DESCRIPTION

The suspension system of the Levelair air suspension seat, Fig. 1, utilizes an air cylinder with air supplied by the vehicle air system.

This seat features instant, automatic adjustment to the vehicle operator's size and weight, thereby seating him at the proper height and providing a jolt-free, vibrationless ride. A new fore and aft isolator eliminates back slap.

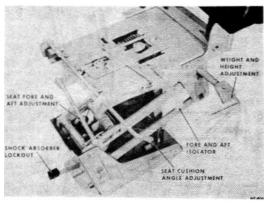


Fig. 2 Seat Adjustments

OPERATION AND ADJUSTMENTS

Operator's Weight

A squeeze lever is provided at the left rear of the seat assembly, Figs. 2 and 3, to adjust the seat to the operator's weight and desired height.

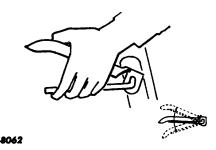


Fig. 3 Height and Weight Adjustment Controls

By squeezing the air control lever as the operator sits down, a valve assembly is actuated to either admit or exhaust air from the air cylinder assembly. This automatically adjusts the seat to properly suspend the vehicle operator's weight within the ride zone as shown in Fig. 4.

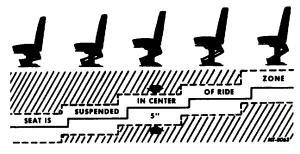


Fig. 4 Ride Zone

The ride zone is approximately five inches (top to bottom). The seat automatically moves to the center of the ride zone, thus preventing "topping" or "bottoming", Fig. 4.

Seat Height

The seat height (ride zone) can be adjusted up to three inches to suit the vehicle operator.

To change seat height, grasp adjuster lever at left rear of seat, Figs. 2 and 3. Squeeze and rotate lever up or down until desired height is reached.

NOTE: The seat height adjustment is an air power adjustment. It is not necessary to lift the seat with the adjustment lever.

Back Cushion Positions

To adjust the back cushion to any position within the provided range, pull or push adjustment lever at right rear of seat until desired position is obtained, Figs. 2 and 5.

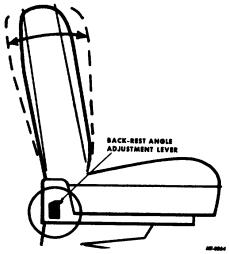


Fig. 5 Back Cushion Position Adjustment Lever

Fore and Aft Positions

The seat can be positioned fore and aft within a four inch range by movement of the foreaft adjustment lever located at the left front of the seat assembly, Figs. 2 and 6.

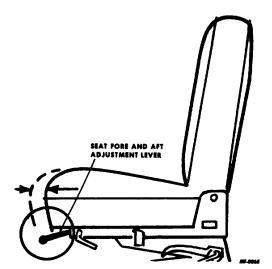


Fig. 6 Fore and Aft Adjustment Lever

Seat Cushion Angle

The front of the seat may be raised to any of four positions by turning the cam lobe adjustment lever located at the left front of the seat assembly, Figs. 2 and 7.

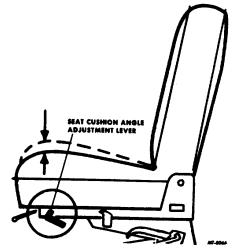


Fig. 7 Seat Cushion Angle Adjustment Lever

Fore and Aft Isolation

Isolation of the operator to eliminate seat back-slap can be obtained by pulling out and toward the rear the lever located at left center of seat assembly, Figs. 2 and 8. The lever will lock in this position and permit the seat assembly to float. To lock the seat assembly in a stationary position, move lever forward and in toward seat assembly.

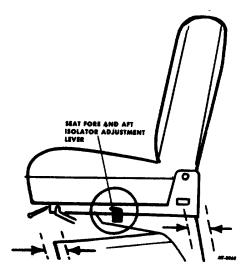


Fig. 8 Fore and Aft Isolator Lever

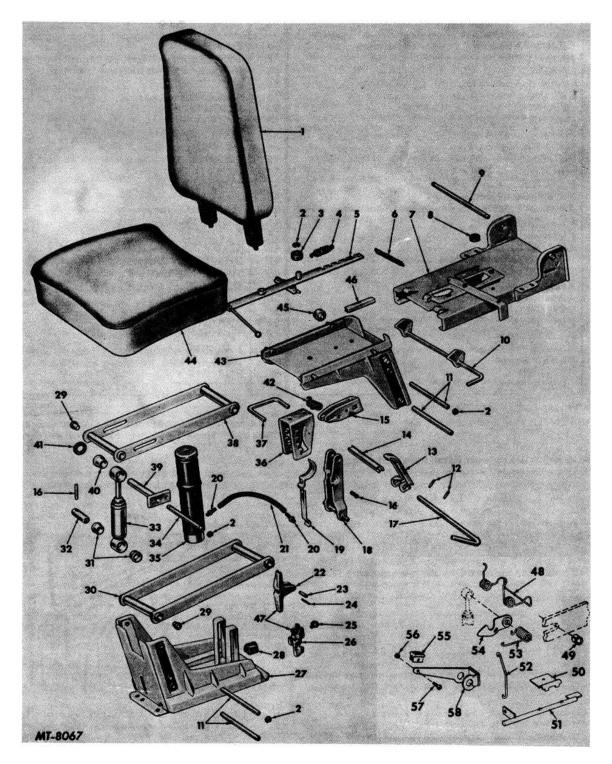


Fig. 9 Air Suspension Seat (Exploded View)

Legend for Fig. 9

<u>Key.</u>	<u>Description</u>	<u>Key.</u>	<u>Description</u>
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29	CUSHION, Back CLIP, Retaining BUMPER SPRING LATCH ASSEMBLY SPRING CHANNEL with LATCH* WASHER, Rubber SHAFT, Pivot CAM ASSEMBLY SHAFT PIN, Roll, 1/4" x 1" HANDLE EXTENSION, Bushing ARM, Adjusting PIN, Roll ROD, Adjusting LEVER ASSEMBLY FOLLOWER ASSEMBLY FITTING HOSE, Air Supply ARM, Rocker* PIN, Roll PIN,	30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58	ARM, Lower* BEARING PIN, Shock Absorber Mounting SHOCK ABSORBER SHAFT CYLINDER, Air RACK* ROD, Weight Adjustment ARM, Upper* TUBE ASSEMBLY BEARING NUT, Push-On* SPRING PANEL, Upper* CUSHION, Seat ROLLER STRIPPING VALVE AND ARM ASSEMBLY SPRING, Torsion BUSHING, Spacer CLIP, Trip Rod ROD, Trip WIRE, Hook SPRING, Torsion LATCH, Lockout PAD, Foot NUT SCREW LEVER, Foot Release
. 101 001 110	ed separately.		

DISASSEMBLY

To disassemble seat assembly, refer to Fig. 9. NOTE: All key numbers refer to Fig. 9.

Remove retaining clip from pivot shaft (9). Support back cushion (1) and remove pivot shaft. Lift off cushion. Remove back cushion position adjusting lever.

Remove bolts and flat washers securing seat cushion (44) to channel and latch assembly (7). Lift off seat cushion and rubber washers (8).

Disconnect air supply line at fitting in valve (26).

Exhaust air from cylinder (35) by squeezing handle (13) and adjusting rod (17) together.

Remove mounting bolts securing seat assembly to cab floor. Lift out seat.

Pull and lock out seat isolator lever.

Pull and hold adjustment lever on latch assembly (5). Move channel assembly (7) forward so that spring (6) at rear of latch assembly can be removed.

Move channel assembly (7) forward ahead of rear

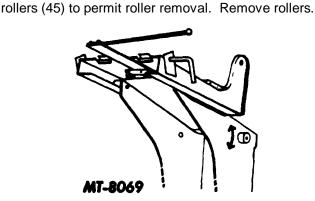


Fig. 10 Removing Channel Assembly from Upper Panel Assembly

Lift channel assembly (7) sufficiently to clear roller shafts (11) and slide assembly off of upper panel assembly (43), Fig. 10.

NOTE: Springs (4): nay catch on forward edge of panel assembly. If this happens, push springs up so that channel can be moved back.

Remove capscrews and washers from top and bottom of air cylinder (35).

NOTE: Observe position of trip rod retaining clip (50) between lower end of air cylinder and seat base (27) so that it can be installed properly during reassembly.

Remove screw and washer securing valve assembly (26) to seat base (27).

Raise and support upper panel assembly (43) at maximum height to permit air cylinder (35), hose (21) and valve (26) to be taken out through front of seat, Fig. 11. Note hose routing through seat assembly during removal to aid in reassembly.

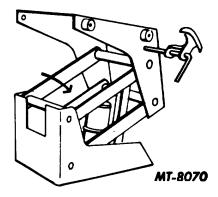


Fig. 11 Upper Panel Assembly Raised to Permit Air Cylinder Removal

Remove torsion spring (48). Disconnect wire hook (52) from lockout latch (54). Remove wire hook and trip rod (51). Note how wire hook is installed to insure proper reassembly.

Remove screw securing tube assembly (39) to upper arm assembly (38). Remove retaining clip (2) from either end of shaft (34). Take out shaft.

Push shock absorber down and towards rear of seat base to provide clearance for removal of tube assembly (39). NOTE: Upper panel assembly must be raised to maximum height.

Remove tube assembly (39), torsion spring (53) and lockout latch (54) as an assembly by pulling tube out of shock absorber. Separate torsion spring and latch from tube.

Remove retaining clips (2) from shafts (11) from upper and lower arm assemblies. Drive out shafts. NOTE: When removing shafts use a drift punch or rod just slightly less in diameter than the shaft, otherwise end of shaft may be mushroomed during removal.

Tilt upper panel assembly sideways to remove lever assembly wear sleeves (18) from channels on seat base (27). Lift off upper panel assembly (43) and upper and lower arm assemblies (38 and 30).

Remove lever assembly bumpers (28) from seat base.

Remove roll pin (16) and shock absorber lower end mounting pin (32). Take out shock absorber (33) and bearings (31). Remove bearing (40) from upper end of shock absorber.

Remove foot release lever (58) from seat base (27).

Remove capscrews securing latch angle to upper panel assembly (43).

Remove pin from weight adjustment rod (37) and take out rod. Remove lever assembly (18) and follower assembly (19) as an assembly. Take out rack (36). Separate follower from lever by removing roll pin (16).

Remove pins (12) from adjusting rod (17). Withdraw adjusting rod and take out spring (42), adjusting arm (15), weight adjustment lever (not illustrated), bushing extension (14) and handle (13).

Hose (21) and fittings (20) may be removed from air cylinder (35). To remove rocker arm (22) from valve (26), take out pins (23 and 24).

Take out cotter pins and remove springs (4) from channel assembly (7). Remove screw and washer securing latch assembly (5) to channel assembly (7). Remove latch assembly.

Remove retaining clip (2) and bumper (3) from latch assembly (5).

Remove isolator lever spring.

Seat cushion cam assembly (10) may be removed by bending up securing tangs on channel assembly (7).

CLEANING, INSPECTION AND REPAIR

Thoroughly clean all parts. Examine all parts for wear or damage and replace where necessary.

REASSEMBLY

Lubricate all pivot points, sliding areas and rollers with "Lubriplate" or its equivalent during reassembly.

Install seat cushion cam assembly on channel assembly (7) and secure by bending tangs around rod. NOTE: Do not tighten tangs on rod excessively, as binding will result.

Install isolator lever spring.

Place bumper (3) on latch assembly (5) and secure with retaining clip (2).

Position latch assembly (5) in channel assembly (7) and secure with screw and washer.

Install springs (4) on underneath side of channel assembly by hooking one end to latch and securing opposite end to channel with cotter pin.

Assemble rocker arm (22) to valve (26) and install pins (23 and 24). Attach valve to air cylinder (35) with fittings (Z0) and hose (21).

Install handle (13) and bushing extension (14) on adjusting rod (17). Insert rod through upper hole on left side of upper panel assembly (43).

Position weight adjustment lever inside adjusting arm (15) and slide them on rod (17), indexing bushing extension (14) with adjusting arm (15). Place spring (42) on rod (17) and push end of rcd through upper hole on right side of upper panel assembly (43).

NOTE: Large hook end of spring is installed on adjusting rod first.

Install pin (12) in right-hand end of adjusting rod (17). Place small hook on spring (42) over pin (12). Opposite end of spring hooks over adjusting arm (15).

Install pin (12) securing weight adjustment lever to adjusting rod (17).

Position rack (36) in upper panel assembly (43).

Assemble follower (19) to lever assembly (18) and secure with pin (16).

Align holes in lever assembly with elongated holes in adjusting arm (15) and secure assembly by inserting short leg of weight adjustment rod (37) through holes. Long leg of rod is inserted through rack (36). Secure rod (37) by installing pin through adjusting arm and into adjustment rod.

Secure latch angle and rack (36) to upper panel assembly (43) with capscrews and washers.

Position foot release lever (58) in seat base (27).

Install upper and lower bearings (40 and 31) in shock absorber (33). Align shock absorber and foot release lever and secure to seat base with mounting pin (32). Install roll pin (16) in mounting pin (32).

Attach lever assembly bumpers (28) to seat base.

Place lower arm assembly (30) in seat base first, then upper arm assembly (38) next. Tilt upper panel assembly (43) sufficiently to position lever assembly wear rollers (18) into guides on seat base.

Install new bushings (29) in upper and lower arm assemblies. Align arm assemblies with seat base and upper panel assembly and install shafts (11).

Secure shafts with retaining clips (2).

NOTE: Be certain that components are properly aligned before attempting shaft installation, otherwise bushings may be damaged. Also, do not mushroom ends of shafts during installation.



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Fig. 12 Lockout Latch, Spring and Tube

Place torsion spring (53) and lockout latch (54) on tube (39), Fig. 12. NOTE: Long hook on spring is placed next to plate on tube.

Raise to maximum height and support upper panel assembly (43).

Depress shock absorber as far as possible and pivot it towards rear of seat sufficiently to provide clearance for installation of tube assembly (39).

Insert tube through shock absorber upper bushing (40). Lift shock absorber to align hole in tube with elongated holes in upper arm assembly (38). Insert shaft (34) through tube and secure with retaining ring (2). Install and tighten securely screw attaching tube assembly (39) to upper arm assembly (38).

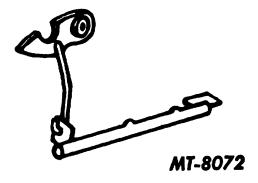


Fig. 13 Lockout Latch, Wire Hook and Trip Rod

Attach wire hook (52) to lockout latch (54) and trip rod (51), Fig. 13. Position trip rod and retaining clip (50) in seat base.

Install torsion spring (48) with coils down. Open ends press against front cross tube of arm assembly (38). Joined ends hook over tube assembly (39).

Attach rocker arm (22) to valve (26) with pins (23 and 24). Install fittings (20) in valve and air cylinder (35). Attach air supply hose (21) to air cylinder. Secure with hose clamp.

Entering through front of seat, position air cylinder with hose in seat base.

Position retaining clip (50) between nibs on trip rod with flat portion of clip under air cylinder (35), Fig. 14. The two square projections on clip must fit into the two holes in seat base (27).

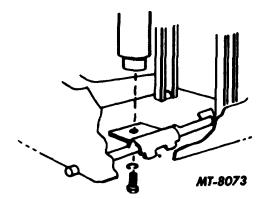


Fig. 14 Installing Trip Rod Retaining Clip

Secure upper end of air cylinder to upper panel assembly (43) and lower end of cylinder to seat base (27) using capscrews and lockwashers. Tighten capscrews securely.

Position valve assembly (26) in seat base (27) and secure to base with screw and washer. Tighten screw securely. Place hose clamp on air supply hose (21) and connect hose to valve assembly.

Install rollers (45) and channel and latch a3sembly (7) on upper panel assembly (43). Install spring (6) at rear of latch assembly.

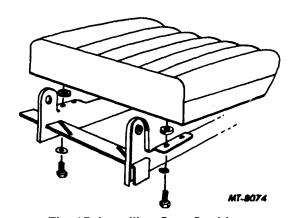


Fig. 15 Installing Seat Cushion

Place seat cushion (44) and rubber washers on channel and latch assembly and secure with bolts and flat washers, Fig. 15.

Insert back cushion position adjuster lever through slots in cushion support struts, Fig. 16.

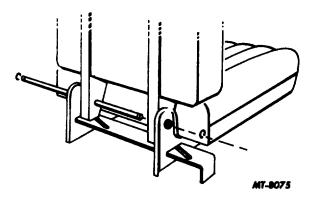


Fig. 16 Installing Back Cushion

Install back cushion by aligning holes in support struts with those in channel and latch assembly. Install pivot shaft (9) and secure with retaining clips, Fig. 16.

NOTE: Shaft will fit snugly in holes and may force strut out of vertical alignment, causing shaft to bind. If this occurs, strut should be moved sideways until it is vertically aligned and held in this position until shaft is moved into final position.

LUBRICATION

At reassembly and periodically thereafter, lubricate rollers, pivot points and sliding areas with "Lubriplate" or equivalent.



BODIES AND CABS

S-SERIES WINDSHIELD WIPER AND WASHER

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CHAPTER I WINDSHIELD WIPER (ELECTRIC)

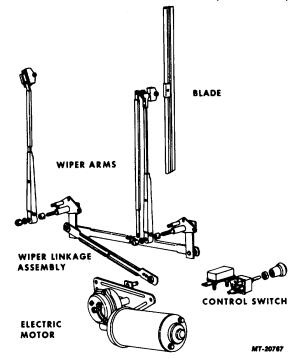


Fig. 1 Electric Windshield Wiper Components

DESCRIPTION

The standard windshield wiper available on S-Series Trucks is the electric cowl mounted dual wiper system shown in Fig. 1. Except for the control switch, which is mounted on the instrument panel, all service on the wiper system is performed at front of cab.

OPERATION

When control switch is turned to "LO" or "HI" wiper speed is controlled accordingly. When control switch is turned off, wiper blades move automatically to "park" position on windshield (50 mm or 2 inches up from bottom of windshield). Reciprocating action of wiper arms results from rotation of drive lever on wiper motor.

IMPORTANT

Do not attempt to move wiper blades through their arc by grasping wiper arm. This action can damage motor internal parts or bend wiper linkage. Also, if blades are frozen to windshield, do not operate control switch until blades have been freed.

REMOVAL

Linkage

- 1. Remove windshield washer hose from fittings on top of cowl.
- 2. Remove wiper blades and arms (Fig. 2). Do not lose articulating rod end clip.

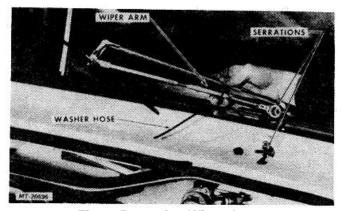


Fig. 2 Removing Wiper Arms

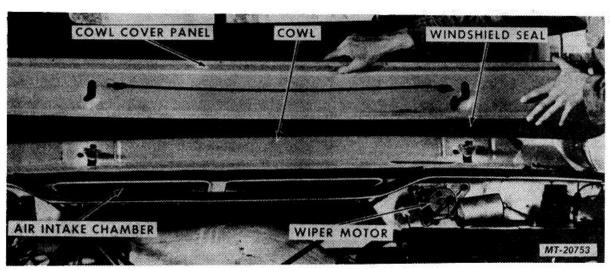


Fig. 3 Removing Cowl Cover Panel

- 3. Remove seven mounting screws and detach cowl cover panel from top of cowl (Fig. 3).
- 4. Disconnect washer hose from fitting on bottom of cowl cover panel.
- 5. Reaching into cowl air intake chamber, unfasten retainer clip from wiper motor drive lever pin and detach linkage rod from drive lever.
- 6. Remove three mounting bolts from each pivot bracket and lift out complete pivot brackets and wiper linkage assembly from inside air intake chamber (Fig. 4).

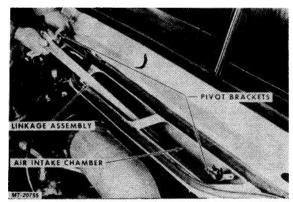


Fig. 4 Removing Windshield Wiper Linkage Assembly

Electric Motor

- 1. Disconnect wiring harness from wiper motor.
- 2. If wiper linkage has not previously been disconnected from motor, reach into cowl air

intake chamber and unfasten clip from wiper motor drive lever.

IMPORTANT

Where motor only is being removed, stop wiper blades (with key switch) at their opposite to "PARK" position and loosen motor bracket to cowl mounting bolts. This will facilitate detaching of wiper linkage from motor drive lever.

3. Remove wiper motor bracket mounting bolts and detach motor assembly. Drive lever should remove through hole in cowl (Fig. 5).

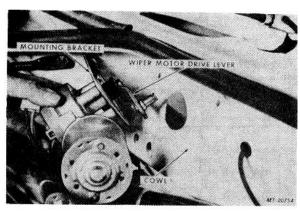


Fig. 5 Removing Windshield Wiper Motor

IMPORTANT

Always disconnect battery ground strap before servicing or removing electrical components.

Control Switch

1. Remove control knob for electric control switch by depressing retaining clip on back of knob with offset or small screwdriver (Fig. . 6).

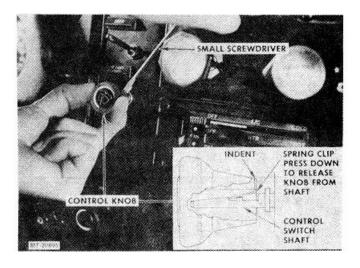


Fig. . 6 Removing Control Knob from Switch

2. Remove mounting screws and detach panel to right of wiper control switch and above heater controls.

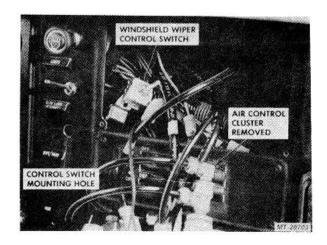


Fig. . 7 Removing Wiper Switch from Instrument Panel

3. Remove mounting nut from switch shaft and demount switch assembly from instrument panel (Fig. . 7)

4. Disconnect wiring leads and remove switch.

INSTALLATION

Reinstalling of windshield wiper system components is the reverse of removal. Be careful when installing cowl cover panel so as to protect windshield seal from damage. When returning wiper arms to drive shafts, control switch should be in "off" position and blades should be positioned in "park" position on windshield (50 mm or 2 inches up from bottom of windshield). If blades do not park as specified, see "ADJUSTMENT". When blades are correctly positioned, install cap nut and tighten to 6-7 N.m (55-60 in.lbs.).

MAINTENANCE

Service on the windshield wiper system is limited to the replacement of components shown in Fig. . 1. Disassembly of either the electric wiper motor or the control switch is not recommended.

ADJUSTMENT

1. Operate wiper motor and turn control switch on instrument panel to "OFF". Wiper blades should automatically move to "park" position on windshield (50 mm or approx. 2 inches up from bottom of windshield).

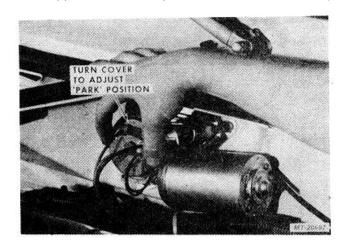


Fig. . 8 Adjusting Wiper Blade Park Position

2. If adjustment is required, loosen motor cover mounting screws and turn cover clockwise or counterclockwise as required to set correct "park" position (Fig. . 8). Retighten cover screws. (Length of stroke is fixed and cannot be changed.)

SPECIFICATIONS

MOTOR TYPE	Electric, direct current
MANUFACTURER	American Bosch
VOLTAGE	12
CRANK ARM ROTATION	Counter-clockwise
WIPER BLADE LENGTH	36 cm (14 inches)

TORQUE CHART

Application	N.m	Ft. Lbs.
Adjusting Cover Mounting Screws	2-2.5	1.5-2
Bracket to Motor Mounting Screws	4.5-7	3-5
Motor Bracket to Cowl Mounting Bolts	27-30	20-22
Lever Arm Shaft Nut	6-7	4.5-5
Wiper Shaft Cap Nut	6-7	4.5-5
Pivot Brackets to Cowl Bolts	13-16	10-12

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TROUBLE SHOOTING (ELECTRIC)

PROBLEM	PROBABLE CAUSE	SOLUTION
Wiper will not operate.	No voltage to wiper	Check for open circuit or
	motor.	blown fuse.
	2. Binds in wiper arm,	2. Eliminate binds.
	shafts or linkage.	
	3. Link rod loose from	3. Secure rod end clip.
	drive lever.	
	4. Faulty switch.	4. Replace switch.
	Faulty motor assembly.	5. Replace motor.
Damaged gear teeth.	Wiper blades striking	Adjust wiper arm park
	windshield molding	position.
	during operation.	
	2. Binding in connecting	Correct linkage.
	links.	
	Operator stopping blades	3. Caution operator.
	manually when wiper is	
	operating.	
	4. Drive arm not held when	4. Hold drive arm in vise or
	drive arm nut is tight-	by hand when tightening
	ened.	nut.
Wiper will not shut off.	Faulty switch.	Replace switch.
Wiper continually shutting off.	 Binding condition in wiper 	Eliminate binds.
	arm shafts, connecting	
	links or drive gear and	
	shaft.	
	Faulty harness connections.	Correct wiring harness
		connectors and terminals.
	Faulty motor assembly.	Replace motor.
Wiper operates at one speed only.	Faulty switch.	Replace switch.
	2. Faulty connection.	2. Correct wiring.
Wiper motor speed excessive under light load but stalls under heavy load.	Faulty motor assembly.	Replace motor.
Wiper motor noisy.	Faulty motor assembly.	Replace motor.
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CHAPTER II WINDSHIELD WIPER (AIR)

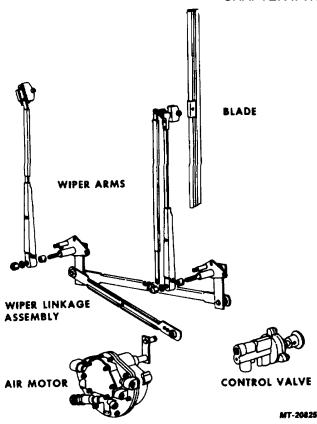


Fig. . 1 Air Windshield Wiper Components

DESCRIPTION

Where air brake equipment is specified for S-Series Trucks, an air operated windshield wiper is also available optionally. This air wiper system (Fig. . 1) consists of an air operated wiper motor, an instrument panel mounted control valve and the same wiper linkage as used for the standard windshield wiper system.

OPERATION

The air wipers operate in a similar manner to conventional wipers so long as air pressure is supplied to the air wiper system. However, to start wipers, control knob must be pulled out. Wiper speed is then controlled by turning knob clockwise or counterclockwise. Push knob in to stop wiper motor. Reciprocating action of wiper arms results from reciprocating action of drive lever on air wiper motor.

REMOVAL

Linkage

Air wiper linkage removal procedure is the same as required for the standard electric wiper as covered in Chapter I.

Air Motor

- 1. Disconnect air lines from fittings on air motor.
- 2. If wiper linkage has not previously been disconnected from air motor, reach into cowl fresh air intake chamber and unfasten clip from air motor drive lever
- 3. Remove wiper motor bracket mounting screws and detach air motor assembly from cowl.

Control Valve

- 1. Remove control valve knob from valve on instrument panel. A small hex key wrench can be used to loosen knob set screws.
- 2. Remove mounting screws and detach panel to right of control valve.
- 3. Remove mounting nut from valve shaft and detach wiper control valve from instrument panel.
- 4. Disconnect air hose from control valve and remove control valve unit.

INSTALLATION

Air wiper components are installed in the reverse order of disassembly procedure. When returning wiper arms to serrated ends of drive shafts, the following steps should be observed to assure correct wiper blade positioning on windshield.

- 1. With vehicle air pressure at 620 kPa (90 psi) note that wiper motor moves wiper blade to "Park" position when control knob is pushed in. Wiper blades should be 25 mm (approx. 1 inch) up from bottom of windshield.
- 2. If adjustment is necessary, remove wiper serrated nut from wiper arm and reposition arm and nut to specified wiper position. Adjust each wiper arm individually. Moving arm or nut one serration is equal to approximately five (5) degrees blade travel.

SPECIFICATIONS

MOTOR TYPE	Reciprocating Air
MANUFACTURER	Trico
FREE RUNNING ARC	115 degs.
STOP TO STOP	130 degs.
WIPER BLADE LENGTH	36 cm (14 inches)
BACK PRESSURE VALVE	IH No. 478630-C1

TORQUE CHART

Application	N.m	Ft.Lbs.
Bracket to Motor Mounting Screws	4.5-7	3-5
Motor Bracket to Cowl Mounting Bolts	27-30	20-22
Lever Arm Shaft Nut	6-7	4.5-5
Wiper Shaft Cap Nut	6-7	4.5-5

TROUBLE SHOOTING (AIR)

PROBLEM	PROBABLE CAUSE	SOLUTION
Motor will not operate.	1. No air to motor.	Unplug air line or correct leaks.
	Binds in wiper arm shafts or linkage.	2. Eliminate binds.
	Defective control valve.	3. Replace valve.
	Defective air motor.	4. Replace motor.
Motor will not shut off.	Defective control valve.	Replace control valve.
Motor operates erratically.	Exhaust port plugged.	1. Clean port.
	Binds in wiper shafts or linkage.	2. Eliminate binds.
	3. Air leak in motor.	3. Replace motor.
Wiper blade strikes wind-	Blade "PARK" position shield molding.	Adjust "PARK" position. out of adjustment.
Motor operates but wipers do not wipe.	Link rod loose from drive lever.	Secure linkage rod end retainer clip.

CHAPTER III WINDSHIELD WASHER

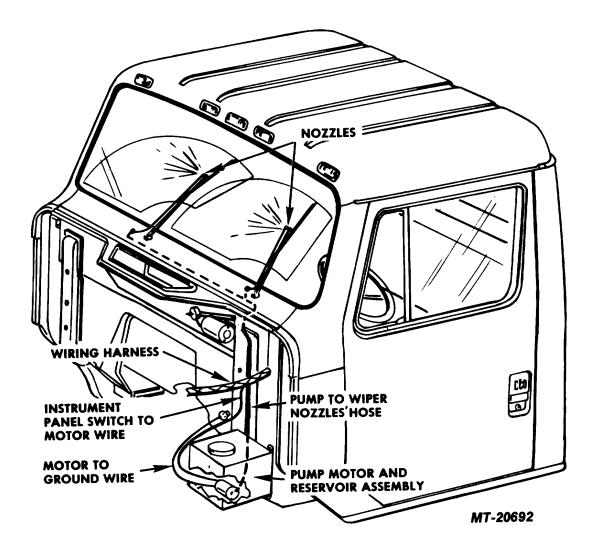


Fig. . 1 Windshield Washer Installation (80" Wide Cab Shown)

DESCRIPTION

The windshield washer (Fig. . 1) consists of a reservoir mounted motor driven displacement type pump that delivers washer solution to the windshield through hoses and nozzles in the wiper arms. Since the pump motor is integral with reservoir, only the complete assembly is available for service.

OPERATION

Two types of controls are used with the windshield washer namely an integral with wiper control switch type for electric wipers and an independent control type for air wipers.

(Independent switch is mounted on instrument panel directly below wiper control valve.) You can operate windshield washer with either type control simply by pushing in on control switch for as long as you want nozzles to spray. Spray

will stop as soon as control is released.

MAINTENANCE

A minimum of service is required to keep windshield washer operating. Keep reservoir filled with IH No. 996726-R2 windshield washer solvent and keep wiper nozzles clean. If dirt enters reservoir, remove reservoir and flush out with clean water. Refill reservoir with specified solvent after reinstalling.



REMOVAL AND INSTALLATION

- 1. Remove the two reservoir-to-cowl mounting bolts and lift complete pump, motor and reservoir from cowl. (Reservoir bottom bolt removal is not required.)
- 2. Separate wiring connector for instrument panel switch-to-motor wire and motor-to-ground wire from pump motor.
- 3. Disconnect pump-to-wiper nozzle hose from pump outlet fitting.
- 4. No further disassembly is required. Do not attempt to remove pump motor from reservoir.

Installation of windshield washer is the reverse of removal procedure. Test the operation of unit and check for leaks after installing.

TROUBLE SHOOTING

IMPORTANT.

Be sure an ample supply of IH No. 996726-R2 windshield washer solvent is maintained in reservoir to insure satisfactory operation of windshield washer.

PROBLEM	PROBABLE CAUSE	SOLUTION
Pump will not operate.	No voltage to pump motor.	Check for open circuit or blown fuse.
	2. Defective switch.	2. Replace switch.
	3. Defective motor.	Replace pump, motor and reservoir assembly.
Pump operates but pressure is weak.	Hoses loose, kinked or damaged.	Reinstall or replace hose.
	Nozzles plugged or dirt in reservoir.	Clean nozzles and service reservoir as required.
	3. Defective motor or pump.	Replace pump, motor and reservoir assembly.
Pump operates but no washer solution delivered.	No solution in reservoir.	1. Fill reservoir.
	Hoses loose, kinked or damaged.	Reinstall or replace hoses.
	Nozzles plugged or dirt in reservoir.	Clean nozzles or reservoir as required.
	4. Solution frozen.	Thaw out system and replace washer solvent.
	5. Defective pump.	5. Replace pump, motor and reservoir assembly.

BRAKES AIR

AIR COMPRESSOR

BENDIX TU-FLO 700

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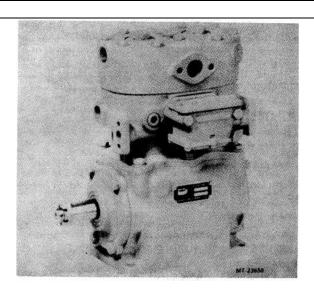


Fig. 1 Exterior View of Air Compressor

DESCRIPTION

The Tu-Flo 700 air compressor is a two cylinder, single stage, reciprocating piston type compressor with a rated displacement of .4387 cubic meters or 15.5 cubic feet of air per minute at 1250 rpm.

The compressor is comprised of three major cast iron major sub-assemblies: the cylinder head, the cylinder block and the crankcase.

The cylinder head houses the discharge valving and is installed to the cylinder blockThe cylinder block contains the cylinder bores and inlet valves and is installed to the crankcase. The crankcase contains the crankshaft and main bearings.

The cylinder head and block are cooled by coolant routed to the compressor from the engine cooling system.

The Tu-Flo 700 compressor utilizes the engine oil pressure system for lubrication.

A name plate is secured to the side of the crankcase, to identify the compressor by part number (Bendix) and serial number.

OPERATION

The compressor is driven by the vehicle engine and operates continuously while the engine is running, but actual compression of air is controlled by the compressor unloading mechanism and the governor.

The governor may be mounted on the compressor and maintains the pressure system to a preset maximum and minimum pressure level.

INTAKE AND COMPRESSION OF AIR (LOADED)

During the down stroke of the piston, a slight vacuum is created between the top of the piston and the head, causing the inlet valve to move up and off its seat(The discharge valve remains on its seat)Atmospheric air is drawn through the air strainer by the open inlet valve and into the cylinder (Fig. 2).

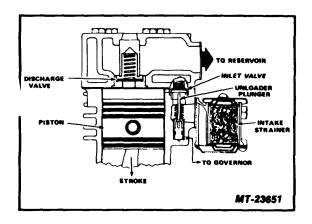


Fig. 2 Intake Stroke

As the piston begins its upward stroke, the air that was drawn into the cylinder on the down stroke is being compressed. Air pressure on top of the inlet valve plus the force of the inlet spring, returns the inlet valve to its seat. The piston continues the upward stroke and compressed air then flows by the open discharge valve, into the discharge line and on to the reservoirs (Fig. 3)As the piston reaches the top of its stroke and starts down, the discharge valve spring and air pressure in the discharge line returns the discharge valve to its seat. This prevents the compressed air in the discharge line from returning to the cylinder bore as the intake and compression cycle is repeated.

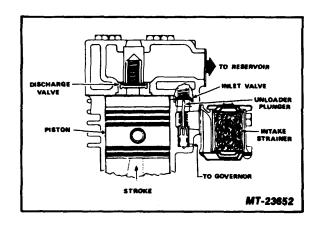


Fig. 3 Compression Stroke

NOT COMPRESSING AIR (UNLOADED)

When air pressure in the reservoir reaches the maximum setting of the governor, compressed air from the reservoir passes through the governor and into the cavity beneath the unloader pistons. This lifts the unloader pistons and plungers. The plungers move up and hold the inlet valves off their seats (Fig. 4).

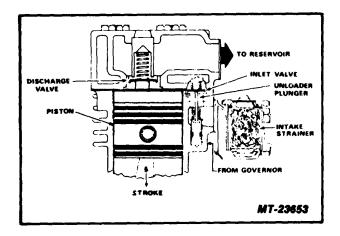


Fig. 4 Unloading Cycle

With the inlet valves held off their seats by the unloader pistons and plungers, air is pumped back and forth between the two cylinders. When air is used from the reservoir and the pressure drops to the cut-in setting of the governor, the governor closes and exhausts the air from beneath the unloader pistons. The unloader saddle spring forces the saddle, pistons and plungers down and the inlet valves return to their seats, then compression is resumed.

LUBRICATION

The engine on which the air compressor is mounted provides the lubrication to the compressor.

Oil is routed from the engine to the oil inlet. An oil passage in the compressor crankshaft allows oil to lubricate the connecting rod crankshaft bearings. Connecting rod wrist pin bushings and crank ball bearings are splash lubricated. Oil return from the compressor to the engine is provided from the compressor through a hose connected from the compressor drain outlet to the vehicle engine crankcase.

COOLING

Air flowing through the engine compartment from the action of the engine's fan and the movement of the

vehicle assists in cooling the crankcase. Coolant flowing from the engine's cooling system through connecting lines enters the compressor and flows through the internal passages in the cylinder block and head and is returned back to the engine. Proper cooling is important in maintaining discharge air temperatures below the maximum recommended, 204.4° C (400° F).

MAINTENANCE

AIR STRAINER

Refer to the Operator's Manual for the interval that the air strainers should be cleaned or replaced.

The operating conditions, experience and type of strainer used may designate more frequent service of the air strainers.

Polyurethane Sponge Strainer

Remove and wash all of the parts. The strainer element should be cleaned or replaced. If the element is cleaned, it should be washed in a commercial solvent or a detergent and water solution. The element should be saturated in clean engine oil, then squeezed dry before replacing it in the strainer. Be sure to replace the air strainer gasket if the entire air strainer is removed from the compressor intake.

Dry Element Pleated Paper Strainer

Remove the spring clips from either side of mounting baffle and remove the cover. Replace the pleated paper filter and remount the cleaned cover, making sure the filter is in position. Be sure to replace the air strainer gasket if the entire air strainer is removed front the compressor intake.

Air Intake Adapters

Some compressors are fitted with compressor intake adapters, which allow the compressor intake to be connected to the engine air cleaner. In this case, the compressor receives a supply of clean air from the engine air cleaner. When the engine air filter is changed, the compressor intake adapter should be checked. If it is loose, remove the intake adapter, clean the strainer plate, if applicable, and replace the intake adapter gasket, and reinstall the adapter securely. Check line connections both at the compressor intake adapter and at the engine air cleaner. Inspect the connecting line for ruptures and replace it if necessary.

DISCHARGE HEAD FITTINGS

Every 80,000 km (50,000 miles) or every 6 months, remove the discharge head fittings and inspect the compressor discharge port and discharge line for excessive carbon deposits. If excessive buildup is noted in either, the discharge line must be cleaned or replaced and the compressor checked more thoroughly.

Carefully inspect the air induction system, oil supply and return system. If necessary, repair or replace the compressor.

Depending upon type of drive, check for proper belt and pulley alignment and belt tension. Adjust if necessary, paying special attention not to over-tighten the belt tension. Check for noisy compressor operation, which could indicate a worn drive gear coupling or a loose pulley. Adjust and/or replace as necessary.

Check all compressor mounting bolts and retighten evenly if necessary. Check for leakage and proper unloader mechanism operation. Repair or replace parts as necessary.

COMPLETE INSPECTION

Every 322,000 km (200,000 miles) or every 24 months, perform a thorough inspection, and depending upon the results of this inspection or experience, disassemble the compressor, clean and inspect all parts thoroughly, repair or replace all worn or damaged parts.

IMPORTANT

In the event it becomes necessary to drain the engine cooling system to prevent damage from freezing, be sure the cylinder head of the compressor is drained also.

GENERAL SERVICE CHECKS

INSPECTION

It is important that the compressor receives a clean supply of air. The air strainer must be kept clean and properly installed. Check compressor mounting to be sure it is tight. Be sure the drive pulleys are in proper alignment and belt tension is properly adjusted. Make sure the oil supply and coolant lines are in good condition and not restricted. Check the unloader mechanism for proper and prompt operation.

OPERATION TESTS

Vehicles manufactured after the effective date of FMVSS 121, with the minimum required reservoir volume, must have a compressor capable of raising air

system pressure from 586-717 kPa (85-100 psi) in 25 seconds or less, with the engine operating at recommended governed speed.

The vehicle must be certified of this performance on new vehicle with all allowances for air systems with greater than minimum required reservoir volume.

AIR LEAKAGE TESTS

Air leakage past the discharge valves can be detected by removing the discharge line, apply air back through the discharge port and listening for air escaping.

The unloader pistons can be checked for leakage by building up the air system until the governor cuts out, then stopping the engine. With the engine stopped, listen for air escaping at the air compressor intake. To pinpoint leakage if noted, apply a small amount of oil around the unloader pistons. No leakage is permitted. If the compressor is not functioning as described or leakage is excessive, it is recommended that it be repaired or replaced.

REMOVE AND REINSTALL

CAUTION

When any component is serviced or removed from the air system, be sure to set the parking brake and/or block the vehicle to prevent it from moving while any service is being performed.

- 1. Drain air pressure from all reservoirs.
- 2. Drain engine cooling system and cylinder head of compressor.
- 3. Disconnect all air, water and oil lines leading to and from the compressor.
- 4. Remove compressor mounting bolts and drive belts as required.
- 5. Remove compressor from engine.
- 6. Use suitable puller to remove pulley or gear from compressor crankshaft after removing crankshaft nut.
- 7. Inspect pulley or gear and associated parts for wear or damage. If any parts are found worn or damaged, they must be replaced.
- 8. Reinstallation of compressor is performed by reversing the removal procedures.

DISASSEMBLY

Before disassembling the compressor, the following parts should be marked for correct alignment at reassembly. Mark front and rear end covers in relation to crankcase. Mark drive end of crankshaft. Mark cylinder head in relation to crankcase and mark base plate or base adapter.

A convenient method to indicate the above relationships is to use a metal scribe to mark the parts with numbers or lines. Do not use a marking method such as chalk that can be wiped off or obliterated during rebuilding.

- 1. Remove all attachments such as governor, air strainer, inlet fittings, discharge fittings and pipe plugs.
- 2. Remove cylinder head capscrews and tap the head with a soft mallet to break the gasket seal.

- 3. Remove inlet valve springs from the head and inlet valves from their guides in the crankcase. Remove inlet valve guides from the valve seats on crankcase taking care not to damage seats.
- 4. Scrape off gasket material from cylinder head and crankcase.
- 5. Unscrew discharge valve seat Ad (head and remove springs, guide and discharge valve.
- 6. If compressor is fitted with an air strainer, inlet elbow or governor, remove same.
- 7. Remove capscrews securing cylinder block to crankcase; separate crankcase and cylinder block and scrape off gasket.
- 8. Remove unloader spring, spring saddle and spring seat from cylinder block.

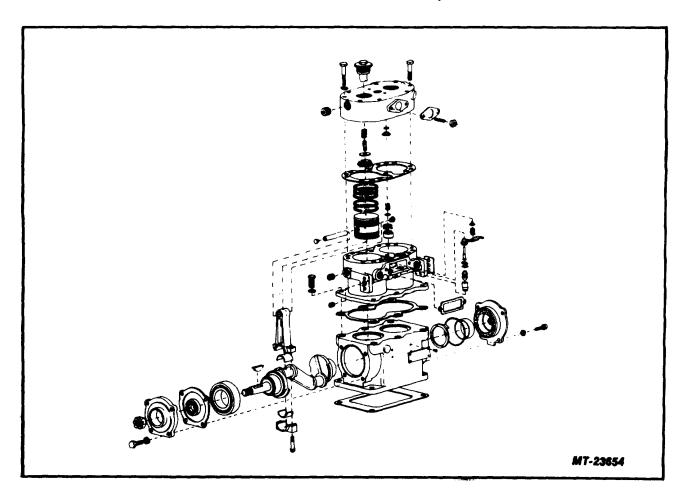


Fig. 5 Exploded View of Tu-Flo 700 Air Compressor

- Remove unloader guides and plungers and with the use of shop air, blow unloader pistons out of cylinder block unloader piston bores.
- 10. Remove inlet valve guides; inlet valve seats can be removed but only if they are worn or damaged and are being replaced. Unloader bore bushings should be inspected but not removed unless they are damaged. If bushings are to be replaced, they can be removed by running a 1/8 in. pipe threaded rod and pulling the bushing straight up and out. Do not use an "easy-out" for removing the bushings.
- Remove the cap screws securing the base plate. Tap with soft mallet to break the gasket seal. Scrape off any gasket material from crankcase and plate.
- 12. Before removing the connecting rods, mark each rod and its cap. Connecting rods are matched to their own cap for proper bearing fit and parts should not be interchanged. Remove bolts and bearing caps Push the piston with connecting rod out top of cylinders
- 13. Reassemble bearing caps on their respective connecting rods.
- 14. Remove piston rings from piston.
- 15. Remove pistons from connecting rods by removing wrist pin teflon plugs and press the wrist pins from pistons and connecting rods.
- 16. Remove key(s) from the crankshaft. Remove any burrs from the crankshaft from where keys were removed. Through drive compressors may have crankshaft key at both ends.
- 17. Remove end covers and gaskets. Remove seals from end cover(s).
- Press the crankshaft and bearings from the crankcase, and press bearings from the crankshaft.

CLEANING AND INSPECTION OF PARTS

Clean all parts using cleaning solvent to remove all dirt, oil and grease.

CYLINDER HEAD

Scrape off all cylinder head gasket material from mounting surface. Remove all carbon deposits from discharge cavities and any rust and scale from cooling cavities of cylinder head.

Scrape all foreign matter from the body surfaces and use compressed air to blow dirt from all cavities. Inspect cylinder head for cracks or damage.

Inspect discharge valve seats for nicks, cracks and excessive wear and replace if necessary. Discharge valve cap nut/stop should be removed, inspected for wear and replaced if excessive peening has occurred. To determine if excessive peening occurred, measure discharge valve travel. Valve travel should not exceed 1.1684 mm (.046 in.). If discharge travel is excessive, replace cap nut/stop assembly, discharge valve and spring.

DISCHARGE VALVES, VALVE STOPS AND SEATS

If the discharge valve seats merely show signs of slight wear, they can be dressed by using a lapping stone, grinding compound and grinding tool. Install the new discharge valve springs and valves. Screw in the discharge valve seats. Discharge valve travel should be between 0.7620 to 1.1684 mm (. 030 to .046 in.).

To test for leakage by the discharge valves, apply 689.48 kPa (100 psi) to the cylinder head discharge port and apply a soap solution to the discharge valves and seats. Leakage in the form of soap bubbles is permissible. If excessive leakage is found, leave the air pressure applied and with the use of a fibre or hardwood dowel and a hammer, tap the discharge valves off their seats several times. This will help the valves to seat and should reduce the leakage. With the air pressure still applied at the discharge port of the cylinder head, check for leakage around the discharge valve cap nut on the top of the cylinder head casting. No leakage is permitted.

INLET VALVES AND SEATS

Inlet valves and springs should be replaced. If the inlet valve seats show signs of slight nicks or scratches, they can be redressed with a fine piece of emery cloth or by lapping with a lapping stone, grinding compound and grinding tool. If the seats are damaged to the extent that they cannot be reclaimed, they must be replaced. The dimension from the top of the cylinder block to the inlet valve should not exceed 2.870 mm (.113 in.) nor be less than 2.5654 mm (.101 in.).

CRANKCASE

Scrape all gasket material from crankcase mounting surface and cylinder head mounting. Clean all carbon and dirt from inlet and unloader passages. Use compressed air to blow excessive dirt and carbon deposits from unloader passages. Clean all oil passages in crankcase.

Inspect crankcase surfaces for cracks and damage.

On compressors where ball bearing main bearings are used, the difference between the outside diameter of the outer race and the inside diameter of the crankcase hole should be .000 to .0381 mm (.000-.0015 in.) loose. This is to maintain the correct press fit. The crankcase must be replaced if the fit is too loose.

On compressors fitted with precision. sleeve main bearings, the difference between the outside diameter of the crankshaft journal and the main bearing inside diameter must not exceed .1270 mm (.005 in.). If the clearance is greater than .1270 mm (.005 in.), the end cover or main bearing must be replaced.

END COVERS

Check for cracks and external damage. If the crankshaft main bearings (sleeve) are installed in the end cover, check for excessive wear and flat spots and replace them if necessary. If the compressor has an oil seal in the end cover, it should be removed by pressing it out of the end cover.

CYLINDER BLOCK

Check the unloader bore bushings to be sure they are not worn, rusted, or damaged. If these bushings are to be replaced, they can be removed by running a 1/8 in. pipe thread tap into the bushings, and inserting a 1/8 in. pipe threaded rod and pulling the bushing straight up and out. Do not use an "easy-out" for removing these bushings. If the inlet valve seats are worn or damaged, so they cannot be reclaimed by facing, they should be replaced. Cylinder bores which are scored or out of round by more than .0254 mm (.001 in.) should be rebored or honed oversize. Oversized pistons and piston rings are available in .2540 mm (.010 in.), .5080 mm (.020 in.) and .7620 mm (.030 in.) oversizes. Cylinder bores must be smooth, straight and round. Clearance between the cast iron pistons and cylinder bores should be between .0508 mm (.002 in.) minimum and .1016 mm (.004 in.) maximum.

PISTONS AND CONNECTING RODS

Check the pistons for scores, cracks, or enlarged ring grooves; replace the pistons if any of these conditions are found. Measure each piston with a micrometer in relation to the cylinder bore diameter to be sure the diametrical clearance is between .0508 mm (.002") minimum and .1016 mm (.004") maximum.

Check the fit of the wrist pins to the pistons and connecting rod bushings. The wrist pin should be a light press fit in the piston. If the wrist pin is a loose fit, the piston and pin assembly should be replaced. Check the fit of the wrist pin in the connecting rod bushing by rocking the piston. This clearance should not exceed .01778 mm (.0007 in.). If excessive clearance is found: Connecting rods of steel have replaceable wrist pins. If wrist pin bushing is worn, press out wrist pin and replace. Ream so that clearance between wrist pin bushing and wrist pin should be between .00508 mm (.0002 in.) and .01778 mm (.0007 in.).

If the connecting rod is aluminum and the wrist pin is worn, discard rod assembly and replace with a new connecting rod assembly.

Check the fit of the piston rings in the piston ring grooves. Check the ring gap with the rings installed in the cylinder bores. Refer to Fig. 6 for correct gap and groove clearance.

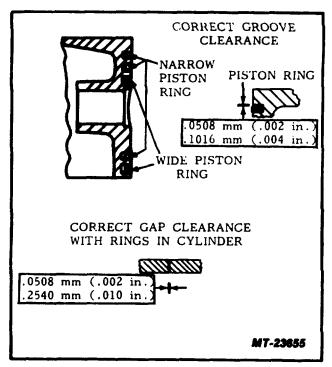


Fig. 6 Piston Rings Installation

CRANKSHAFT

Check the crankshaft threads, keyways, ends and all machined and ground surfaces for wear, scores, or damage. Standard crankshaft journals are 28.575 mm-28.5547 mm (1.1250 in.-1.1242 in.) in diameter. If the crankshaft journals are excessively scored or worn, or out of round, the crankshaft must be replaced. Connecting rod bearing inserts are available in .2540 mm (.010 in.), .5080 mm (.020 in.), and .7620 mm (.030 in.) undersizes for compressors with reground crankshafts.

On crankshafts with ball bearings, the main bearing journals must be maintained so ball bearings are a snug fit. If snug fit does not exist, the crankshaft should be replaced.

If the crankshaft has sleeve bearings, the clearance between crankshaft journal must not exceed .1270 mm (.005 in.). If clearance is excessive, the sleeve bearing and crankshaft should be replaced with appropriate undersize parts, If crankshafts are fitted with oil seal rings, the oil seal ring groove or grooves must not be worn. The ring groove walls must have a good finish and they must be square. Check to be sure the oil passages are open through the crankshaft.

CONNECTING ROD BEARINGS

Used bearing inserts must be replaced. Connecting rod caps are not interchangeable. The locking slots of the connecting rod and cap should be positioned adjacent to each other. Clearance between the connecting rod journal and the connecting rod bearing must not be less than .00762 mm (.0003 in.) or more than .05334 mm (.0021 in.) after rebuilding.

REASSEMBLY

All torques contained herein are assembly torques and typically can be expected to fall off after assembly is accomplished. Do not retorqued after initial assembly torques fall.

If the crankshaft is fitted with oil seal rings, install rings. Position ball bearing(s) and crankshaft in crankcase, making certain the drive end of the crankshaft is positioned in the crankcase as marked before disassembly. If one end of the crankcase is counterbored for a ball bearing, make certain the crankshaft is installed through the correct end of the crankcase. Carefully press the crankshaft and bearings into the crankcase.

- 2. Position a new rear end cover gasket over the rear end of the crankcase, making certain the oil hole in the gasket lines up with the oil hole in the crankcase. Install end cover with oil seal ring (if used) on crankcase. The end cover should be positioned correctly in relation to the oil holes in the gasket and crankcase. Install cap screws with lock washers and torque to 19.77-25.423 Nm (175-225 in. lbs.).
 - If the opposite end cover requires an oil seal, the new seal should be pressed into the end cover. Install a new end cover gasket and carefully install end cover over crankshaft and to crankcase to avoid damage to seal.
 - Install cap screws and lock washers and torque to 19.77-25.423 Nm (175-225 in. lbs.).
- 3. If new wrist pin bushings are to be used (steel rods only) they should be pressed into the connecting rods so that the oil hole in the bushing lines up with the one in the rod. The new bushings should then be reamed or honed to provide between .0508 mm (.0002 in.) and .01778 mm (.0007 in.) clearance on the wrist pin. Position the connecting rod in the piston and install a teflon button on each side of the piston.
- 4. Install the piston rings in the correct location with the ring pip-marks up. Stagger the position of the ring gaps. prelubricated the piston, piston rings, wrist pin, and connecting rod bearings with clean engine oil before installing them in the compressor.
- Remove the connecting bolts, bearing and bearing cap from one connecting rod. Turn the crankshaft so that one of its connecting rod journals is in the downward, center posit: on.
- 6. Install the crankshaft journal bearing segments in the connecting rod and connect the rod cap. Insert the connecting rod with piston through the top of the cylinder.
- 7. Position and attach the bearing cap to the connecting rod. Tighten the connecting rod bolts evenly and torque to 14.124-15.819 Nm (125-140 in. lbs.).
- 8. Install the other connecting rod and piston in the same manner. It is recommended that new connecting rod cap screws be used.

- 9. A new unloader kit (Fig. 7) should be used when reassembling the compressor. The pistons in the kit are prelubricated with a special lubricant* and require no further lubrication. Install unloader pistons in their bores taking care not to cut O-ring or distort back-up rings. Position unloader plungers in their guides and slip them in and over the tops of the pistons. Install unloader spring seat in crankcase inlet cavity. A small hole is drilled in crankcase for this purpose.
- * Lubricant Specifications: #328 for Unloader Seals. A dimethyl polysiloxane fluid to be used for lubrication of silicone rubber seals as compressor unloader system and other applications, (Bendix Part No. 239370)
- 10. Position the saddle between unloader piston guides so its forks are centered on guides. Install unloader spring making sure it seats over the spring seats both in crankcase and on saddle. Install inlet valve guides; then position valves in their guides. There should be a loose sliding fit between the guides and valves.
- 11. Install the inlet valve springs in the cylinder head by applying a turning motion to the spring after it is in the head. The turning motion should dig the spring wire into the spring seat in the bottom of the spring bore in the head. Should this procedure fail after repeated attempts, use a very small quantity of grease to hold them in place (just enough to keep the springs from falling out).

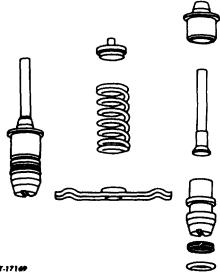


Fig. 7 Unloader Mechanism

- Place the cylinder head gasket on the cylinder block. Carefully align the cylinder head assembly on the block and install the capscrews, tightening them evenly to a torque of 19.77-25.423 Nm (175-225 in. lbs.).
- 12. Position the base plate or base adapter gasket on the crankcase and install the base plate adapter as marked before disassembly. Tighten the capscrews securing the base plate or base adapter evenly to a torque of:

1/4" -20 hex hd 9.604-12.994 Nm(85-115 in lbs) 5/16"-18 hex hd 10.621-14.123 Nm(95-125 in lbs)

TEST

In order to properly test a compressor under operating conditions, a test rack for correct mounting, cooling, lubricating and driving the compressor is necessary. Such tests are not compulsory if the unit has been carefully rebuilt by an experienced person. A compressor efficiency or build-up test can be run which is not too difficult. An engine lubricated compressor must be connected to an oil supply line of at least 103.4 kPa (15 psi) during the test and an oil return line must be installed to keep the crankcase drained.

Connect to the compressor discharge port, a reservoir with a volume of 24.6 I (1500 cu. in.) including the volume of connecting line. With the compressor operating at 2100 RPM, the time required to raise the reservoir's pressure from 586-689 kPa (85-100 psi) should not exceed 5 seconds. During this test, the compressor should be checked for gasket leakage and noisy operation as well as unloader operation and leakage.



TROUBLE SHOOTING

The following is a listing of the most commonly experienced compressor deficiencies and their probable causes.

Excessive Build-up and Recovery Time

- 1. Dirty intake strainer.
- 2. Restriction in the compressor inlet or discharge lines or cavities.
- 3. Leaking or broken discharge valves.
- 4. Drive belt slipping.
- 5. Inlet valves worn excessively or stuck open.
- 6. Excessive air system leakage.
- 7. Excessive wear on piston rings and/or cylinders.

Noisy Compressor Operation

- 1. Loose drive gear or pulley.
- 2. Excessively worn drive coupling.
- 3. Worn or burned out bearings.
- 4. Excessive wear.
- 5. Improper lubrication to the compressor.

Restrictions in the cylinder head or discharge line.

Excessive Oil Passage

- 1. Dirty air strainer.
- 2. A small, kinked or restricted oil return line.
- 3. Back pressure from the engine crankcase.
- 4. High inlet vacuum at the compressor.
- Defective oil seal or oil seal ring in the end cover(s).
- 6. Piston rings improperly installed.
- 7. Excessive ring or cylinder wear.
- 8. Excessive engine oil pressure.

Compressor Fails to Unload

- 1. Defective or worn unloader pistons or bores.
- 2. Inlet cavity restrictions.
- 3. Defective governor.
- Unloader line from governor pistons kinked or the cavity beneath the unloader pistons restricted.
- 5. Unloader mechanism binding or kinked.



SPECIFICATIONS

Model	METRIC 700	ENGLISH 700
Number of Cylinders	2	2
Capacity at 1250 RPM	0.4387 m ³	15.5 cfm
Bore	69.85 mm	2.75"
Stroke	45.974 mm	1.81"
Maximum Speed of Compressor, RPM	3000	3000
Cooling	Water	Water
Minimum Coolant Flow at Maximum RPM	9.46 liters/min.	2.5 gal./min.
Piston-to-Cylinder Bore Clearance	0.0508-0.1016 mm	002"004"
Number of Rings Used on Each Piston	5	5
Ring Gap in Cylinder Bore	0.0508-0.2540 mm	002"010"
Ring Fit in Grooves	0.0508-0.1016 mm	002"004"
Wrist Pin Clearance	0.1778 mm Max.	0007" Max.
Connecting Rod Bearing Clearance	00762-, 05334 mm	0003" 0021"
Discharge Valve Travel	0.7620-1.1684 mm	030"046"
Dimension from Top of Cylinder Block to Inlet Valve Seat	2.870 mm Max. 2.5654 mm Min.	113" Max. 101" Min.

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AIR COMPRESSOR

TU-FLO 501 BENDIX

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SPECIFICATIONS

Model	METRIC 501	ENGLISH 501
Number of Cylinders	2	2
Capacity at 1250 RPM	0.3398m3	12 cfm
Bore	66.675mm	2-5/8"
Stroke	38.000mm	1-1/2"
Maximum Speed of Compressor, RPM	3000	3000
Cooling	Water	Water
Piston-to-Cylinder Bore Clearance	0.0508 0.1016mm	002" .004"
Number of Rings Used on Each Piston	3	3
Ring Gap in Cylinder Bore	0.0508 0.2540mm	002" .010"
Ring Fit in Groove:		
Тор	0.0508 0.1016mm	002" to .004"
2nd	0.0508 0.1016mm	002' to .004"
3rd	0.0254 0.0762mm	001" to .003"
Wrist Pin Clearance	0.1778mm Max.	0007" Max.
Wrist Pin Bushing	13.4976 13.5052mm	5314" .5317"
Connecting Rod Bearing Clearance	00762 .05334mm	0003" .0021"
Discharge Valve Travel	1.0414 1.4478mm	041" to .057"
Dimension from Top of Cylinder Block To Inlet Valve Seat	2.8702mm Max. 2.5654mm Min.	113" Max. 101" Min.

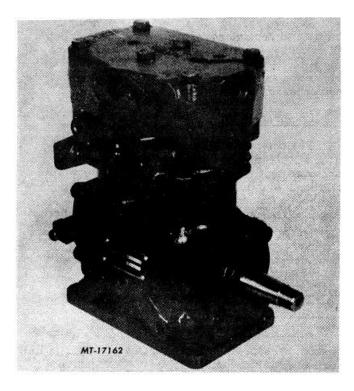


Fig. 1 Exterior View of Tu-Flo 501 Air Compressor

DESCRIPTION

The Tu-Flo 501 air compressor is a two-cylinder, single stage, reciprocating piston type, with a rated displacement of 0.3398 cubic meters or 12 cubic feet of air per minute at 1250 RPM.

The compressor is constructed of two major assemblies, the head and the crankcase. The head houses the discharge valving and is installed on the upper portion of the crankcase. The crankcase is a one-piece casting combining the cylinder block and crankcase. The upper portion of the casting houses the cylinder bores and inlet valving and the lower portion houses the crankshaft and main bearings.

Two methods are employed for cooling the compressor during operation. The cylinder head is connected to the engine's cooling system, while the cylinder bore portion of the crankcase has external fins for efficient cooling.

All Tu-Flo 501 compressors utilize the engine's oil pressure system to lubricate internal moving parts.

OPERATION

General

The compressor is driven by the engine and runs continuously while the engine is operating, but the actual compression of air is controlled by the governor

mechanism in the compressor, starts or stops the compression of air by loading or unloading the compressor when the pressure in the air brake system reaches the desired minimum of 552-586 kPa (80-85 psi) or maximum of 689-717 kPa (100-105 psi).

Intake and Compression of Air (Loaded)

During the downstroke of each piston a partial vacuum is created above the piston which causes the flat circular inlet valve to move up and off its seat. The flat discharge valve will remain on its seat. Air drawn through the intake port enters the cylinder above the piston through the inlet valve (Fig. 2). As the piston starts the upward stroke, the air pressure on top of the inlet valves plus the inlet valve return spring force closes the inlet valve. The air above the piston is further compressed until the pressure lifts the discharge valve and the compressed air is discharged through the discharge line into the reservoirs (Fig. 3). As each piston starts its downstroke the discharge valve above it returns to its seat, preventing the compressed air from returning to the cylinder and the same cycle is repeated.

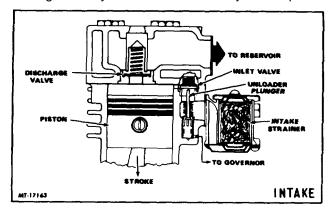


Fig. 2 Intake of Air

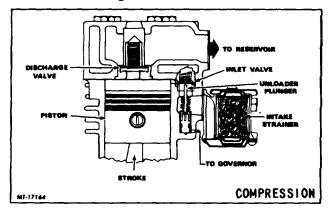
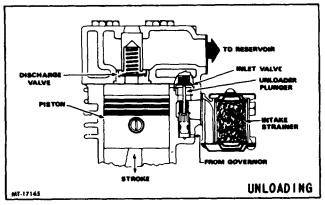


Fig. 3 Compression of Air

Not Compressing Air (Unloaded)

When the air pressure in the reservoir reaches the maximum setting of the governor of 689-717 kPa (100-105 psi), compressed air from the reservoir passes through the governor into the cavity below the unloading pistons in the compressor cylinder block. This air pressure lifts the unloading pistons which, in turn, lift the inlet valves off the seats (Fig. 4).



4 Compressor Unloading Mechanism

Passage of Air During Noncompression

With the inlet valves held off their seats by the unloader pistons and plungers, air is pumped back and forth between the two cylinders. When air is used from the reservoir and the pressure drops to the cut-in setting of the governor, the governor closes and exhausts air from beneath the unloader pistons. The unloading saddle spring forces the saddle, pistons and plungers down and the inlet valves return to their seats, thus compression is resumed.

MAINTENANCE

Every 16,000 km (10,000 Miles)

Depending upon the operating conditions and type of strainer used, service the air strainers.

1. Polyurethane Sponge Strainer

Remove and wash all parts. The strainer element should be cleaned or replaced. If the element is cleaned, it should be washed in a commercial solvent or a detergent and water solution. The element should be saturated in clean engine oil; then squeezed dry before replacing it in the strainer. Be sure to replace the gasket if entire strainer was removed from compressor intake.

2. Dry Element Pleated Paper Air Strainer Remove spring clips from side of mounting baffle and remove

cover. Replace pleated paper filter and reinstall cleaner cover making sure the filter is in position. Be sure to replace air strainer gasket if entire strainer is removed from compressor intake.

3. Compressors with Intake Adapters

The compressor receives clean air from engine air cleaner. When engine air cleaner is serviced or filter is changed, the intake adapter and hose should be inspected. Inspect connecting hoses for ruptures or loose connections. Replace hose if required or tighten connections if needed. If intake adapter is loose, remove it, clean strainer plate (if applicable) and replace adapter gasket. Then reinstall adapter; tighten all hose connections securely.

Every 80,000 km (50,000 Miles) or Every 6 Months Remove discharge head fittings and inspect the compressor discharge port and discharge line for excessive carbon deposits. If excessive buildup is noted in either, the discharge line must be cleaned or replaced and compressor checked more thoroughly paving special attention to air induction system, oil supply and return system, and proper cooling. necessary, repair or replace compressor. Check for proper belt pulley alignment and belt tension. Adjust, if required, paying special attention not to overtighten belt tension. Check for noisy compressor operation which could indicate a worn drive gear coupling or a loose pulley. Adjust and/or replace as required. Check all compressor mounting bolts; retighten evenly, if Check for leakage and proper unloader mechanism operation. Replace any defective parts.

Every 322,000 km (200,000 Miles) or Every 24 Months

Perform a thorough inspection by disassembling the compressor. Clean and inspect all parts thoroughly; repair or replace all worn or damaged parts or replace compressor depending upon the results of inspection and experience.

IMPORTANT

In the event it becomes necessary to drain the engine cooling system to prevent damage from freezing, be sure the cylinder head of compressor is drained also.

GENERAL SERVICE CHECKS

Inspection

It is important that the compressor receives a clean supply of air. The air strainer must be kept clean and properly installed. Check compressor mounting to be sure it is tight. Be sure the drive pulleys are in proper alignment and belt tension is properly adjusted. Make sure the oil supply and coolant lines are in good condition and not restricted. See that the cooling fins on the crankcase are not clogged with dirt, grease, etc. Check the unloader mechanism for proper and prompt operation.

Operation Tests

Vehicles manufactured after the effective date of FMVSS 121, with the minimum required reservoir volume, must have a compressor capable of raising air system pressure from 586-717 kPa (85-100 psi) in 25 seconds or less, with the engine operating at maximum governed speed. The vehicle must be certified of this performance on new vehicle with all allowances for air systems with greater than minimum required reservoir volume.

Air Leakage Tests

Air leakage past the discharge valves can be detected by removing the discharge line, apply air back through the discharge port and listening for air escaping. The discharge valves and the unloader piston can be checked for leakage by building up the air system until the governor cuts out, then stopping the engine. With the engine stopped, listen for air escaping at the air compressor intake. To pinpoint leakage if noted, apply a small amount of oil around the unloader pistons. If there is no leakage noted at the unloader pistons, the discharge valves may be leaking. If it is not functioning as described or leakage is excessive, it is recommended that it be repaired or replaced.

REMOVE AND REINSTALL

CAUTION

When any component is serviced or removed from the air system, be sure to set the parking brake and/or block the vehicle to prevent it from moving while any service is being performed.

- 1. Drain air pressure from all reservoirs.
- 2. Drain engine cooling system and cylinder head of compressor.

- 3. Disconnect all air, water and oil lines leading to and from the compressor.
- 4. Remove compressor mounting bolts and drive belts as required.
- 5. Remove compressor from engine.
- Use suitable puller to remove pulley or gear from compressor crankshaft after removing crankshaft nut.
- 7. Inspect pulley or gear and associated parts for wear or damage. If any parts are found worn or damaged, they must be replaced.
- 8. Reinstallation of compressor is performed by reversing the removal procedures.

DISASSEMBLY

Before disassembling the compressor, the following parts should be marked for correct alignment at reassembly. Mark front and rear end covers in relation to crankcase. Mark drive end of crankshaft. Mark cylinder head in relation to crankcase and mark base plate or base adapter.

- Remove all attachments such as governor, air strainer, inlet fittings, discharge fittings and pipe plugs.
- Remove six cylinder head capscrews and tap the head with a soft mallet to break the gasket seal.
- Remove inlet valve springs from the head and inlet valves from their guides in the crankcase. Remove inlet valve guides from the valve seats on crankcase taking care not to damage seats.
- 4. Scrape off gasket material from cylinder head and crankcase.
- 5. Unscrew discharge valve seats from cylinder head and remove discharge valve and springs.
- 6. To remove the discharge valve stops, support the machined surface of the cylinder head on an arbor press bed and carefully press the stops from the top of the head and out the bottom. Be sure to allow sufficient clearance for the stops between the press bed and bottom of cylinder head. Discard inlet valve and springs, the discharge valves and springs and the discharge valve seats, if defective.
- 7. Remove base plate or adapter mounting capscrews. Use a soft hammer or mallet to break seal.



- 8. Before removing the connecting rods, mark each rod and its cap. Connecting rods are matched to their own cap for proper bearing fit and parts should not be interchanged. Straighten the lock tabs on connecting rod locks and remove bolts and bearing caps. Push the piston with connecting rod out top of cylinders.
- 9. Reassemble bearing caps on their respective connecting rods.
- 10. Remove piston rings from piston.
- Remove pistons from connecting rods by removing wrist pin lock wires or teflon plugs and press the wrist pins from pistons and connecting rods.
- Remove key from crankshaft. Through drive type compressors may have a crankshaft key at each end. Remove drive end cover. Remove end cover.

- 13. Remove both small seal rings from crankcase and "O" ring from the front end cover.
- Remove capscrews from rear end cover and remove rear end cover. Use care in removing end cover so as not to damage main bearing if bearing is used.
- 15. Remove both small seal rings from crankcase and O-ring from end cover.
- If compressor is equipped with ball type main bearings, press crankshaft and ball bearings from crankcase. Then press bearings from crankshaft.
- 17. Remove unloader spring, spring saddle and spring seat from the inlet cavity of crankcase using a long nose pliers.

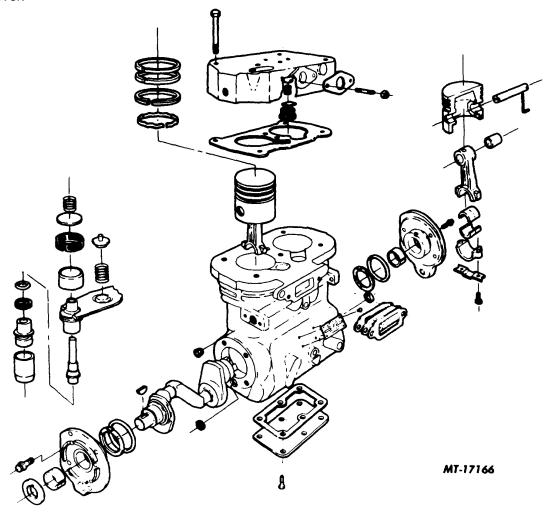


Fig. 5 Exploded View of Tu-Flo 501 Air Compressor

- 18. Remove unloader plunger and guides.
- 19. Position a shop cloth over the inlet cavity and apply air pressure to governor mounting pad unloader port to blow the unloader pistons out of their bores and into the inlet cavity.

CLEANING AND INSPECTION OF PARTS

Clean all parts using cleaning solvent to remove all dirt, oil and grease.

Cylinder Head

Scrape off all cylinder head gasket material from mounting surface. Remove all carbon deposits from discharge cavities and any rust and scale from cooling cavities of cylinder head. Scrape all foreign matter from the body surfaces and use compressed air to blow dirt from all cavities. Inspect cylinder head for cracks or damage.

Inspect discharge valve seats for nicks, cracks and excessive wear and replace if necessary. Discharge valve stop should be inspected for wear and replaced if excessive peening has occurred. To determine if excessive peening occurred, measure discharge valve travel. Valve travel should not exceed 1.45mm (.057"). To remove discharge valve stops, refer to Step No. 6 in DISASSEMBLY.

Valve stop bores in the cylinder head must be inspected for excessive scoring. Use a new cylinder head body if excessive scoring is noted.

Crankcase

Scrape all gasket material from crankcase mounting surface and cylinder head mounting. Clean all carbon and dirt from inlet and unloader passages. Use compressed air to blow excessive dirt and carbon deposits from unloader passages. Clean all oil passages in crankcase.

Inspect crankcase surfaces for cracks and damage.

On compressors with ball bearing main bearings, the difference between the O.D. of the outer race and the I.D. of the crankcase bore should be .000 to .0381mm (.000" to .0015") loose to maintain the correct press fit. Replace crankcase if the fit is too loose.

On compressors with sleeve-type main bearings, the difference between the O.D. of the crankshaft journal and main bearing I.D. must not exceed .165mm (.0065"). If clearance is greater than

.165mm (.0065") the end cover or main bearing must be replaced.

Check the unloader bore bushings to be sure they are not worn, rusted or damaged. If bushings are to be replaced, they can be removed by running a 1/8" pipe thread tap into the bushing and inserting a 1/8" pipe threaded rod and pulling the bushing straight up and out. Do not use an easy-out for removing these bushings. If inlet valve seats are worn or damaged, so they cannot be reclaimed by facing, they should be replaced.

Cylinder bores should be checked with an inside micrometer (Fig. 6) or calipers.

Cylinder bores which are scored or out-of round by more than .0254mm (.001") or tapered more than .0508mm (.002") should be rebored or honed oversize. Oversized pistons and piston rings are available in .2540mm (.010"), .5080mm (.020") and .7620mm (.030") oversizes. Cylinder bores must be smooth, straight and round. Clearance between the cast iron pistons and cylinder bores should be between .0508mm (.002") minimum and .1016mm (.004") maximum.

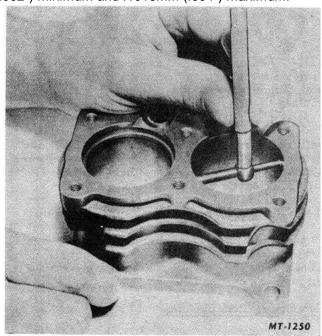


Fig. 6 Measuring Cylinder Bores

End Cover

Check end covers for cracks and external damage. If main bearings are installed in end cover, check for excessive wear and flat spots and replace them if required. The oil seal, should be replaced using a press.

SUBTITLE HERE!!!

Pistons

Check pistons for scores, cracks or enlarged ring grooves. Measure piston with a micrometer in relation to cylinder bore diameter (refer to SPECIFICATIONS).

Check the fit of the wrist pin to the pistons and connecting rod bushings. Wrist pin should be a light press fit in the piston. If wrist pin is a loose fit, the piston and pin assembly should be replaced. Check the fit of wrist pin in connecting rod bushing by rocking the piston. This clearance should not exceed .01778mm (.0007"). Replace the wrist pin bushings if excessive clearance is found. Wrist pin bushings should be reamed after being pressed into the connecting rods (refer to SPECIFICATIONS for fit). Replace the used wrist pin lock wires.

Check the ring gap with rings positioned in cylinder bores and fit of piston in ring grooves. Refer to SPECIFICATIONS for correct gap and groove clearances.

Crankshaft

Check crankshaft threads, keyways, tapered ends and all machined and ground surfaces for wear, scores or Standard crankshaft journals are 28.575 28.5547mm (1.1250" 1.1241") in diameter. crankshaft journals are excessively scored or worn or out-of-round and cannot be reground, the crankshaft must be replaced. Connecting rod bearing inserts are available in .254mm (.020"), .5080mm (.020") and .7620mm (.030") undersizes for compressors with reground crankshafts. Main bearing journals must be maintained so the ball bearings are a snug fit or so that no more than .1651mm (.0065") clearance exists between the precision sleeve main bearing and the main bearing journals on the crankshaft. In crankshafts fitted with oil seal rings, the oil seal ring groove or grooves must not be worn. The ring groove walls must have a good finish and they must be square. Check to be sure the oil passages are open through the crankshaft.

Connecting Rod Bearings

Used bearing inserts must be replaced. Connecting rod caps are not interchangeable. The locking slots of the connecting rod and cap should be positioned adjacent to each other. Clearance between the connecting journal and the connecting rod bearing must not be less than .0508mm (.0003") or more than .05334mm (.0021") after rebuilding.

<u>Discharge Valves, Valve Stops and Seats</u> (Fig. 7)

If the discharge valve seats merely show signs of slight wear, they can be dressed by using a lapping stone, grinding compound and grinding tool. if the discharge valve stops are to be replaced, an application of a sealer is required, such as Loctite Retaining Compound #75. Be sure that the press fit between the discharge valve stop outside diameter and the valve stop bore in the cylinder head is a minimum of .02032mm (.008") and a maximum of .07112mm (.0028"). If this fit cannot be maintained, a new cylinder head body must be used. Be sure to completely support the outside top of the cylinder head casting, while pressing in the replacement stops. Install the new discharge valve springs and valves. Screw in the discharge valve seats. Discharge valve travel is listed in the SPECIFICATIONS.

To test for leakage by the discharge valves, apply 689 kPa (100 psi) air pressure through the cylinder head discharge port and apply a soap solution to the discharge valves and seats. A slight leakage in the form of soap bubbles is permissible. If excessive leakage is found, leave the air pressure applied and with the use of a fibre or hardwood dowel and a hammer, tap the discharge valves off their seats several times. This will help the valves to seat and should reduce the leakage. With the air pressure still applied at the discharge port of the cylinder head, check for leakage around the discharge valve stops exposed on the top of the cylinder head casting. No leakage is permitted.

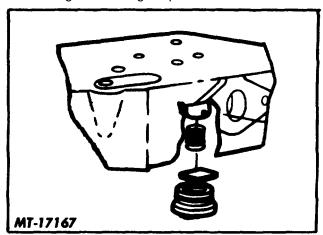


Fig. 7 Discharge Valve, Valve Stop and Seat

Inlet Valves and Seats (Fig. 8)

Inlet valves and springs should be replaced. If the inlet valve seats show signs of slight nicks or scratches, they can be redressed with a fine piece of emery cloth or by lapping stone, grinding compound and grinding tool. If the seats are damaged to the extent that they cannot be

reclaimed, they must be replaced. Refer to SPECIFICATIONS for the dimensions from top of cylinder block to inlet valve seat.

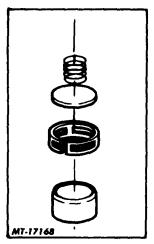


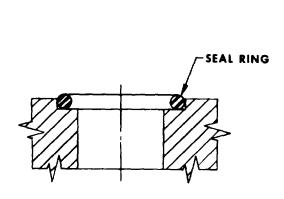
Fig. 8 Inlet Valve and Seat

REASSEMBLY

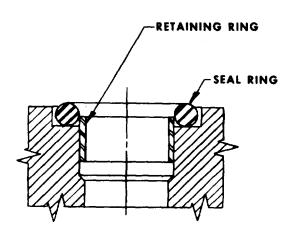
All torque values contained herein are assembly torque and can be expected to fall off after assembly is completed. <u>Do not retorque</u> after initial assembly torques FT1.

All flange mounted compressors <u>must be</u> <u>assembled without</u> a gasket between the crankcase and flange adapter and some compressors do not require gaskets on the end cover. Install the new crankcase gaskets <u>only</u> where they were removed during disassembly. Failure of the compressor would result if gaskets are used when not required.

- I. Compressors which use a ball type main bearing, press the ball bearing onto the correct end of the crankshaft. Position the ball bearing and the crankshaft in the crankcase making sure the drive end of the crankshaft is positioned in the crankcase as marked before disassembly. Carefully press the crankshaft and ball bearing into the crankcase using an arbor press.
- Compressors with a front ball bearing, place two small seal rings in the countersunk holes at the front of the crankcase, as well as an end cover gasket. Install the front end cover in proper position as marked before disassembly taking care not to damage the new oil seal.
- 3. Compressors with a rear ball bearing, place two small seal rings in countersunk at the rear of the crankcase. In one application a gasket is used and in another a large O-ring is placed in the counterbore at the rear of the crankcase. These are in addition to the seal rings. Install the rear end cover in the proper position as marked before disassembly. On some compressors the area for the two small seal rings has been increased slightly and the seal ring thickness increased. When the thicker O-rings are utilized a retaining ring will also be used as shown in Fig. 9.
- 4. Compressors with a sleeve bearing either front or rear, place the two small seal rings in the countersunk holes in the crankcase. Where seal rings are used, an end cover gasket must not be used. Place the O-ring seal in the groove around the flange adapter or the end cover, and affix the thrust washer.



ORIGNAL SEAL RING INSTALLATION



IMPROVED SEAL RING RETENTION

Fig. 9 Variations in Small Seal Ring Installations



Install the flange adapter or end cover in the proper position as marked before disassembly taking care not to damage the sleeve bearing. Secure the flange adapter, front or rear cover to the crankcase by tightening the capscrews to the following torque values.

- 7/16" Capscrews, Cast Iron Flange Adapter, 51.5-61 Nm (38-45 ft. lbs.)
- 7/16" Capscrews, Cast Aluminum End Cover, 34-40.7 Nm (25-30 ft. lbs.)
- 5/16" Capscrews or Stud and Nut, All End Covers, 20.3-24.4 Nm (15-18 ft. lbs.)
- 7/16" Capscrews, Through Drive Compressor -- Cast Iron and Covers, 34-40.7 Nm (25-30 ft. lbs.)
- 5. If new wrist pins are being installed, they should be pressed into the connecting rods so that the oil hole in the bushing lines up with the one in the rod.

The new bushings should be reamed or honed to provide .00254mm (.0001") to .01524mm (.0006") clearance on the wrist pin. Position the connecting rod in the piston and press in the wrist pin. Some compressors will have the wrist pin secured in the piston by a lock wire extending through matching holes in wrist pin and piston boss, anchored in a hole in the side wall of the piston. If the original pistons are used the wrist pin must be pressed in so the hole in the wrist pin aligns with that of the piston and secure same by inserting the new lockwire through the hole in piston and wrist pin and lock the wire by snapping the short 900 section into the lockwire hole in the bottom of the piston.

Later design compressors will have the wrist pin secured by Teflon buttons in either end of the wrist pin, allowing the wrist pin to float. The Teflon buttons may be used with either new or old wrist pins.

- 6. The late design pistons have two rings above the wrist pin and one below. Install piston rings in the correct location with ring pip marks up. Stagger the position of ring gaps. Pre-lubricate piston, rings, wrist pin and connecting rod bearings with clean engine oil before installing them in the compressor.
- Remove bolts from connecting rod bearing cap. Turn crankshaft so that one of the connecting rod journals is in the downward center position.

- Install crankshaft journal bearing segments in connecting rod and rod cap.
- 8. Install connecting rod with piston through top of cylinder. Attach bearing cap to connecting rod making sure that a lock strap is positioned on the cap. Torque the rod bolts to 13.5-16.3 Nm (120-150 inch pounds or 10-12 ft. lbs.). Bend lock strap prongs against hex head of bolts.
- 9. Install remaining piston and connecting rod in the same manner.
- 10. A new unloader kit (Fig. 10) should be used when reassembling the compressor. The pistons in the kit are prelubricated with a special lubricant* and require no further lubrication. Install unloader pistons in their bores taking care not to cut O-ring or distort back-up rings. Position unloader plungers in their guides and slip them in and over the tops of the pistons. Install unloader spring seat in crankcase inlet cavity. A small hole is drilled in crankcase for this purpose.

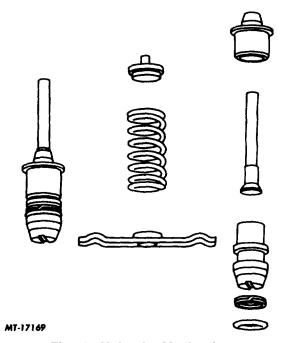


Fig. 10 Unloader Mechanism

* Lubricant Specifications: #328 for Unloader Seals. A dimethyl polysiloxane fluid to be used for lubrication of silicone rubber seals as compressor unloader system and other applications, (B.W. Part No. 239379).



- 11. Position the saddle between unloader piston guides so its forks are centered on guides. Install unloader spring making sure it seats over the spring seats both in crankcase and on saddle. Install inlet valve guides; then position valves in their guides. There should be a loose sliding fit between the guides and valves.
- 12. Install the inlet valve springs in the cylinder head by applying a turning motion to the spring after it is in the head. The turning motion should dig the spring wire into the spring seat in the bottom of the spring bore in the head. Should this procedure fail after repeated attempts, use a very small quantity of grease to hold them in place, just enough to keep the springs from falling out. Place the cylinder head gasket on the cylinder block. Carefully align the cylinder head assembly on the block and install the capscrews, tightening them evenly to a torque of 34-40.7 Nm (25-30 ft. lbs.).
- 13. Position the base plate or base adapter gasket on the crankcase and install the base plate adapter as marked before disassembly. Tighten the six capscrews securing the base plate or base adapter evenly to , torque of 17.6-23 Nm (13-17 ft. lbs.) for base cover and 51.5-61 Nm (38-45 ft. lbs.) for base adapter.

TEST

In order to properly test a compressor under operating conditions, a test rack for correct mounting, cooling, lubricating and driving the compressor is necessary. Such tests are not compulsory if the unit has been carefully rebuilt by an experienced person. A compressor efficiency or build-up test can be run which is not too difficult. An engine lubricated compressor must be connected to an oil supply line of at least 103.4 kPa (15 psi) during the test and an oil return line must be installed to keep the crankcase drained.

Connect to the compressor discharge port, a reservoir with a volume of 24.6 1 (1500 cu. in.) including the volume of connecting line. With the compressor operating at 2100 RPM, the time required to raise the reservoir's pressure from 586-689 kPa (85-100 psi) should not exceed 5-7 seconds. During this test, the compressor should be checked for gasket leakage

and noisy operation as well as unloader operation and leakage.

TROUBLE SHOOTING

The following is a listing of the most commonly experienced compressor deficiencies and their probable causes.

Excessive Build-up and Recovery Time

- 1. Dirty intake strainer.
- Restriction in the compressor inlet or discharge lines or cavities.
- 3. Leaking or broken discharge valves.
- 4. Drive belt slipping.
- 5. Inlet valves worn excessively or stuck open.
- 6. Excessive air system leakage.
- 7. Excessive wear on piston rings and/or cylinders.

Noisy Compressor Operation

- 1. Loose drive gear or pulley.
- 2. Excessively worn drive coupling.
- 3. Worn or burned out bearings.
- 4. Excessive wear.
- 5. Improper lubrication to the compressor.
- 6. Restrictions in the cylinder head or discharge line.

Excessive Oil Passage

- 1. Dirty air strainer.
- 2. A small, kinked or restricted oil return line.
- 3. Back pressure from the engine crankcase.
- 4. High inlet vacuum at the compressor.
- Defective oil seal or oil seal ring in the end cover(s).
- 6. Piston rings improperly installed.
- 7. Excessive ring or cylinder wear.

Compressor Fails to Unload

- 1. Defective or worn unloader pistons or bores.
- 2. Defective governor.
- 3. Unloader line from governor kinked or the cavity beneath the unloader pistons restricted.
- 4. Unloader mechanism binding or kinked.





AIR COMPRESSOR

TU-FLO 400, 500 AND 600

BENDIX

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SPECIFICATIONS

(AIR COMPRESSOR)

MODEL	Tu-Flo 400	Tu-Flo 500	Tu-Flo 600
Number of Cylinders	2	2	2
Capacity (cfm) (at 1250 RPM)	7-1/4	12	14-1/2
Bore (Inches)	2-1/16	2-1/2	2-3/4
Stroke (Inches)	1-1/2	1-11/16	1-11/16
Maximum Speed for Compressor (RPM)	3000	3000	2400
Cooling	Air or Water	Water	Water
Piston-to-Cylinder Bore Clearance (In.)	.002004	.002004	.002004
Number of Rings Used on Each Piston	4	5	5
Ring Gap in Cylinder Bore (Inch)	.007019	.005015	.0035015
Ring Fit in Grooves (Inch):			
Тор	.0015003	.002004	.00150035
2nd	.0015003	.002-,.004	.00150035
3rd	.0015003	.035055	.00150035
4th	.0015003	.002004	.00150035
5th		.035055	.00150035
Wrist Pin-to-Connecting Rod Bushing	.00010006	.00010006	.00010006
Clearance (Inch)			
Connecting Rod Bearing Clearance (In.)	.00030021	00030021	.00030021
Discharge Valve Lift (Inch)	.036058	.056070	.046
Inlet Valve Seat Dimension Not to Exceed	.145	.145	.145
from Top of Block Not Less Than	.101	.101	.101

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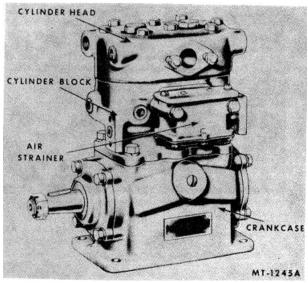


Fig. 1 Exterior View of Tu-Flo 400 and 500Compressor

DESCRIPTION

The Tu-Flo 400, 500 and 600 compressors are single-acting reciprocating piston type compressors. The rated capacity of a compressor is based on the piston displacement in cubic feet per minute when operating at 1250 RPM. The capacity of the Tu-Flo 400 is 7-1/4 cubic feet per minute. The capacity of the Tu-Flo 500 is 12 cubic feet per minute. These compressors have automatic inlet valves while the Tu-Flo 600 is 14-1/2 cubic feet per minute.

The Tu-Flo 400 compressors have either water or air-cooled cylinder heads and cylinder blocks. The Tu-Flo 500 and 600 compressors have water-cooled cylinder heads and water-cooled cylinder blocks. Various mounting and drive adaptations are used depending on design of the engine.

Engine lubricated compressors are dependent on the vehicle engine for oil and oil pressure, Fig. 2. In these compressors oil from the vehicle engine enters the compressor through a passage in the compressor end cover and is fed to the connecting rod bearings through drilled holes in the crankshaft. The wrist pins are lubricated through holes in the top of the connecting rod wrist pin bearing and bushing by means of oil dripping from a drip boss on the piston. The main

bearings are splash lubricated. Surplus oil returns to the engine crankcase through the open compressor base.

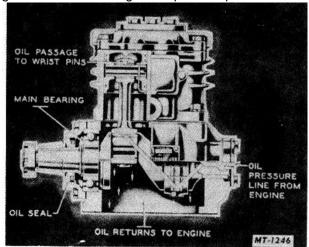


Fig. 2 Sectional View of Compressor Oiling System OPERATION

The compressors run continuously while the engine is running, but the actual compression of air is controlled by the governor, which, acting in conjunction with the unloading mechanism in the compressor cylinder block, starts or stops the compression of air by loading or unloading the compressor when the pressure in the air brake system reaches the desired minimum (80-85 p. s. i.) or maximum (100-105 p.s.i.).

Compressing Air (Loaded)

During the down stroke of each piston a partial vacuum is created above the piston which unseals the inlet valve, allowing air drawn through the intake strainer to enter the cylinder above the piston, Fig. 3. As the piston starts the upward stroke, the air pressure on top of the inlet valves plus the inlet valve return spring force closes the inlet valve. The air above the piston is further compressed until the pressure lifts the discharge valve and the compressed air is discharged through the discharge line into the reservoir, Fig. 4. As each piston starts its down stroke the discharge valve above it returns to its seat, preventing the compressed air from returning to the cylinder, and the same cycle is repeated.

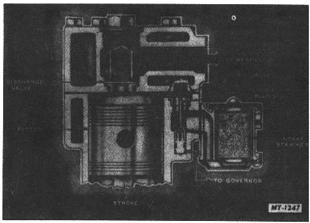


Fig. 3 Intake of Air

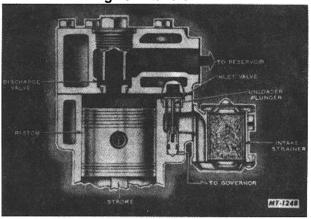


Fig. 4 Compression of Air

Not Compressing Air (Unloaded)

When the air pressure in the reservoir reaches the maximum setting of the governor (100-105 p. s. i.), compressed air from the reservoir passes through the governor into the cavity below the unloading pistons in the compressor cylinder block. This air pressure lifts the unloading pistons, which, in turn, lift the inlet valves off their seats, Fig. 5.

Passage of Air During Noncompression

With the inlet valves held off their seats the air during each upstroke of the piston is forced through the air inlet cavity and to the other cylinder where the piston is on the downstroke. When the air pressure in the reservoir is reduced to the minimum setting of the governor (80-85 p. s. i.), the governor releases the air pressure beneath the unloading pistons. The unloading piston return spring then forces the pistons down and the

inlet valve springs return the inlet valves to their seats and compression is resumed.

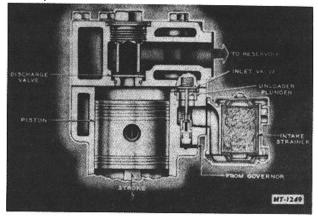


Fig. 5 Compressor Unloading Mechanism REMOVE

- 1. Drain air brake system.
- 2. Drain engine cooling system, compressor cylinder head and compressor cylinder block.
- 3. Disconnect all air, water and oil lines connected to compressor.
- 4. Remove compressor drive belt.
- 5. Remove compressor mounting bolts and remove compressor from engine.
- 6. Use a suitable puller to remove the pulley from the compressor crankshaft after removing the crankshaft nut.

DISASSEMBLY

Remove grease or dirt from the exterior of the compressor by scraping, if necessary, followed by the use of cleaning solvent and a brush.

Tu-Flo compressors should have the following items marked showing proper relationships prior to disassembly. Center punch marks can be used if desired.

- 1. Position of cylinder block in relation to crankcase.
- Position of end covers in relation to the crankcase.
- 3. Position of crankshaft in relation to crankcase.

Removing and Disassembling Cylinder Head

Remove capscrews or nuts from studs attaching cylinder head and lift off cylinder head. The cylinder may have to be tapped with a rawhide hammer to break gasket joint.

Remove cylinder head gasket and scrape off any gasket material that may remain on cylinder head and block.

Remove discharge valve cap nuts and lift out discharge valve springs and discharge valves.

Removing and Disassembling Piston and Connecting Rod Assemblies

Straighten prongs of connecting rod bolts and remove bolts and bearing caps. Then push pistons with connecting rods attached out the top of the cylinder block. Replace caps on each connecting rod to avoid damage to bearings. Connecting rod caps and connecting rods are already marked with center punch marks to show the proper position of the caps on the rods.

Remove piston rings from each piston. If pistons are to be removed from connecting rods, remove wrist pin lock wires from wrist pins and press pins from pistons and connecting rods.

Removing Crankshaft

Remove capscrews or nuts from studs, securing end cover to crankcase at drive end of crankshaft.

Remove end cover with oil seal and gasket. If oil seal needs replacing, remove it from end cover.

Remove capscrews or nuts from studs, holding opposite end cover to crankcase. Remove end cover and gasket.

Some crankcases are fitted with a shoulder to position the crankshaft in the crankcase. In such cases the crankshaft may be removed only through one end of the crankcase. Press crankshaft and ball bearings out of crankcase.

Removing Cylinder Block

When cylinder head is removed from cylinder block, the inlet valve springs and inlet valves should be removed.

If compressor is fitted with an air strainer, remove screws and lock washers securing air strainer in place and remove air strainer and air strainer gasket.

If compressor has a Type D or D-2 governor mounted on cylinder block, remove governor and gasket.

Remove capscrews or nuts securing cylinder block to crankcase and remove cylinder block and cylinder block gasket.

Remove unloader spring and unloader spring seat.

Remove unloader spring saddle, unloader plunger and unloader pistons. Remove unloader piston grommets. Remove inlet valve seat bushings only if seats are worn or damaged.

CLEANING AND INSPECTION OF PARTS

Clean all parts using cleaning solvent to remove all traces of dirt, oil and grease before inspection.

Cylinder Head and Components

Put cylinder head body through a cleaning solution to remove all carbon from discharge valve cavities and to remove all rust and scale from water cavities. Use air pressure to blow dirt out of all cavities. Scrape carbon, dirt, and particles of old gaskets from all surfaces.

Clean discharge valves not damaged or worn excessively by lapping them on a piece of crocus cloth on a flat surface.

Oil Passages

Clean thoroughly all oil passages through 'crankshaft, connecting rods, crankcase and end covers. If necessary, probe oil passages with wire and flush with cleaning solvent.

Cylinder Block

Put cylinder block through a cleaning solution to remove all carbon and dirt from inlet passages and unloader passages so as to remove rust and scale from water cavity.

Clean inlet valves that are not damaged or worn excessively by lapping them on a piece of crocus cloth on a flat surface.

Scrape particles of old gaskets from all surfaces.

Air Strainer

Wash curled hair from air strainer in cleaning solution and then saturate it with clean oil, squeezing out excess oil before replacing it in air strainer.

Ball Bearings

All ball bearings must be cleaned thoroughly in cleaning solvent.

INSPECTION OF PARTS

Cylinder Head Body

Inspect cylinder head body for cracks or breaks. Replace if any defects are found.

Water Passages

Test water jacket of cylinder head and cylinder block for leakage, using air pressure. Replace unit if leakage is found.

Discharge Valve Springs

Discard all used discharge valve springs and replace with new springs.

Discharge Valves and Seats

Inspect condition of discharge valves and discharge valve seats. If discharge valves are grooved deeper than .003" where they contact the seats, they should be replaced. If the discharge valve seats are worn excessively so there is no longer sufficient metal left to reclaim the seat by using a lapping stone, the seats should be replaced.

Crankcase and End Covers

Check crankcase and end covers for cracks and broken lugs. Replace if any damage is found.

End Covers

If an oil seal ring is used in the end cover, check fit of ring in the ring groove and have .008" to . 015" clearance at the gap when placed in the end bore of the crankshaft. Check oil seal ring for wear. If worn thin or damaged, the oil seal ring must be replaced. Inspect oil ring groove in end cover. If ring wear has formed a step pattern in groove, replace end cover or machine groove for next oversize oil seal ring.

Crankcase Bearing Bores

Check fit of ball bearings in crankcase. Bearings must be a finger press fit. If crankcase bearing bores are worn or damaged, the crankcase should be replaced.

Cylinder Block

Check for cracks or broken lugs on cylinder block. Also check unloader bore bushings to be sure they are not worn, rusted or damaged. If these bushings are to be replaced, they can be removed by running a 1/8" pipe thread tap inside the bushing, then inserting a 1/8" pipe threaded rod and pulling the bushing straight up and out. Do not use an easy-out for removing these bushings.

Inlet Valve and Seats

Inspect condition of inlet valves and seats. If inlet valves are grooved deeper than .003" where they contact the seat, they should be replaced. If the inlet valve seats are worn or damaged so that they cannot be reclaimed by facing or lapping, seats should be replaced.

Cylinder Bores

Check cylinder bores for evidence of excessive wear, out-of-round, or scoring. Cylinder bores which are scored or out-of-round more than . 002", Fig. 6, or tapered more than . 003", should be rebored or honed oversize. Oversize pistons are available in . 010", . 020" or . 030" oversize. Cylinder bores must be smooth, straight and round. Refer to specifications for proper clearance between piston and cylinder bore. Aluminum pistons are cam ground.



Fig. 6 Measuring Cylinder Bore Diameter

Pistons

Inspect pistons for scores, cracks or damage. If scores or cracks are found, replace the piston. Check each piston with a micrometer, Fig. 7, in relation to the cylinder bore diameter to be sure the proper clearance is obtained as outlined in the specifications.

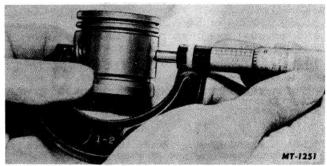


Fig. 7 Measuring Piston Diameter Piston Rings

Check fit of piston rings in the ring grooves. Also check ring gap with rings installed in cylinder bores, Fig. 8. Refer to specifications for correct ring gap and groove clearance.

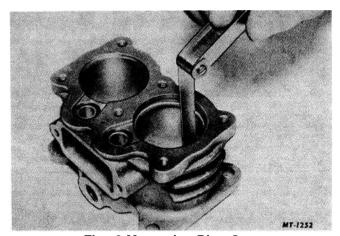


Fig. 8 Measuring Ring Gap

Wrist Pins

Check fit of wrist pins in pistons and connecting rods. Wrist pins must be a light press fit in piston. If wrist pin is a loose fit in the piston, the wrist pin, piston or both must be replaced. Check fit of wrist pin in connecting rod bushing by rocking the piston. Clearance of wrist pin to connecting rod bushing should not exceed .0015". If excessive clearance is apparent, replace wrist pin bushing in connecting rod. Wrist pin bushings should be reamed after being pressed in place.

Discard all used wrist pin lock wires and replace with new.

Connecting Rod Bearings

Inspect connecting rod bearings for proper fit on crankshaft journals. Also check connecting rod bearings for wear. If worn, cracked, or broken, the inserts must be replaced. Connecting rod caps are not interchangeable. Position the caps so that the two locking slots are both located adjacent to the same capscrew. Refer to specifications for proper connecting rod bearing clearance.

Crankshaft

Crankshaft journals which are more than .001" out-of-round or scored must be reground. When regrinding, the fillets at the ends of the journals must be maintained. Connecting rod bearing inserts are available in .010", .020" and .030" undersize for reground crankshafts. Screw threads, keyways, tapered ends and all ground and machined surfaces of the crankshaft must not be mutilated or worn excessively.

Main bearing journals must not be worn sufficiently to prevent the ball bearings being a press fit. The oil seal ring groove in crankshafts fitted with oil seal rings must not be worn sufficiently to prevent a good fit on the oil seal ring. Walls of the oil seal ring grooves must be square and have a good finish.

Main Bearings

Check for wear or flat spots; if damaged, the bearings must be replaced. If sleeve bearing type, the bearing should be checked for scores or wear and replaced if necessary.

REPAIRS

Discharge Valves and Seats

If discharge valve seats merely show signs of slight scratches, they can be reclaimed by using a lapping stone and grinding compound. If seats cannot be reclaimed, install new seats. After installing new discharge valves, discharge valve springs and discharge valve cap nuts, the discharge valve travel should be checked. This can be accomplished from the bottom side of cylinder head by measuring the movement of discharge valve from its seat. Refer to specifications for correct

To test for leakage, apply 100 p. s. i. air pressure through the discharge port of the cylinder head and apply soap suds to the discharge valve openings in the floor of the cylinder head. Leakage should not exceed a one inch soap bubble in not less than five seconds.

If excessive leakage is found, leave the air pressure applied and using a fiber or hardwood dowel and light hammer, tap the discharge valves off their seats several times to improve the seal between the valves and their seats. If the valves and valve seats have been reconditioned properly, this will reduce the leakage.

Leakage tests must also be made by applying soap suds around the discharge valve cap nuts with air pressure applied as above. Leakage at cap nuts is not permissible.

Inlet Valves and Seats

If inlet valve seats show signs of slight scratches or wear, they can be reclaimed by using a lapping stone and grinding compound. If the seats cannot be reclaimed in this manner, they should be replaced. Install new inlet valve seats by pressing them into cylinder block to dimensions shown in the specifications.

Inlet valves not worn excessively or damaged can be reclaimed by lapping them on a piece of crocus cloth on a flat surface.

REASSEMBLY

Installing Cylinder Block

Place new cylinder block gasket in position on crankcase studs. Position cylinder block on crankcase in accordance with markings made before disassembly. Install nuts and lock washers securing cylinder block to crankcase.

Installing Crankshaft

If the crankshaft is fitted with oil seal rings, install rings. Position ball bearings and crankshaft in crankcase, being sure the drive end of the crankshaft is positioned as marked before disassembly. If one end of the crankcase is counterbored for holding bearing, be sure the crankshaft is installed through the correct end of the crankcase. Carefully press crankshaft and bearings into crankcase using arbor press.

Place a new rear end cover gasket in position over studs on rear end of crankcase being sure the oil hole in the gasket lines up with the oil hole in the crankcase. If end cover includes an oil seal ring, install oil ring. Position end cover over studs in crankcase being sure oil holes in end cover line up with oil holes in gasket and crankcase. Install capscrews or nuts securing end cover in place. Install pipe plugs in end cover oil openings which are not in use.

If opposite end cover includes an oil seal and the seal has been removed, press a new seal in the end cover. Install a new end cover gasket. Carefully position the end cover to avoid damage to oil seal and install capscrews or nuts securing end cover in place, Fig. 9.

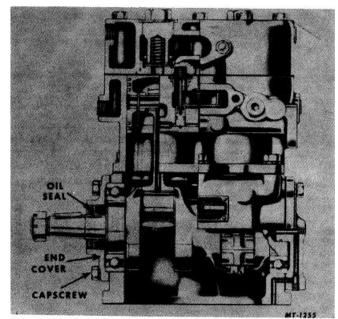


Fig. 9 Sectional View of Block and Crankcase

Assembling Pistons and Connecting Rods

If wrist pin bushings have been removed from connecting rods, press new bushings into place making sure that the oil holes in the bushings line up with the oil hole in the connecting rods. Bushing must then be reamed, honed or bored to provide the proper running clearance on the wrist pin as shown in the specifications. Position connecting rod in piston and press wrist pin into position with lock wire holes in pin aligned with lock wire hole in piston. Install new wrist pin lock wire in wrist pin so that the long end extends through piston and wrist pin and short end can be snapped into the lock wire hole near the bottom of the piston skirt, Fig. 10. Do not use pin is loose. pistons in which the wrist

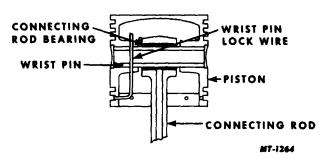


Fig. 10 Installing Wrist Pin Lock Wire

Install piston rings by hand, Fig. 11. Particular care must be taken when installing piston rings so that the pip mark on the ring is toward the top of the piston. Stagger the position of the ring gaps.

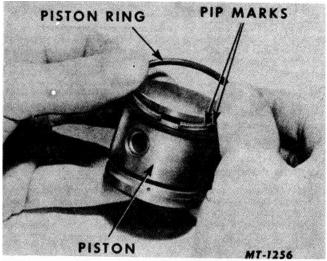


Fig. 11 Installing Piston Rings
Installing Pistons and Connecting Rods

Before installing pistons and connecting rods, thoroughly lubricate pistons, piston rings, wrist pin bearings and connecting rod bearings with clean engine oil.

Turn crankshaft so as to position one crankshaft journal downward. Remove bearing cap from connecting rod.

Insert the connecting rod and piston through top of number one cylinder so that the connecting rod bearing makes contact with the crankshaft journal. Position and attach bearing cap to rod. The cap is in the correct position when the two locking slots in the bearing inserts and in the rod and cap are both located adjacent

to the same connecting rod bolt. Then install the lock wire through both capscrew heads and secure. Install the two capscrews and slotted nuts. Then install cotter pins in the capscrews.

Turn crankshaft until other journal is downward and install second connecting rod and piston in same manner.

Assembling and Installing Unloader Pistons

Lubricate the unloader piston bores in the cylinder block and also the unloader piston and unloader piston grommet with clean engine oil. If new unloader kits are being installed, the pistons in the kit are prelubricated. Install unloader piston grommet on unloader piston. Install unloader pistons and unloader plungers through the top of the cylinder block taking care to avoid cutting the unloader piston grommets on the block. Install unloader spring saddle on unloader plungers. Install spring seat in top of cylinder block strainer opening and place unloader spring between spring guide and spring saddle. Install inlet valve guides if they have been previously removed.

Assembling and Installing Cylinder Heads

Install discharge valve in the cylinder head. Install discharge valve spring and discharge valve cap nut, Fig. 12.

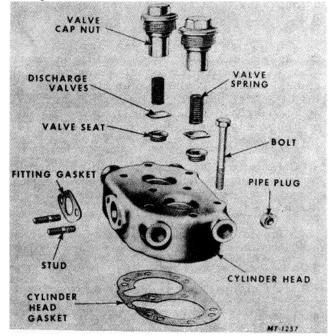


Fig. 12 Exploded View of Cylinder Head

Install inlet valves and inlet valve springs in cylinder block. Place new cylinder head gasket on block. Carefully align inlet valve springs with inlet valve guides in cylinder head and secure head to block by tightening cylinder head nuts evenly.

Assembling and Installing Air Strainer

If compressor assembly includes an air strainer, assemble air strainer, Fig. 13. Using a new gasket, position and install strainer on cylinder block.

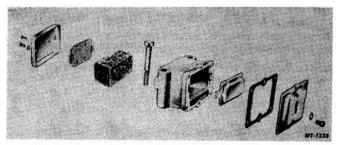


Fig. 13 Exploded View of Air Strainer REINSTALL

Clean oil supply line so that oil will flow freely through the line.

Be sure oil return line or passages through brackets are clean and unrestricted so that oil can return to engine. Always use a new mounting gasket and be sure oil hole in gasket and compressor is properly aligned with oil supply line.

Inspect drive pulley or gear for wear or damage. They must have a neat fit on crankshaft making sure it properly contacts the shaft and not ride the key. Tighten nut securely and install cotter pin. Be sure air cleaner is clean and properly installed. If air intake is connected to engine air cleaner or supercharger, these connections must be tight with no leakage.

Clean or replace any damaged or dirty air or water lines which may be corroded before connecting them to the compressor. Use a new discharge fitting gasket.

Align compressor drive and adjust to proper belt tension. Tighten mounting bolts securely and evenly.

After compressor is installed, operate it and check for air, oil or water leaks at connections. Be sure to check for noisy operation.

TESTING COMPRESSOR

A compressor efficiency or build-up test can be run which is not too difficult. Before the test the crankcase of a selflubricated type compressor should be properly filled with lubricating oil. An engine lubricated compressor must be connected to an oil supply line of at least 15 pounds pressure during the test and an oil return line must be installed to keep the crankcase drained. The compressor (when tested) should be tested without a strainer.

To the discharge port of the compressor connect a reservoir or reservoirs whose volume plus the volume of the connecting line equals 1300 cubic inches. Run the compressor between 1700 and 1750 RPM. Elapsed time that the compressor takes to build up from 0 to 100 psi depends on the type compressor as follow s:

	Build-Up Time
Type Compressor	0 to 100 PSI
Tu Flo 400	47 Seconds Maximum
Tu Flo 500	30 Seconds Maximum
Tu Flo 600	25 Seconds Maximum

During the above test the compressor should be checked for oil leakage and noisy operation.

MAINTENANCE

It is good practice to follow a preventive maintenance schedule at regular mileage intervals to extend the service life of the air compressor. These mileage intervals represent requirements for normal conditions. For severe service or unusual operating conditions the intervals should be reduced accordingly.

Daily:

If the compressor is a self-lubricated type, its oil level should be checked at the same time the engine oil level is checked. The oil level should be kept between the bottom of the dip stick threads and the bottom of the dip stick. The oil should be changed often enough to keep it nonabrasive and noncorrosive.

IMPORTANT: Should it be necessary to drain the engine cooling system to prevent damage from freezing, water-cooled compressors must be drained, as both cylinder block and cylinder head are water cooled. Use drain cock or remove head and/or block pipe plugs.



5,000 Miles:

Service compressor air strainer. Remove and wash all parts including curled hair in cleaning solvent. Saturate curled hair with clean engine oil and squeeze dry before replacing it in the strainer.

Check compressor mounting and drive for alignment, belt tension, etc. Adjust if necessary. 10, 000 Miles:

If compressor is self-lubricated type, the oil should be drained and the compressor crankcase flushed and refilled with clean engine oil.

35,000 Miles:

Remove compressor discharge valve cap nuts and check for presence of excessive carbon deposits. Also, check the discharge line for carbon. If excessive carbon is found in either check, the cylinder head or discharge line should be cleaned or replaced.

If compressor is self-lubricated type, service crankcase breather. Clean and wash breather in cleaning solvent.

If the compressor is lubricated from the engine, clean oil supply line to compressor. Also clean oil return line to engine crankcase if chassis is so equipped.

100, 000 Miles:

Depending upon operating conditions and experience, disassemble compressor, clean and inspect all parts thoroughly. Repair or replace all worn or damaged parts.

TROUBLE SHOOTING

<u>Compressor Fails to Maintain Adequate Pressure in the Air Brake System</u>

- 1. Dirty intake strainer.
- 2. Excessive carbon in compressor cylinder head or discharge line.
- 3. Discharge valves leaking.
- 4. Excessive wear.
- Drive belt slipping.
- 6. Inlet valves stuck open.
- 7. Excessive leakage of inlet valves.

Noisy Operation

- 1. Loose drive pulley.
- Excessive carbon in cylinder head or damaged line.
- 3. Worn or burned-out bearings.

4. Excessive wear.

Compressor Passes Excessive Oil

- 1. Excessive wear.
- 2. Dirty air strainer.
- 3. Excessive oil pressure.
- Oil return line or passage to engine compressor crankcase flooded.
- 5. Oil seal ring in end cover excessively worn.
- 6. Back pressure from engine crankcase.
- 7. Piston rings improperly installed.

Compressor Does Not Unload

- 1. Defective unloading piston grommet.
- 2. Unloading cavity plugged with carbon.
- 3. Unloading mechanism binding or stuck.



AIR BRAKES

IH (MIDLAND) PISTON TYPE COMPRESSOR

MODELS EL-740, 7.4 AND 12

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SPECIFICATIONS

MODEL	EL-740	7.4	12
Number of Cylinders	2	2	2
	.21 m3/min	.21 m3/min	.33 m3/min
	(7.4 cfm)	(7.4 cfm)	(12 cfm)
Lubrication	Engine Lubricated	Engine Lubricated	Engine Lubricated
Cooling	Air or Water	Air or Water	Water
Drive	Belt or Gear	Belt or Gear	Belt or Gear
Bore and Stroke	50.8 x 41.3 mm	50.8 x 41.3 mm	60.3 x 41.3 mm
	(2 x 1-5/8")	(2 x 1-5/8")	(2-3/8 x 1-5/8")
Governor Setting:			
Cut-in	641-676 kPa	641-676 kPa	641-676 kPa
	(93-98 psi)	(93-98 psi)	(93-98 psi)
Cut-out	758-807 kPa	758-807 kPa	758-807 kPa
	(110-117 psi)	(110-117 psi)	(110-117 psi)
Connecting Rod Bearings:			
Bearing Clearance	.01270508 mm	.01270508 mm	.01270508 mm
	(.00050020")	(.00050020")	(.00050020")
Rod to Crankshaft Side Clearance	.05082032 mm	.05082032 mm	.05082032 mm
	(.002008")	(.002008")	(.002008")
Piston Clearance:			
Cast Iron	.03812035 mm	.03812035 mm	.03812035 mm
	(.,00150025")	(.00150025")	(.00150025")
Aluminum	.01140 mm	.01-,140 mm	.127165mm
	(.0040055")	(.0040055")	(.0050065")
Number of Rings Each Piston	4	3	3
Dieter Dies Con-			
Piston Ring Gap:	407 054	070 054	005 470
Compression Rings	127254 mm	.076254 mm	.025178 mm
Oil Ding	(.005010")	(.003010")	(.001007")
Oil Ring	.254-1.016 mm	.076254 mm	.2032-1.016 mm
Piston Ring Groove Clearance:	(.010040")	(. 003010")	(.008040")
Top Compression Rings	.02540635 mm	.01270635 mm	.03810889 mm
Top Compression Kings	(.0010025")	(.00050025")	(.00150035")
Second Compression Ring	.02540762 mm	.01270635 mm	(.00150035) .03810889 mm
Jecond Compression King	(.001003")	(.00050025")	(.00150035")
Third Compression Ring	.02540762 mm	(.00050025)	(.00150035)
Third Compression King	(.001003")		
Oil Ring	Tight Fit	.01270635 mm	Tight Fit
	right Fit	(.00050025")	right Fit
		(.00050025)	
Piston Pin to Connecting Rod	.00510152 mm	.00510152 mm	.00510152 mm
Bushing Clearance	(.00020006")	(.00020006")	(.00020006")
Dashing Clearance	(.0002 .0000)	(.0002 .0000)	(.0002 .0000)



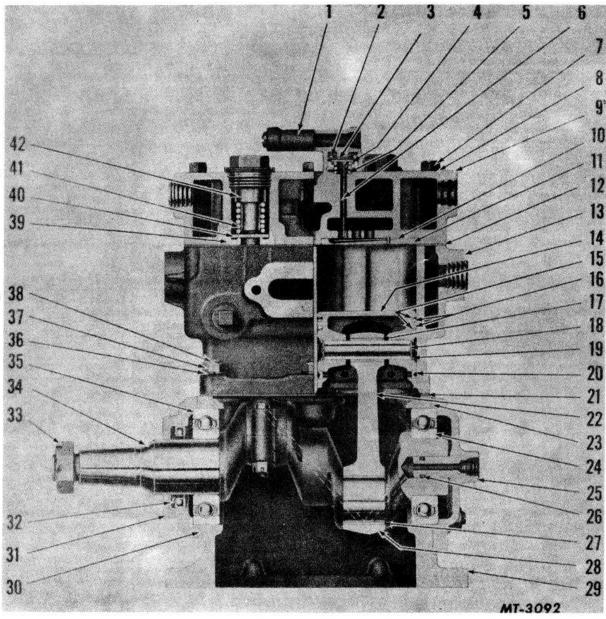


Fig. 1 IH Piston Type Air Compressor (Original Design)
Legend for Fig. 1

17	D 1.11	17	D : ::	1/	D : ::	17	D : ::
<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
1.	Valve, unloader,	11.	Guard, inlet valve	23.	Gasket	33.	Nut, end shaft
	assembly	12.	Gasket	24.	Bearing, rear	34.	Crankshaft
2.	Expanders, spring	13.	Block, cylinder	25.	Cap, end, rear	35.	Bearing, front
	cup	14.	Piston		bearing	36.	Washer, lock
3.	Diaphragm, rubber	15.	Expanders	26.	"O" ring seal	37.	Nuts
4.	Disc, valve	16.	Ring, compression	27.	Bearing half	38.	Studs
5.	Spring, return	17.	Bushing	28.	Cap, bearing	39.	Seat, valve
6.	Pin, inlet valve	18.	Pin, piston	29.	Crankcase	40.	Valve, exhaust
7.	Screw, cap	19.	Ring, snap	30.	Gasket	41.	Spring, exhaust
8.	Washer, lock	20.	Ring, oil	31.	Cap, end, front	42.	Cage, exhaust
9.	Head, cylinder	21.	Gasket		bearing		valve
10.	Valve, inlet	22.	Rod, connecting	32.	Seal, oil		

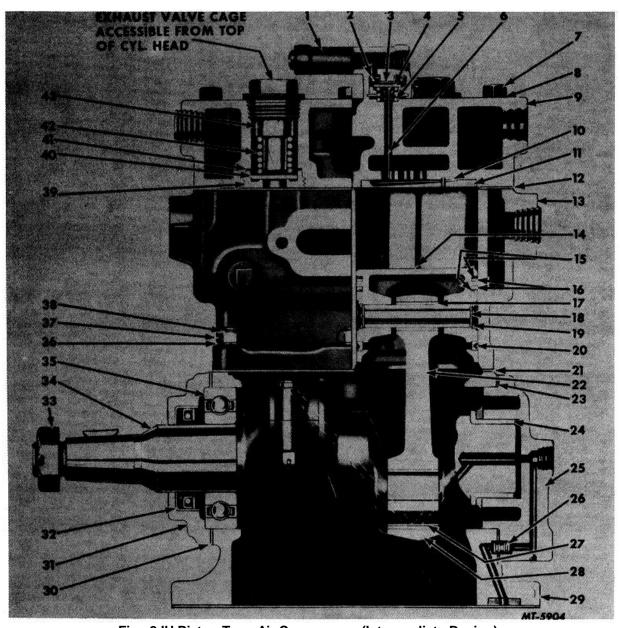


Fig. 2 IH Piston Type Air Compressor (Intermediate Design)

Key	Description	Key	Description	Key	Description	Key	Description
1.	Valve, unloader,	11.	Guard, inlet valve	23.	Gasket	33.	Nut, end shaft
	assembly	12.	Gasket	24.	Bearing, rear	34.	Crankshaft
2.	Expanders, spring	13.	Block, cylinder		sleeve type		Bearing, front
3.	cup	14.	Piston	25.	Cap, end, rear	36.	Washer, lock
3.	Diaphragm, rubber	15.	Expanders		bearing	37.	Nuts
4.	Disc, valve	16.	Ring, compression	26.	Tube, cross-over	38.	Studs
5.	Spring, return	17.	Bushing	27.	Bearing, half	39.	Seat, valve
6.	Pin, inlet valve	18.	Pin, piston	28.	Cap, bearing	40.	Valve, exhaust
7.	Screw, cap	19.	Ring, snap	29.	Crankcase	41.	Gasket
8.	Washer, lock	20.	Ring, oil	30.	Gasket	42.	Spring, exhaust
9.	Head, cylinder	21.	Gasket	31.	Cap, end, frt. brg.	43.	Cage, exhaust
10.	Valve, inlet	22.	Rod, connecting	32.	Seal, oil		valve
	CTS-2177Q - Page 4						

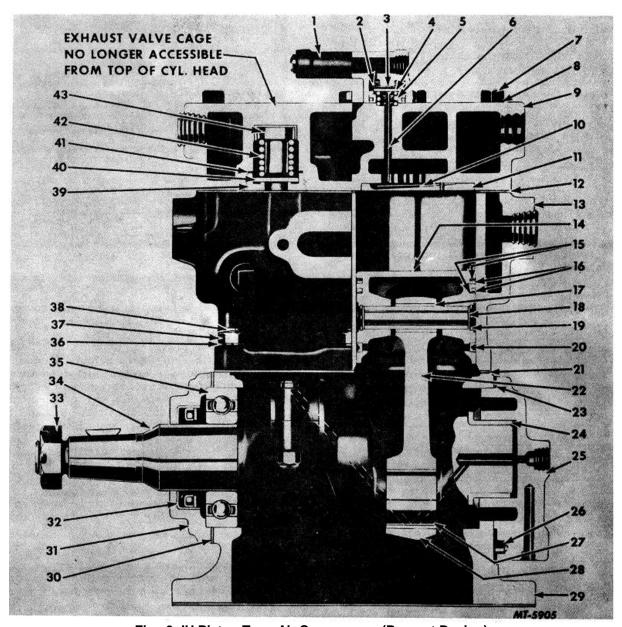


Fig. 3 IH Piston Type Air Compressor (Present Design)
Legend for Fig. 3

<u>Key</u>	<u>Description</u>	<u>Key</u>	Description	<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
1.	Valve, unloader,	11.	Guard, inlet valve	23.	Gasket	33.	Nut, end, shaft
	assembly	12.	Gasket	24.	Bearing, rear	34.	Crankshaft
2.	Expanders, spring	13.	Block, cylinder		sleeve type	35.	Bearing, front
	cup	14.	Piston	25.	Cap, end, rear	36.	Washer, lock
3.	Diaphragm, rubber	15.	Expanders		bearing	37.	Nuts
4.	Disc, valve	16.	Ring, compression	26.		38.	Studs
5.	Spring, return	17.	Bushing	27.	Bearing, half	39.	Seat, valve
6.	Pin, inlet valve	18.	Pin, piston	28.	Cap, bearing	40.	Valve, exhaust
7.	Screw, cap	19.	Ring, snap	29.	Crankcase	41.	Gasket
8.	Washer, lock	20.	Ring, oil	30.	Gasket	42.	Spring, exhaust
9.	Head, cylinder	21.	Gasket	31.	Cap, end, frt, brg.	43.	Cage, exhaust
10.	Valve, inlet	22.	Rod, connecting	32.	Seal, oil		valve



DESCRIPTION

The air compressors contained herein are single acting, reciprocating type with two cylinders and lubricated by the engine lubricating system.

The cylinder head on Model EL-740 or 7.4 compressor may either be air or water cooled and all cylinder heads are water cooled on the Model 12 type compressors.

LUBRICATION

These air compressors depend upon the vehicle's engine for oil and oil pressure. Two types of lubricating systems are employed. Type "A" rear bearing cover with sleeve bushing or integral bearing provides lubrication through the port in center of cover directly into bearing area and crankshaft (Fig. 4). Type "B" rear bearing cover with sleeve or integral bearing (Fig. 5) has drilled oil channels and facilitates either of the following types of lubrication.

1. Base Type Lubrication

Oil flows through the crankcase base and hole in base gasket, continues through oil passageway, through cross-over tube, up vertical passageway of rear bearing cover and into compressor crankshaft.

2. Side Type Lubrication

The plug is removed from rear bearing cover. Oil enters compressor the same as with type "A" rear bearing cover. The oil passageway in the engine mounting base must be plugged and cross-over tube must still be used

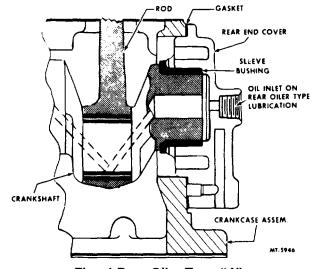


Fig. 4 Rear Oiler Type "A"

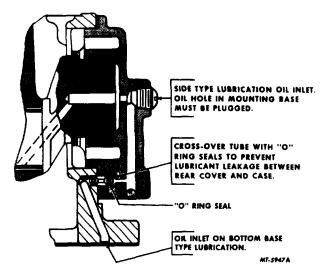


Fig. 5 Bottom Oiler Type "B"

between rear bearing cover and crankcase to prevent oil seepage.

Openings are provided in crankshaft passage at each connecting rod bearing journal connecting the rod bearings. Excess oil forced through clearances between connecting rod and crankshaft is thrown off in the form of a spray which lubricates the walls of cylinders, wrist pins and ball bearing at front, and sleeve type bearing at rear of crankshaft.

Excess oil is returned to the engine crankcase through open base of compressor and mounting bracket on engine.

OPERATION

When the compressor is mounted on a vehicle, compressor crankshaft turns continuously as long as the vehicle's engine is running.

Actual compression of air is controlled by a compressor governor which may be mounted on the compressor or remote. The governor acts in conjunction with unloader valve assembly on compressor cylinder head to start and stop the compression of air at predetermined pressures.

The compressor, therefore, operates under two different conditions:

- 1. When the compressor is running and compressing air or loaded.
- 2. When the compressor is running and not compressing air or unloaded.

Regardless of the operating condition, the cavity in the cylinder head above inlet valve is always filled with air at atmospheric pressure. Having passed through the air cleaner, this air is ready to be admitted to cylinders.

Operation Under Loaded Conditions (Figs. 1, 2, 3 and 6)

Most key numbers shown in the text match Figures 1, 2 and 3. When they do not match, a key number with reference to figure number will be shown; e.g. (25, Figs. 2 and 3).

With each downstroke of the piston, atmospheric air forces inlet valve (10) open and flows into the cylinder during full downward stroke of the piston.

When piston starts on the upstroke, it compresses air in the cylinder and closes inlet valve (10). When this air pressure becomes high enough, it overcomes pressure of the exhaust valve spring (41, Fig. 1); (42, Figs. 2 and 3) and air pressure in the system above the exhaust valve which tends to hold the valve closed. Pressure in the cylinder forces exhaust valve (40) off its seat (39). Some air within the cylinder passes into the exhaust cavity in the cylinder head and into the air supply system through exhaust port in cylinder head.

When air pressure above and below exhaust valve (40) is equalized, exhaust valve spring (41, Fig. 1); (42, Figs. 2 and 3) closes exhaust valve. The piston starts on its next downstroke and the pumping cycle is repeated.

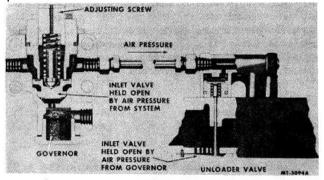


Fig. 6 Governor and Unloader Valve in Pumping Cycle

Operation Under Unloaded Conditions (Figs. 1, 2, 3 and 7)

When pressure in the air supply system reaches maximum pressure for which the governor is set, the governor actuated by air pressure cuts out and from the reservoir delivers air

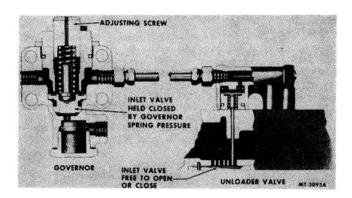


Fig. 7 Governor and Unloader Valve Not Pumping

pressure to unloader valve assembly (1). Pressure on unloader diaphragm (3) forces inlet valve plungers (6) down to hold inlet valves (10) open. As long as inlet valves are open, the air drawn into the cylinder is merely forced back into the cavity above inlet valve and the other cylinder so no compression takes place.

When air pressure in the air supply system drops to minimum pressure for which the governor is set, air is released from unloader valve assembly. Inlet valve return springs (5) move the inlet valve plungers (6) upward. The inlet valve (10) returns to closed position and the intake and compression cycle is resumed.

CONSTRUCTION (Figs. 1, 2 and 3)

Most key numbers shown in the text match Figs. 1, 2 and 3. Where they do not match, a key number with reference to figure number will be shown; e.g. (24, Figs. 2 and 3).

The air compressor is made up of four subassemblies. These are the crankcase assembly, cylinder block assembly, cylinder head assembly and governor assembly.

The crankshaft (34) is supported by crankcase (29) which is flanged at the bottom of both ends and drilled to take four attaching bolts.

The crankshaft is supported in the crankcase by a rear sleeve bearing (24, Figs. 2 and 3) and a front ball bearing (35). The front ball bearing (35) is a press fit on the crankshaft and in the case. End movement of the crankshaft and bearing is controlled by front bearing end cap (31) and rear bearing end cap (25). Gaskets (23 and 30) are used on mating surfaces to insure oil tight joints.

An oil seal (32) in front bearing end cap (31) has a rubber lip which rides against surface of shaft to prevent oil from creeping out

along the shaft. On present and intermediate release air compressors (Figs. 2 and 3), the "O" ring is omitted at the rear sleeve bearing. On original release design air compressor, the "O" ring seal (26, Fig. 1) is installed in a groove in the rear end cap bearing against sides of the drilled oil passage to prevent any loss of oil and oil pressure.

The cylinder block (13) is secured to crankcase (29) by six studs (38), lockwashers (36) and nuts (37).

A gasket (21) used between crankcase (29) and cylinder block (13) insures an oil tight joint.

Each piston (14) of the Model 7.4 and 12 compressors is equipped with two compression rings (16). (Production compression rings are of one-piece construction.) Service compression rings have expanders (15) near the top of piston One oil ring (20) is located near the lower end of the piston. Two compression rings seal the area around the pistons and prevent any loss of compression. The oil ring at the lower end of pistons prevents excess oil from entering compression chambers above the piston.

Each piston of the Model EL-740 compressor has three compression rings and a lower three-piece oil ring (Fig. 9).

Piston is attached to connecting rod (22) by a pressed fit pin (18) which prevents rotation of the piston. Additional insurance to prevent rotation or endwise movement is provided by two snap rings (19).

The Model 7.4 uses a spring steel lock wire, one end of which is inserted into the bore of pin and the other end of the lock wire is inserted in a drilled hole in piston (see Fig. 8).

The EL-740 uses a button on each end of the piston pin to prevent end movement (Fig. 9).

The piston pin bore in the upper end of connecting rod may be fitted with a bushing (17) pressed into place. The bore in the bearing is slightly larger than the diameter of the pin to permit a floating fit between piston and connecting rod. Late design connecting rods will not have this bushing (Fig. 9).

The lower end of the connecting rod is fitted to the crankshaft with a replaceable split-type bearing (27) between connecting rod and bearing journal of crankshaft. The connecting rod cap (28) is held in place with a castellated nut and cotter pin on original and intermediate release air compressors. Nylok nuts are used on present release air compressors.

Aluminum connecting rods and pistons are being used on present release air compressors. Original and intermediate release air compressors used steel connecting rods and cast iron pistons.

Never use cast iron pistons with aluminum connecting rods. Never use one cast iron piston and one aluminum piston. Never use one steel connecting rod and one aluminum connecting rod. Use new aluminum pistons in pairs when replacing cast iron pistons.

The cylinder head (9) on Model 12 is secured to the cylinder block (13) with ten capscrews (7). A gasket (12) seals the joint between the mating surfaces of cylinder head and block. The Model 7.4 and EL-740 compressors have six studs.

Air inlet and exhaust openings are provided in the under side of the cylinder head directly above each piston. The inlet valves (10) and exhaust valves (40) serve to open or close inlet and exhaust openings when compressor is operating.

Inlet valves (10) seat against cylinder head and are secured in place by inlet valve guards (11) staked in place. Exhaust valves (40) have removable seats (39). The exhaust valve springs (41, Fig. 1); (42, Figs. 2 and 3) located directly above the exhaust valves bear against exhaust valve cages (42, Fig. 1); (43, Figs. 2 and 3) in the cylinder head to hold exhaust valve closed until air pressure in cylinder is built up high enough to overcome exhaust valve spring pressure. Exhaust valve cage is no longer accessible from the top of the cylinder head on present release type air compressors. Exhaust valve cage is accessible from the top of cylinder head on original and intermediate release type air compressors.

The unloader valve assembly (1) is secured to cylinder head with two capscrews. Two rubber diaphragms (3) are installed with coil spring cup expanders (2) and valve discs (4). Inlet valve pins (6) and return springs (5) extend downward through cylinder head to open and close inlet valves (10)

DISASSEMBLY OF COMPRESSOR

Remove Unloader Valve and Governor

- 1. Remove copper tube and fitting from unloader valve assembly.
- 2. Remove two capscrews and remove unloader valve assembly from cylinder head.
- 3. If compressor governor is mounted on compressor, disconnect copper tube leading to unloader valve.

- 4. Disconnect copper tube fitting at reservoir port of governor.
- 5. Remove two nuts, lockwashers and lift governor assembly and mounting bracket off cylinder head.
- 6. On compressors having the compressor governor mounted in a remote position, it is only necessary to remove copper tube fitting from unloader valve assembly.

Remove Cylinder Head Assembly

Prick punch both cylinder head assembly and cylinder block assembly to insure that the cylinder head assembly will be installed in the same position from which it was removed. Remove ten capscrews and lift head assembly (9) and cylinder head gasket (12) off cylinder block assembly.

Remove Cylinder Block Assembly

Prick punch both the block assembly (13) and crankcase (29) to insure that the cylinder block will be installed in the same position from which it was removed. Remove six nuts (37), lockwashers (36) and lift block straight up until clear of pistons. Remove gasket (21).

Remove Piston and Connecting Rod Assembly

Turn crankcase on its side and rotate crankshaft to bring one connecting rod to the bottom of its stroke. Working through the bottom of the crankcase, remove cotter pin and cap bolt nut from each cap bolt (on original and intermediate release type air compressors). Remove nylok nuts on present release design air compressors. Remove connecting rod cap (28) and remove piston and connecting rod assembly (22) from top of crankcase. Replace cap on connecting rod and install both cap nuts loosely. Repeat the operation to remove second piston and connecting rod assembly.

Identify connecting rod cap and connecting rod as being a matched assembly by using a quick-drying paint, marking each piece in a distinctive manner.

Remove Crankcase Bearing End Caps

Remove bolts and lockwashers from front and rear bearing end caps and remove end caps from crankcase.

1. Front bearing end cap Drive oil seal (32) out of recess and discard.

2. Rear bearing end cap (with original release design air compressor)

Work a piece of wire under seal (26, Fig. 1) and pry seal out of its groove in stem of cap. Remove seal and discard.

3. Rear bearing end cap (with intermediate and present design air compressors)

Check sleeve type bearing (24, Figs. 2 and 3) in rear end cap for wear. If standard sleeve bearing is worn beyond 35.1255 mm (1.3825"), replace end cap. Bearing and cap are replaced as an assembly. See Chart for crankshaft diameter at rear bearing and rear bearing cap sleeve bushing I.D.

Remove Crankshaft and Crankshaft Bearing Assembly

When disassembling a compressor with a tachometer drive (Fig. 8), remove tachometer drive before removing crankshaft.

Position crankshaft (34) so that front connecting rod bearing journal is in alignment with the cut-out portion of crankshaft bearing bore in front end of crankcase (29).

Using a soft-faced hammer, drive against rear end of crankshaft until bearing is free from supporting bore; remove crankshaft.

Removing Ball Bearing from Crankshaft

Press or pull ball bearing (35) from front end of crankshaft (34) using an arbor press or bearing puller.

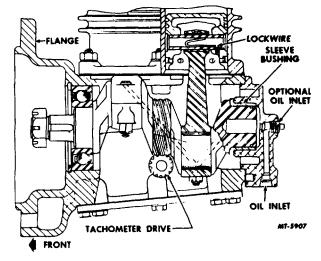


Fig. 8 Air Compressor with Tachometer Drive (Model 7.4 Illustrated)



Cleaning, Inspection and Repair

<u>Cleaning</u>: Clean ball bearing and crankshaft thoroughly using volatile mineral spirits. Run a length of wire or a wire brush through oil passages in crankshaft to loosen any hardened oil deposits. Flush passages thoroughly upon completion.

Inspection: Check inside and outside dimensions against dimensions given on specification sheet and replace if either dimension is not up to standard. Check dimensions of all four crankshaft bearing journals, discarding crankshaft if any journals are not within standard. Replace crankshaft if keyway on front end is chipped or misshapened, or if threads are stripped. After inspection, thoroughly coat bearings and crankshaft with preservative oil.

Repair: No repairs are possible other than running a thread chaser over the threads to remove any roughness or flattened areas. Press one bearing onto front end of crankshaft using an arbor press. Protect threads on end of crankshaft against damage from rough handling by installing a 3/4-16 NF nut, or by wrapping them with friction or adhesive tape.

REBUILD OF PISTON AND CONNECTING ROD ASSEMBLY

Disassembly (Figs. 9 and 10)

- 1. Remove compression rings and oil ring from each piston.
- 2. To remove piston pin on Model 7.4, clamp piston bottom side up in a vise equipped with soft copper or lead jaws. Insert a pointed tool into hole in bottom side of piston pin boss inside piston. Press downward to force end of lock wire out of hole. Reach into bore of piston pin with a pair of thin nose pliers and withdraw lock wire from bore.

On Model EL-740 compressor, it is not necessary to remove end buttons to remove piston pin (Fig. 9). Force pin from piston and rod assembly. After pin has been removed, the buttons can be easily removed and discarded.

Model 12 compressors do not use lock wire. A snap ring at each end of piston pin holds it securely in place.

- 3. Remove piston pin. Using an arbor slightly smaller than the diameter of piston pin, tap pin out of connecting rod and piston.
- 4. Remove connecting rod. Lift rod out of piston and remove piston from vise.

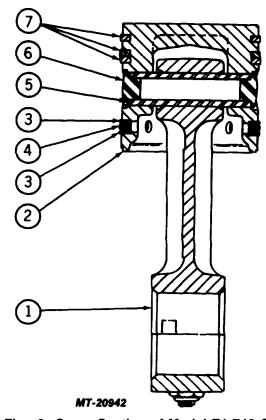


Fig. 9 Cross Section of Model E1-740 Compressor Piston and Connecting Rod Assembly

5. If inspection reveals bearing to be damaged or worn, discard and use a new connecting rod.

Cleaning

Clean all parts thoroughly using volatile mineral spirits. Scrape all carbon deposits from head of piston and from ring grooves. Clean out oil return holes in base of oil ring groove.

Inspection and Repair

- 1. <u>Piston</u>: Visually examine piston for cracks or damage that would make piston unfit for further use. Scoring or abrasion marks, if not serious, may be removed with a light cut of a hand hone stone. Check clearance of rings in ring grooves, diameter of piston pin bore and diameter of piston as indicated in SPECIFICATIONS.
- 2. <u>Piston Pin</u>: Check fit of piston pin and replace if clearance is not within the range given in SPECIFICATIONS.

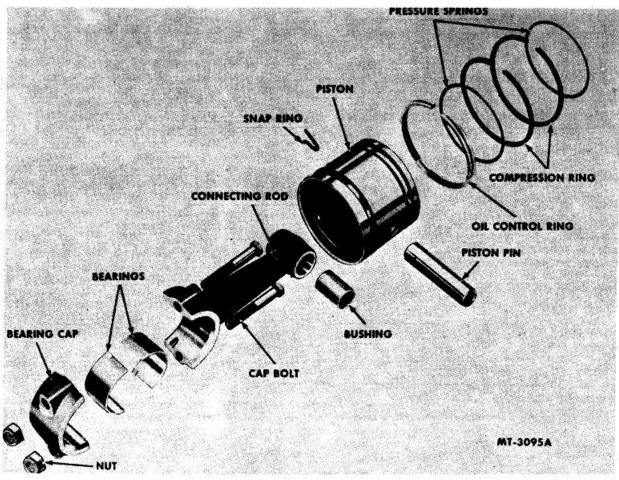


Fig. 10 Model 7.4 and Early Design Model 12 Air Compressors – Piston and Connecting Rod Assembly (Exploded View)

3. Connecting Rod:

- Measure the inside diameter of bearing in upper end of rod. Discard rod if clearance is greater than maximum given in SPECIFICATIONS.
- b. Select a new connecting rod bearing and install one half of bearing in connecting rod and the other half in connecting rod cap.
- c. Check connecting rod bearing clearance and connecting rod inside clearance as follows:
- (1) If crankshaft and connecting rod were marked as instructed, check markings and install connecting rod on crankshaft on same journal from which it was removed. Install connecting rod cap on rod making sure that match marks on both cap and rod are

in alignment. Install cap bolt nuts and tighten to a torque of 11-14 N.m (8-10 ft lbs).

- (2) If connecting rod can be moved on the crankshaft, it indicates that bearing has sufficient clearance. If rod cannot be moved, there is insufficient clearance between bearing and bearing journal of crankshaft. Insufficient clearance is usually the result of journal being out-of-round, or use of improperly sized bearings. Replace defective parts and again check clearance as above.
- (3) When sufficient bearing clearance is attained, slide connecting rod over against one side of journal. Check clearance between opposite side of rod and side of journal using a feeler gage. Refer to SPECIFICATIONS for dimensions. If clearance exceeds maximum dimensions, replace connecting rod and cap.

- (4) When correct side clearance is attained, check excessive clearance between connecting rod bearing and bearing journal. Remove connecting rod cap and install a piece of brass shim stock .0508 6.35 x 19.05 mm (.002-1/4 x 3/4") on the crankshaft journal. Remove any burrs or roughness from edges of shim stock before installing.
- (5) Install cap making sure match marks are again aligned. Install cap bolt nuts and tighten to a torque of 11-14 N.m (8-10 ft lbs). Hold crankshaft and attempt to move connecting rod. If clearance is correct, connecting rod will be immovable. If connecting rod moves, there is excessive clearance between connecting rod bearing and crankshaft journal. This is usually the result of journal being worn or the use of improperly sized bearings.

If clearance is excessive, remove connecting rod, replace defective parts and again check as above. When bearing is properly fitted, remove connecting rod and cap and the piece of shim stock from crankshaft. Leaving both halves of bearing in place, immediately install cap on connecting rod, securing it loosely in place with cap bolts and cap bolt nuts. If piston and crankshaft were not previously marked, mark these parts as instructed. Check fit of second connecting rod in same manner. After completing all inspection operations, coat all parts with preservative oil.

Assembly

1. Piston and Connecting Rod

On Model 7.4, clamp piston upside down in a vise equipped with soft copper or lead jaws and start piston pin into piston pin bore in piston. The lock wire holes for piston pin lock wire in both piston pin and piston must be in accurate alignment before piston pin is started into place. Line up bore in upper end of connecting rod with piston pin and tap piston pin into place making sure lock wire holes are in alignment. Install lock wire engaging bend end in holes in both piston and piston pin. Remove assembled parts from vise and rock piston to make sure piston pin is a free fit in the rod.

On EL-740, install new end buttons on piston pin. With appropriate size arbor either tap or press piston pin and button assembly into piston and connecting rod. Be sure that buttons are flush or below surface of piston.

On Model 12, install piston pin and apply snap rings to each end of pin.

2. Piston Rings

Check piston ring-to-groove clearance before installation of piston rings. Use a feeler gage and check clearance between each ring and ring groove in piston. Clearances are given in the SPECIFICATIONS.

Install piston rings using a ring expander. Install two compression rings, oil rings and side pressure springs when used as follows:

a. Top Groove

Insert cast iron ring first with single pip mark (.) toward top of piston. Then install side pressure spring, when used, on top of cast iron ring with convex side toward top of piston and gap 180 degrees from gap in cast iron ring.

b. Second Groove

Insert cast iron ring first with two pip marks (..) toward top of piston. Then install side pressure spring on lower side of cast iron ring with concave side toward top of piston and gap 180 degrees from gap in cast iron ring. The EL-740 compressor utilizes two cast iron rings in the second groove. The pip marks on these rings must also be toward top of piston.

When installation of compression rings is completed, position ring gaps 180 degrees apart.

c. Bottom Groove

When a single cast ring is used, insert with beveled side toward top of piston.

When two oil rings are used with a ring expander, first assemble ring expander in groove followed by two steel rings. Position oil rings so that gaps are 180 degrees apart.

REBUILD OF BEARING END CAPS

Cleaning and Inspection

Clean all parts in volatile mineral spirits. Inspect front bearing cap for cracks and damage on finished face. If cap is cracked, or if there are serious gouges or scratches on the finished face, cap must be replaced. Minor imperfections may be removed with a hand honing stone.

SIZE	CRANKSHAFT DIAMETER AT REAR BEARING	REAR BEARING CAP SLEEVE I. D.	RUNNING CLEARANCE
Standard	35.0113 - 35.0987 mm	35.0444 - 35.0825 mm	.033 mm (.0013") Min.
	(1.3779 - 1.3784")	(1.3797 - 1.3812")	.8382 mm (.0033") Max.
.254 mm (.010) u/s	34.7574 - 34.7701 mm	34.7904 - 34.8285 mm	.033 mm (.0013") Min.
	(1.3684 - 1.3689")	(1.3967 - 1.3712")	.8382 mm (.0033") Max.
.508 mm (.020") u/s	34.5034 - 34.5161 mm	34.5364 - 34.5745 mm	.033 mm (.0013") Min.
	(1.3584 - 1.3589")	(1.3597 - 1.3612")	.8382 mm (.0033") Max.
.762 mm (.030") u/s	34.2494 - 34.2621 mm	34.2824 - 34.3205 mm	.033 mm (.0013") Min.
	(1.3484 - 1.3489")	(1.3497 - 1.3512")	.8382 mm (.0033") Max.

Check sleeve type bearing in rear end cap for wear. If standard sleeve bearing is worn beyond 35.1255 mm (1.3825"), replace end cap. Bearing sleeve and cap are replaced as an assembly.

See Chart for crankshaft diameter at rear bearing and rear bearing cap sleeve bushing I.D.

Assembly

1. Front Bearing Cap

Set bearing cap, finished face up, on the bed of an arbor press. Position oil seal over the recess in cap with side of seal carrying part number facing up. Using a wood block or flat plate of metal between arbor and seal, press seal into cap.

2. Rear Bearing Cap

Lightly oil I.D. of rear bearing cap sleeve type bearing.

REBUILD OF CYLINDER HEAD ASSEMBLY

Disassembly

Cylinder head with exhaust valve gage accessible from top of cylinder head (refer to Figs. 1 and 2).

- 1. Scrape all carbon accumulations from under side of cylinder head and clamp cylinder head, top side up, in a bench vise equipped with soft copper or lead jaws.
- 2. Remove exhaust valve cage. Unscrew cage, lift cage straight up and remove from cylinder head (42, Fig. 1; (43, Fig. 2). Remove spring. Remove second valve cage and spring in the same manner.

- 3. Remove exhaust valve. Remove cylinder head from bench vise and invert head to cause both valves to drop out of head.
- 4. Remove inlet valve guard. Clamp cylinder head, bottom side up, in bench vise and insert blade of a small screwdriver under the edge of guard and pry guard out of cylinder head.
- 5. Remove inlet valves.
- 6. Remove exhaust valve seat and seat washer. Remove seat from cylinder head. Lift washer from its position in the bottom of exhaust valve seat hole in cylinder head. Remove second valve seat and washer in the same manner.

Disassembly (Fig. 11)

Cylinder head with exhaust valve cage no longer accessible from top of cylinder head.

- 1. Scrape all carbon accumulations from under side of cylinder head and clamp cylinder head, bottom side up, in a bench vise equipped with soft copper or lead jaws.
- 2. Remove exhaust valve seat and seat washer. Lift washer from its position in the bottom of exhaust valve seat hole in cylinder head.
- 3. Remove exhaust valve, spring and exhaust valve cage.
- 4. Remove second valve seat, etc., in the same manner.
- 5. Remove inlet valve guard. Insert blade of a small screwdriver under the edge of guard and pry guard out of cylinder head.
- 6. Remove inlet valves.

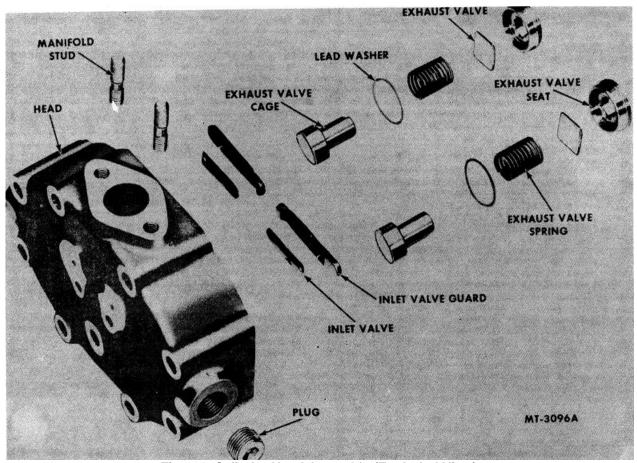


Fig. 11 Cylinder Head Assembly (Exploded View)

Cleaning and Inspection

Thoroughly clean all parts using volatile mineral spirits. Clean and scrape all carbon deposits from air inlet and exhaust cavities in cylinder head. A light coating of rust in the waterpassage is not objectionable. However, if there are heavy accumulations of rust or other foreign substances clinging to passage walls, break these formations up by chipping them with a sharp tool and then clear passage by forcing cleaning solvent, under pressure, through the passage.

1. Cylinder Head

Check head for cracks, replacing head if such damage is evident. Check inlet valve seating surfaces and finished surfaces, against which gaskets are used, for roughness or scratches. Using extreme care to maintain inlet valve seating surfaces flat and true, remove slight imperfections with hand honing stone. Replace head if surfaces are seriously gouged or damaged. When inlet

valve guard is staked in place, slight burrs are raised in edges of recesses in which valve guards are installed. Use an abrasive wheel or a file to remove these burrs. Flush entire cylinder head with cleaning solvent after completing this operation. Check all tapped openings for rough or damaged threads.

Exhaust Valves and Seals

Inspect sealing areas of exhaust valves and exhaust valve seats for scratches, gouges or pits. If such defects are evident, but only to a minor degree, they may be removed by lapping if lapping equipment is available. If suitable lapping equipment is unavailable, parts must be replaced.

Only minor imperfections may be removed by lapping. Replace any parts that are deeply grooved or pitted. Immediately upon completion of this operation, protect exhaust valve and exhaust valve seat against parts in the cylinder head as instructed.

3. Inlet Valve and Valve Guard

If inlet valve is nicked, burred or pitted, replace valve. The pin in valve end must be a tight fit in pin hole located in under side of guard. Replace either valve, guard or both if fit is not tight. Use an abrasive wheel or a file to remove any burrs or roughness from edges of guard. Upon completion of this operation, wash guard in cleaning solvent to remove all metallic particles.

4. Inlet Valve Plungers

Use a straight edge to check plungers for straightness. Inspect both ends of plungers for evidence of wear. Replace plungers for either of these imperfections.

5. <u>Exhaust Valve & Inlet Valve Plunger Springs</u> Check both free length and loaded length of all four springs.

Assembly

1. Install exhaust valve seat. Clamp cylinder head in a bench vise equipped with soft copper or lead jaws. Install one washer in each exhaust opening in the head. Install and tighten seats. When fully tightened, seats must be either flush with or slightly below the finished surface of cylinder head.

The above procedure is used on cylinder heads of the original and intermediate release type design.

On present release design cylinder head, clamp cylinder head in a bench vise equipped with soft copper or lead jaws, bottom side up. From bottom of cylinder head, install valve cage, exhaust valve spring, exhaust valve, washer and exhaust valve seat. Tighten seat. When fully tightened, seats must be either flush with or slightly below the finished surface of cylinder head.

- 2. Install inlet valves in cylinder head. To secure correct application of inlet valves (refer to Fig. 12 for letters in parenthesis), install inlet valve (B) on pin (E) in inlet valve guard (A). Place a straight edge across length of guard (A to A). The inlet valve should then be midway between lower edge of straight edge and angular face of guard.
- 3. Install inlet valve and guard. Place valve in inlet valve recess of cylinder head with pin hole in valve aligned with pin hole in head. Install guard on top of inlet valve with pin in bottom surface of guard engaged



Fig. 12 Method for Checking Inlet Valve Application

in pin holes in valve and head. Tap guard firmly into place. When finally positioned, guard must be flush with or slightly below finished face of head.

- 4. Stake inlet valve guard. After guard is seated, secure in position by staking. Using a punch with a narrow blunt point peen a small area of cylinder head metal over against side of guard. Install second inlet valve and guard in the same manner.
- 5. Check operation of inlet valve. Invert cylinder head in bench vise and, using one inlet valve plunger without spring, check operation of inlet valves. Insert plungers into inlet valve plunger hole in cylinder head. Open and close inlet valve a few times by alternately pressing down and releasing plunger. Note, by feel, the action of plunger each time inlet valve closes. The valve should close with a definite snap action causing a slight bouncy feeling to be transmitted to plunger. If valve action is sluggish, parts must be disassembled and the cause eliminated before proceeding further.

Procedures 6 and 7 are for original and intermediate release design cylinder heads.

- 6. Install exhaust valves by using a small spot of heavy grease as an adhesive. Fasten each valve to the end of a stick of wood, about the size of a pencil, and lower the valves onto their seats in the cylinder head.
- 7. Install exhaust valve cage by setting spring on top of exhaust valve. Tighten cage.

REBUILD OF UNLOADER ASSEMBLY

Remove Unloader Valve Assembly

Disconnect copper tube fitting. Remove two capscrews and lockwashers; then remove unloader valve from cylinder head. Remove inlet valve plungers and springs.

Disassembly (Fig. 13)

1. Remove snap ring (on original and intermedi-

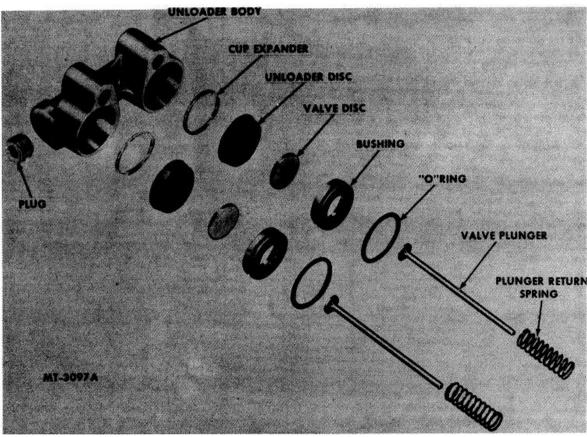


Fig. 13 Unloader Valve Assembly (Exploded View)

ate release design air compressors, "O" ring on present release design air compressors), bushing and disc.

2. Remove unloader cups and expanders.

Cleaning and Inspection

- 1. Wash all parts in cleaning fluid,
- 2. Inspect inner bores of body; they must be smooth.

Assembly

- 1. Install cup expanders in unloader cup.
- 2. Install new unloader cups in unloader body.
- 3. Install valve discs, bushings and snap rings on original and intermediate release design air compressors; "O" ring on present design compressor.
- 4. Install 1/8" pipe plug in one tapped port of assembly. Apply air pressure of 689.5 kPa (100 psi) to opposite end of assembly. No air leaks allowed.

ASSEMBLY OF COMPRESSOR Install Cylinder Block Assembly

- 1. Install cylinder block gasket over the six studs in top of crankcase. Model EL-740 uses capscrews.
- 2. Remove two cap bolt nuts and cap from lower end of each connecting rod. Position cylinder block (with pistons and connecting rod assemblies) over top studs in crankcase so that lower ends of connecting rods are just below top surface of crankcase.
- 3. Lower crankcase over the six studs while guiding lower ends of connecting rods onto connecting rod journals of crankshaft. Secure cylinder block in place with six nuts and lockwashers. Tighten nuts to a torque of 16-23 N.m (12-17 ft lbs). Model EL-740 uses capscrews.

Install Connecting Rod Cap

Check connecting rod and cap identification marks to make sure these parts are properly mated. Align the match marks and install caps on connecting rods. Secure each cap in place with two cap bolt nuts and tighten to 24 N.m (8 ft lbs). If cotter pin holes do not line up with nuts, tighten nuts beyond the above mentioned torque value. Install cotter pins.

Aluminum connecting rod caps are secured with nylok nuts and do not require a cotter pin. Use new nylok nuts to secure bearing caps with steel connecting rods.

Install Cylinder Head

On Model 7.4 or EL-740, install gasket on cylinder head making sure cut-out sections of gasket are positioned on same side of head as exhaust valve seats. Install gasket and cylinder head on six studs in the cylinder block. Apply six nuts and lockwashers and tighten to 16-23 N.m (12-17 ft lbs). The EL-740 compressor uses bolts instead of studs.

On Model 12, the cylinder head gasket has no cut-out sections for the exhaust valve seats. Install gasket and cylinder head on cylinder block; install ten capscrews and tighten to 16-23 N.m (12-17 ft lbs).

Install Unloader Valve Assembly

Install inlet valve plungers and springs in cylinder head. Carefully position unloader valve assembly over plungers and fasten unloader valve in place with two lockwashers and capscrews. Tighten to 1.4 2.7 N.m (1-2 ft lbs).

GOVERNOR Description

The governor (Fig. 14 Present Design; Fig. 15 Original Design; Fig. 16 Intermediate Design) is an air control device which works with the air compressor unloader mechanism. It functions automatically to maintain a preset air pressure range in the air system.

The governors contained in this text are applicable to vehicles with air brake systems prior to FMVSS 121. Refer to Section CTS-2673, Air Brake Components, for governors which apply to FMVSS 121 air brake systems.

Operation

Where governor operation differs (present, intermediate or original design), the key number with reference figure number will be shown.

With engine shut off and no air in the system, governor spring (11) holds plunger (10) in down position, seating inlet valve (6) on body.

With engine running, compressed air passes from reservoir to port of governor. As pressure increases, it gradually raises inlet valve (6) from its seat until maximum or cut-out pressure is built up. At this point, inlet valve (6) snaps to full open position raising plunger

(10), compressing spring (11) and seating exhaust valve (7, Fig. 15); valve assembly (6, Fig. 14 and Fig. 16). Reservoir pressure then passes through a small orifice in the inlet valve and around outside diameter of exhaust valve (7, Fig. 15); valve assembly (6, Fig. 14 and 16) to fill the center cavity of governor and pass through connecting tube to top cavity in the unloader assembly.

When reservoir pressure drops to minimum or cut-in setting, reduced pressure from the reservoir allows governor spring (11) to force plunger (10) down to seat inlet valve (6) against body and at the same time unseat exhaust valve (7, Fig. 15); valve assembly (6, Fig. 14 and 16) which allows air pressure in the unloader and governor to exhaust through the port in the governor adjusting screw.

<u>Disassemble Compressor Governor</u> Present Design (Fig. 14)

- 1. Remove end cap (1) and filter (3).
- 2. Remove lock nut (13), loosen lock nut (9) and remove exhaust valve housing (8) with "O" ring (7) from body (5).
- 3. Remove adjusting screw (12) from exhaust valve hosing (8). Lift out governor spring (11) and plunger (10).
- 4. Remove inlet and exhaust valve assembly (6) from body (5).

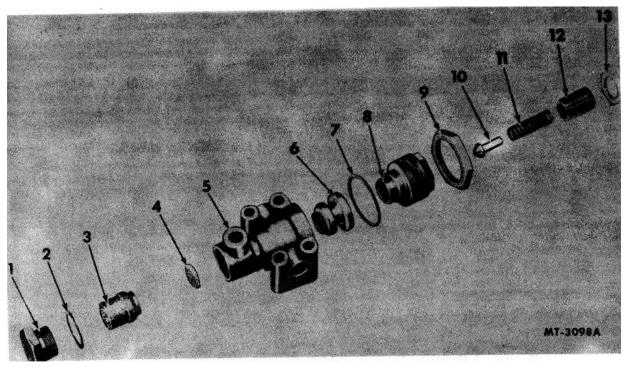
Cleaning and Inspection of Parts

- 1. Clean all parts in cleaning solvent or mineral spirits.
- 2. Inspect plunger for wear. If damaged or worn, it must be replaced.
- 3. Inspect inlet and exhaust valve assembly.

If there is any wear of metal section or damage to valve face, it must be replaced.

Governor Assembly and Adjustment - Present Design (Fig. 14)

- 1. Install valve assembly (6) into body (5).
- 2. Install plunger (10) and spring (11).
- 3. Install "O" ring (7) on exhaust valve housing (8). Apply thin coat of lubricant to O.D. of "O" ring. Turn exhaust valve housing (8) in body (5) until housing bottoms on valve assembly (6). Do not tighten. Turn housing (8) back 3/4 turn. Install locknut (9) loosely on valve housing.



Key	Description	Key	Description	<u>Key</u>	Description
1.	Cap, end	6.	Valve, inlet and exhaust	10.	Plunger
2.	Not Used		assembly	11.	Spring
3.	Filter	7.	"O" ring	12.	Screw, adjusting
4.	Not Used	8.	Housing, exhaust valve	13.	Nut, lock
5.	Body	9.	Nut, lock		

Fig. 14 Governor - Present Design (Exploded View)

4. Turn in adjusting screw (12) nine complete turns while making sure valve housing is held stationary.

Top of adjusting screw (12) should protrude approximately 9.5 mm (3/8") beyond exhaust valve housing (8). Install locknut (13) loosely on adjusting screw.

- 5. Install filter (3) in end cap (1). Install end cap and filter in body.
- 6. Mount governor on a compressor and connect reservoir and unloader to respective openings in governor. (Ports on the governor are marked "unl" for unloader and "res" for reservoir.) The reservoir should be supplied with a pressure gauge and a bleed valve.
- 7. Build up pressure in reservoir and open bleed valve to stabilize pressure at 793 kPa (115 psi). If governor cuts out before 793 kPa (115 psi) is reached, turn adjusting screw (12) in (clockwise) one complete turn

and repeat this step.

- 8. Slowly back off (turn counterclockwise) adjusting screw (12) until governor cuts out.
- 9. Slowly bleed off air from reservoir until governor cuts in (compressor starts pumping).

Cut-in pressure should be between 641-676 kPa (93-98 psi).

- 10. If cut-in pressure is below 641 kPa (93 psi high range), hold adjusting screw (12) while turning exhaust valve housing (8) out (counterclockwise) approximately 1/6 turn.
- 11. If cut-in pressure is above 676 kPa (98 psi low range), hold adjusting screw while turning exhaust valve housing in (clockwise) approximately 1/6 turn. 1/6 Turn will result in a range change of approximately 35 kPa (5 psi).



12. After every adjustment, repeat Steps 9 thru 11 until proper range is obtained.

CAUTION

Pressure differential between cut -in and cut-out must not be lower than 103 kPa (15 psi). This could result in erratic operation.

- 13. Recheck cut-out pressure. If not 793 kPa (115 psi), turn adjusting screw (12) in to increase pressure or out to decrease pressure until compressor cuts out at 793 kPa (115 psi).
- Tighten both adjusting screw locknuts (13) and exhaust valve housing locknut (9) and recheck operation.

Readjustment of Governor on Vehicle

Readjustment may be necessary if the range (difference between cut-out and cut-in pressure) falls below 103 kPa (15 psi) or if the pressure setting is incorrect. Before making any readjustments, the governor filter and governor supply line (reservoir) should be checked for any restriction. Once these items are checked and readjustment is still required, proceed as follows:

- 1. Loosen both adjusting screw locknuts (13) and exhaust valve housing locknut (9).
- 2. Turn adjusting screw (12) out (counterclockwise) approximately four turns.
- Turn exhaust valve housing (8) in (clockwise) until contact is made with valve (6).
 - Do not tighten as this will damage seat.
- 4. Back off exhaust valve housing (8) 3/4 turn.
- 5. Holding exhaust valve housing (8), turn in adjusting screw (12) three turns after contact with spring is made. When contact is made with spring, slight resistance can be felt. If no difference in resistance can be felt, turn adjustment screw in until screw protrudes 9.5 mm (3/8") beyond exhaust valve housing (8).
- Build up air pressure to 793 kPa (115 psi) and shut off engine. If governor cuts out before reaching 793 kPa (115 psi), turn adjusting screw (12) in (clockwise) one complete turn and repeat this step.
- 7. With pressure holding at 793 kPa (115 psi) slowly turn adjusting screw (12) out

- (counterclockwise) until governor cuts out (dull pop).
- 8. Start engine and slowly bleed down air pressure until governor cuts in. Cut-in pressure should be between 641-676 kPa (93-98 psi).
- 9. If cut-in pressure is below 641 kPa (93 psi high range), hold adjusting screw (12) while turning exhaust valve housing (8) out (counterclockwise) approximately 1/6 turn.
- If cut-in pressure is above 676 kPa (98 psi low range), hold adjusting screw (12) while turning exhaust valve housing (8) in (clockwise) approximately 1/6 turn. 1/6 Turn will result in a range change of approximately 35 kPa (5 psi).
- 11. After every adjustment, repeat Steps 8 thru 10 until proper range is obtained.

CAUTION

Pressure differential between cut-in and cut-out must not be lower than 103 kPa (15 psi). This could result in erratic operation.

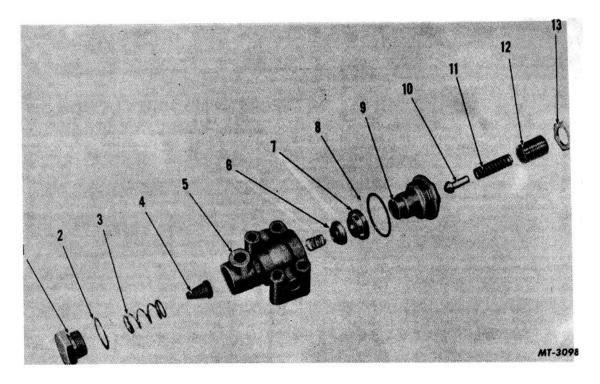
- 12. Recheck cut-out pressure. If not 793 kPa (115 psi), turn adjusting screw (12) in to increase pressure or out to decrease pressure until compressor cuts out at 798 kPa (115 psi).
- 13. Tighten both adjusting screw locknut (13) and exhaust valve housing locknut (9) and recheck operation.

<u>Disassemble Compressor Governor</u> - Original (Fig. 15) and Intermediate (Fig. 16)

- 1. Remove end cap (1), gasket (2), spring or filter (3) and air cleaner (4).
- 2. Remove lock nut (13), exhaust valve housing (9) and shims (8) from body (5).
- 3. Lift out spring (11), plunger (10) and exhaust valve (7) on original design.
- 4. Remove inlet valve (6). On some governors the inlet and exhaust valve are machined as one piece.

Cleaning and Inspection of Parts

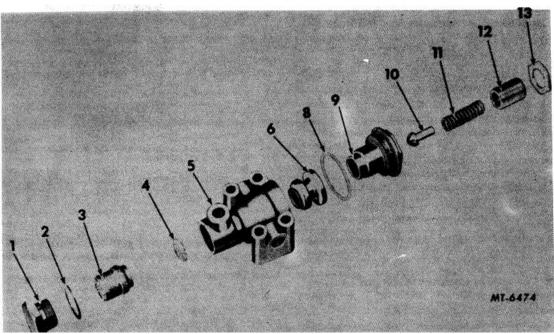
- Clean all parts in cleaning solvent or mineral spirits.
- Inspect plunger for wear. If damaged or worn, it must be replaced.



<u>Key</u>	<u>Description</u>	<u>Key</u>	Description	<u>Key</u>	Description
1	Cap, end	6	Valve, inlet	10	Plunger
2	Gasket	7	Valve, exhaust	11	Spring, governor
3	Spring	8	Shims	12	Screw, adjusting
4	Cleaner, air, assembly	9	Housing, exhaust valve	13	Nut, lock
5	Body		.		

Fig. 15 Governor - Original Design (Exploded View)

- Inspect exhaust valve. If there is any wear of metal section or damage to valve face, it must be replaced.
- 4. Inspect inlet valve for wear or damage. It must be replaced if worn or damaged.
- Governor Assembly and Adjustment Original (Fig. 15) and Intermediate (Fig. 16)
- 1. Install valve assembly (6) into body (5). Install exhaust valve (7) when separate.
- 2. Install plunger (10) and spring (11).
- Install three shims (8) on exhaust valve housing (9). Turn exhaust valve housing (9) into body (5) until housing is tight. Prior to assembly, make sure housing (9) and body (5) mating surfaces and spacers (8) are clean.
- 4. Turn in adjusting screw (12) nine complete turns while making sure valve housing is held stationary. Top of adjusting screw (12) should protrude approximately 9.5 mm (3/8") beyond exhaust valve housing (9). Install locknut (13) loosely on adjusting screw.
- 5. Install screen (4) in body (5). Install filter (3) in end cap (1). Put washer (2) on end cap (1). Install end cap (1) with washer (2) and filter (3) into body (5).
- 6. Mount governor on a compressor and connect reservoir and unloader to the respective openings in the governor. (Ports on governor are marked "unl" for unloader and "res" for reservoir.) The reservoir should be supplied with a pressure gauge and a bleed valve.
- 7. Build up pressure in reservoir and open



<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>	Key	Description
1 2 3 4 5	Cap, end Washer Filter Screen Body	6 7 8 9	Valve, inlet and exhaust assembly Shims Housing, exhaust valve	10 11 12 13	Plunger Spring Screw, adjusting Nut, lock

Fig. 16 Governor Intermediate Design (Exploded View)

bleed valve to stabilize pressure at 793 kPa (115 psi). If governor cuts out before 793 kPa (115 psi) is reached, turn adjusting screw (12) in (clockwise) one complete turn and repeat this step.

- 8. Slowly back off (turn counterclockwise) adjusting screw (12) until governor cuts out.
- Slowly bleed off air from reservoir until governor cuts in (compressor starts pumping).
 Cut-in pressure should be between 641-676 kPa (93-98 psi).
- 10. If cut-in pressure is below 641 kPa (93 psi high range), remove exhaust valve housing (9) with adjusting screw (12), locknut (13) and shims (8) as a complete unit. Add the necessary shims (8). One shim (8) is equal to a range change of approximately 27.6 kPa (4 psi). Install exhaust valve housing (9) with adjusting screw (12), locknut (13) and shims (8) as a complete unit into body (5) and tighten.
- 11 If cut-out pressure is above 676 kPa (98 psi low range), remove exhaust valve housing (9) with adjusting screw (12), locknut (13) and shims (8) as a complete unit. Remove necessary shims (8). One shim (8) is equal to a range change of approximately 27.6 kPa (4 psi). Install exhaust valve housing (9) with adjusting screw (12), locknut (13) and shims (8) as a complete unit into body (5) and tighten.
- After every adjustment, repeat Steps 7 thru 11 until proper range is obtained.

CAUTION

Pressure differential between cut-in and cut-out must not be lower than 103 kPa (15 psi). This could result in erratic operation.

13. Recheck cut-out pressure. If not 793 kPa (115 psi), turn adjusting screw (12) in to increase pressure or out to decrease pressure until compressor cuts out at 793 kPa (115 psi).

14. Tighten adjusting screw locknut (13) and recheck operation.

Readjustment of Governor on Vehicle - Original (Fig. 15) and Intermediate (Fig. 16).

Readjustment may be necessary if range (difference between cut-out and cut-in pressure) falls below 103 kPa (15 psi) or if pressure set-ring is incorrect. Before making any readjustments, governor filter and governor supply line (reservoir) should be checked for any restriction. Once these items are checked and readjustment is still required, proceed as follows:

- 1. Loosen adjusting screw locknut (13) and exhaust valve housing (9).
- 2. Remove exhaust valve housing (9) with adjusting screw (12), locknut (13) and shims (8) as a complete unit.
- 3. Remove shims (8) and put back three shims (8) on exhaust valve housing (9).
- 4. Turn exhaust valve housing (9) with adjusting screw (12), locknut (13) and shims (8) as a complete unit into body (5) and tighten.
- 5. Turn adjusting screw (12) until screw protrudes 9,5 mm (3/8") beyond exhaust valve housing (9).
- 6. Build up air pressure to 793 kPa (115 psi) and shut off engine. If governor cuts out before reaching 793 kPa (115 psi), turn adjusting screw (12) in (clockwise) one complete turn and repeat this step.
- 7. With pressure holding at 793 kPa (115 psi) slowly turn adjusting screw (12) out (counterclockwise) until governor cuts out (dull pop).
- 8. Start engine and slowly bleed down air pressure until governor cuts in. Cut-in pressure should. be between 641-676 kPa (93-98 psi).
- 9. If cut-in pressure is below 641 kPa (93 psi high range), remove exhaust valve housing (9) with adjusting screw (12), locknut (13) and shims (8) as a complete unit. Add necessary shims (8). One shim is equal to a range change of 27.6 kPa (4 psi). Install as in Step 4.

- If cut-in pressure is above 676 kPa (98 psi low range), remove exhaust valve housing (9) with adjusting screw (12), locknut (13) and spacers (8) as a complete unit. Remove necessary shims (8). One shim is equal to a range change of 27.6 kPa (4 psi). Install as in Step 4.
- 11. After every adjustment, repeat Steps 6 thru 10 until proper range is obtained.

CAUTION

Pressure differential between cut-in and cut-out must not be lower than 103 kPa (15 psi). This could result in erratic operation.

- Recheck cut-out pressure. If not 793 kPa (115 psi), turn adjusting screw (12) in to increase pressure or out to decrease pressure until compressor cuts out at 793 kPa (115 psi).
- 13. Tighten adjusting screw locknut (13) and recheck operation.

MAINTENANCE

As Required

- Service wet-type compressor air cleaner every month (Fig. 17). Remove and wash all parts in cleaning solvent. Saturate curled hair with clean engine oil and squeeze out excessive oil before replacing it in strainer body. Compressors which draw their air through the engine air cleaner require no additional maintenance over than normally required for the air cleaner. Dry type compressor air cleaners are to be cleaned or replaced every 5 months or every 19,000 km (12,000 miles).
- 2. Check compressor mounting and drive for alignment and belt tension. Tighten and adjust as necessary.

Every Six Months

1. Since compressor is engine lubricated, remove compressor oil supply line and clean line thoroughly to insure adequate lubrication.

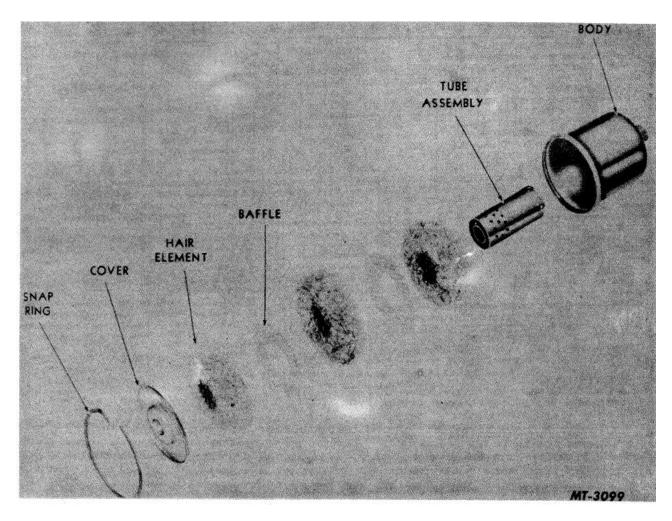


Fig. 17 Compressor Air Cleaner (Exploded View)

2. Remove governor air strainers and wash thoroughly in cleaning fluid.

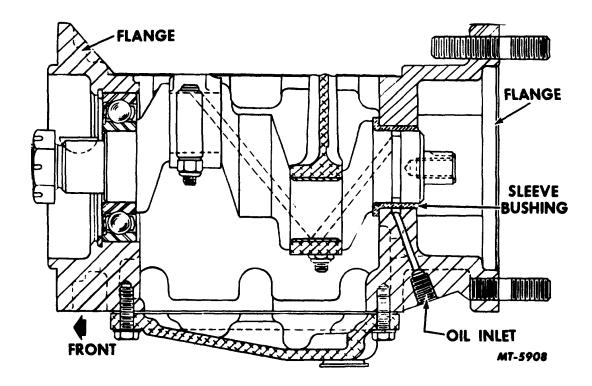


Fig. 18 Crankcase of Flange-Type Air Compressor (Short Version)

Some few air compressors have been released with air compressor crankcase types illustrated in Figs. 18 and 19. The front flange is part of *he crankcase. The rear flange is part of the rear bearing or sleeve bushing

retainer. Basic disassembly, reassembly and servicing is the same as pulley driven type air compressor.

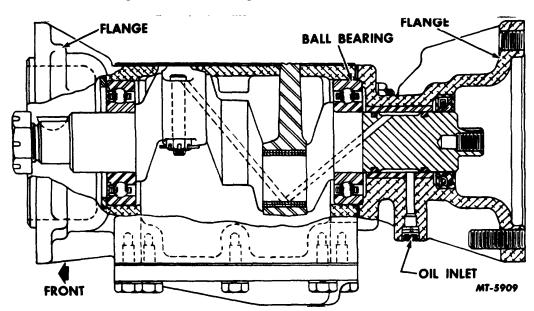


Fig. 19 Crankcase of Flange-Type Air Compressor (Long Version)



TROUBLE SHOOTING (GOVERNOR)

COMPLAINT	CAUSE	SOLUTION
Low or high range	Improper adjustment.	Readjust.
	2. Worn seat on valve.	Replace valve.
High or no cut-out pressure.	1. Improper adjustment.	Readjust.
	2. Clogged governor filter.	Replace filter.
	3. Restricted supply line	Remove restriction.
	4. Sticky valve.	Clean valve and body.
Air leak out of exhaust hole or fluttering.	Improper adjustment (Range too low).	Readjust.
	2. Clogged filter.	Replace filter.
	3. Restricted supply line.	Remove restriction.
	 Supply line too small when air is taken from governor line for other purposes. 	Increase supply line or replumb air lines from governor to reservoir.
	5. Damaged valve seat.	Replace valve.
Low cut-out pressure.	Improper adjustment.	Readjust.
	2. Spring taken a set.	Replace spring.

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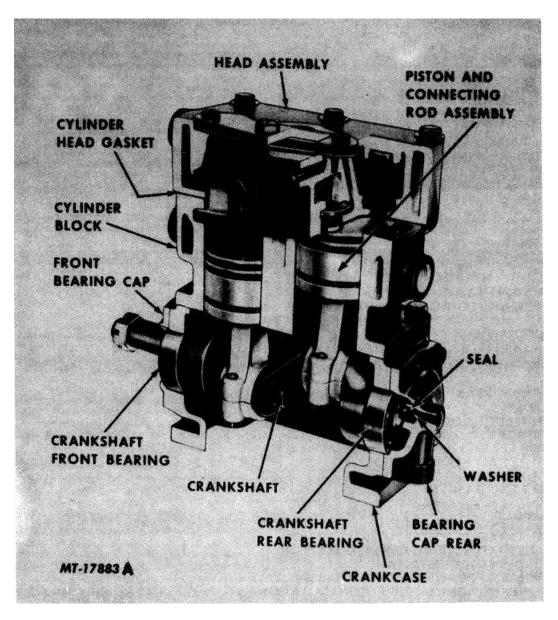


AIR COMPRESSOR

MIDLAND-ROSS MODELS EL-1300 AND EL-1600

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Cutaway View of Air Compressor

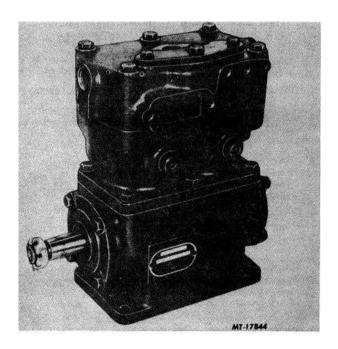


Fig. 1 EL-1300 Model Air Compressor

DESCRIPTION

The EL-1300 compressor has a rated displacement of .36 cubic meters per minute or 12.9 cubic feet per minute at 1250 rpm. The EL-1600 compressor has a rated displacement of .46 cubic meters per minute or 16.1 cubic feet per minute at 1250 rpm. The EL-1600 is basically the same as the EL-1300 except the EL-1600 has a longer stroke. Both compressors are two cylinder reciprocating type.

The crankshaft main bearings of the base mount compressors are ball bearing type, front and rear. Some flange mounted compressors may have sleeve type main bearings either front or rear. Connecting rod bearings are replaceable insert type. Each piston has two compression rings in each of the two ring grooves above the piston pin and two oil rails and one expander ring below the piston pin. Snap rings are used at both ends of the piston to retain the pin in the piston.

All valves and unloader components are installed within the cylinder head. The inlet and exhaust valve discs are spring loaded against seats installed in the bottom of the head. The unloader mechanism is installed from the top of the head.

The compressor governor is mounted directly to the cylinder head or can be remotely mounted. The governor controls the minimum and maximum air pressure supplied by the compressor.

OPERATION

COMPRESSION

With the down stroke of each piston, air is drawn into the cylinder through a disc-type inlet valve in the cylinder head. As the pistons begin the upward stroke, the inlet valve closes and the trapped air above the piston is then compressed.

When the air pressure in the cylinder becomes greater than the air pressure in the cylinder head above the exhaust valve, the exhaust valve is then forced open off its seat. Air is then allowed to pass through the exhaust port into the head cavity into the line leading to the air reservoir. When the piston starts its downward stroke the exhaust valve returns to its valve seat and the compressed air will not return to the cylinder. The intake and compression cycle is then repeated.

UNLOADING (NOT COMPRESSING)

When air pressure in the system reaches maximum pressure which is set by the governor, the governor causes the unloader pins to hold the inlet valves off their seats. With inlet valves open, air passes freely back and forth between the cylinder and intake cavity in the head causing no compression of air. When air pressure in the system is reduced to air governor cut-in setting, the governor operates unloader pins, releasing inlet valves and compression of air is then resumed.

UNLOADER REPLACEMENT

If the air compressor should fail to maintain sufficient pressure or supply excessive air pressure, the unloader mechanism pins or seals could be defective.

The unloader components can be serviced or replaced without removing the compressor from the vehicle engine.

REMOVE UNLOADER

1. Bleed off main air reservoir.

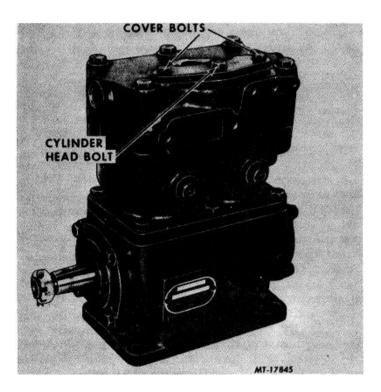


Fig. 2 Unloader Cover Assembly

- Remove two hex head unloader cover bolts and cylinder head bolt located in center of unloader cover (Fig. 2).
- 3. Remove unloader cover. Unloader seal and end of pin will protrude from head.
- 4. Remove unloader pins with seals and unloader springs (Fig. 3). Discard seals and cover gasket.

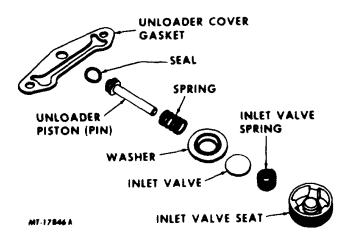


Fig. 3 Unloader Components

INSTALL UNLOADER

- 1. Install new O-ring type seals between flanges on unloader pistons if "V" lip seals are used between the flanges of unloader piston. Make sure that the "V" is facing up.
- 2. Form a 14 mm (9/16") ball of lubricant and apply to the seal. Use a silicone lubricant which is intended for dynamic lubrication between oil resistant rubber seals and metal parts, meeting MIL-L-4343A requirements.
 - Dow-Corning Corporation #33 medium weight grease is suggested. (For optional lubricant refer to BRAKES AIR, COMPONENTS, General Lubrication Specifications, Item 3.
- 3. Position unloader assemblies and springs in bores of cylinder head.
- Position new gasket on cylinder head; then install unloader cover assembly with cover bolts and cylinder head bolt. Torque bolts as specified in Torque Chart.

DISASSEMBLY

The air compressor crankcase, cylinder block and cylinder head are designed so that these basic components may be assembled in various ways to meet various installation requirements. To guard against the parts being assembled incorrectly, these parts should be marked in some manner prior to disassembly.

AIR CLEANER REMOVAL

Some compressor installations do not have a separate air cleaner. These models are equipped with a hose to the engine air cleaner and only the hose disconnect will be required.

To remove the air cleaner, remove the two bolts which secure the air cleaner and manifold to the cylinder head. Remove air cleaner and manifold as one unit from air compressor.

CYLINDER HEAD REMOVAL

Remove six head bolts attaching the head to cylinder block. Tap cylinder head with a soft mallet to loosen head; then remove head assembly. Discard head gasket.

CYLINDER HEAD DISASSEMBLY

Refer to Fig. 4 for key numbers in parenthesis.

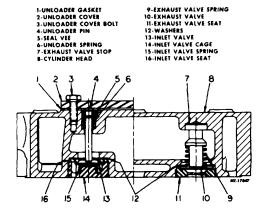


Fig. 4 Cross Section of Cylinder Head

- Position cylinder head on table and remove the two unloader cover bolts (3) and washers. Remove unloader cover (2) from head. Remove unloader gasket (1) and discard. Remove unloader pins (4) and springs (6). Remove seals (5) from unloader pins and discard seals.
- Turn head over and remove exhaust valve seats (11) using a 14 mm (9/16") Allen wrench. Remove exhaust valve (10), washer (12), spring (9) and valve stop (7) if not of press fit. Discard washer (12). Do not remove valve stop if it is press fit design.

Late design cylinder heads used on these compressors utilize pressed in type exhaust valve stops. Do not attempt to remove pressed in exhaust valve stops.

If the exhaust valve stop is loose, worn, damaged or does not meet Specifications from the valve stop surface, the complete head assembly must be replaced.

 Remove inlet valve cages (14) with valve cage tool (SE-2613 shown in Fig. 5); then remove inlet valve springs (15), inlet valves (13), inlet valve seats (16) and washers (12). Discard washers.

PISTON AND CONNECTING ROD REMOVAL

Turn crankshaft so that one connecting rod is at bottom of stroke. Remove connecting rod bolts and bearing cap. Remove piston and rod assembly from top of cylinder block. After connecting rod and piston assembly have been removed, temporarily install bearing cap on connecting rod from which cap was removed by loosely installing rod bolts.

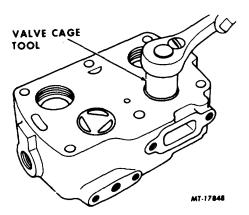


Fig. 5 Valve Cage Tool SE-2613

Bearing cap must be reinstalled on rod from which it was removed.

Position other rod at bottom of stroke by turning crankshaft and remove rod and piston as previously described.

PISTON AND CONNECTING ROD DISASSEMBLY

Refer to Fig. 6.

Remove piston pin snap rings from piston assembly and press piston pin out of piston and connecting rod. Then remove compression and oil rings from piston using conventional piston ring expander.

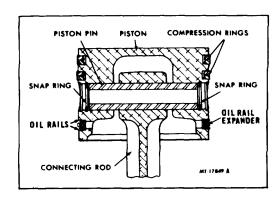


Fig. 6 Cross Section of Piston Assembly

CYLINDER BLOCK REMOVAL

Remove six bolts and lockwashers which secure cylinder block to crankcase; then separate cylinder block from crankcase. Discard gasket.

CRANKSHAFT AND BEARING REMOVAL

- Remove the four crankshaft bearing cap bolts on each bearing cap and remove caps. Discard gaskets.
- Press the shaft seal from front bearing cap and discard seal.
- 3. Remove seal and bowed washer or spring from rear bearing cap.
 - Do not remove crankshaft and bearings from crankcase unless an inspection reveals the necessity for removal.
- Place crankcase-crankshaft-bearing assembly in an arbor press, supporting crankcase adjacent to rear bearing. Use an adapter (shown in Fig. 7) and press crankshaft rear bearing assembly from crankcase and out through rear bore.

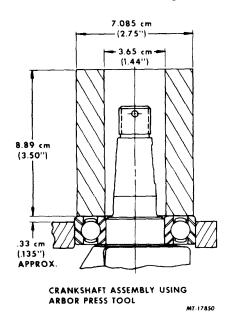


Fig. 7 Crankshaft Bearing Adapter

- When rear bearing is free from case use a bearing puller and pull rear bearing from crankshaft.
- Reinstall front bearing in bore of crankcase and press shaft toward front of case. When front bearing is free of crankcase, use the bearing puller and remove front bearing from crankshaft.
- 7. Crankshaft can then be moved rearward and out bottom of crankcase.

CLEANING, INSPECTION AND REPAIR

Wash all parts thoroughly in clean solvent. Make sure all carbon deposits are removed from pistons and cylinder head. Be sure all drilled oil passages in crankshaft are open. Clean all carbon from piston ring grooves in piston.

If any of the components are not within the specified limits (listed in SPECIFICATIONS), that particular part must be replaced.

CYLINDER HEAD

Examine cylinder head for cracks and damaged threads. Examine unloader seal bore diameters for scoring or pitting. Replace head if any damage is evident. Be sure all passages are free from foreign matter.

Examine exhaust valve seat for damage or wear. Measure valve guide diameter and distance from top of valve seat to valve seating surface.

Measure the wear on both sides of inlet and exhaust valves. The valve must be replaced if cracked or grooved on either side.

Be sure to inspect inlet, exhaust and unloader springs for loads at specified heights.

Exhaust valve stops must be inspected for damage and wear. Be sure to measure distance from valve end of stop to surface on which spring seats. Refer to Specifications.

If the exhaust valve stop is loose, worn, damaged or does not meet Specifications from the valve stop surface, the complete head assembly must be replaced.

Inspect inlet valve cage for damage and wear. Measure the valve guide diameter and distance from top of cage to valve stop. The inlet valve seat must not be damaged. Be sure to measure valve seating surface to surface which contacts valve cage.

Inspect unloader pins for damage and measure length of unloader pins.

PISTONS

Pistons must be inspected for damage, such as cracks or scoring. Measure outside diameter of both pistons just below the compression ring grooves; then compare this diameter with inside diameter of respective cylinder bore. Be sure to measure the piston at 90 degree angle to piston pin bore to enable correct measurement.

If piston diameter is more than .020 cm (.008") smaller than cylinder bore, the piston must be replaced. Service pistons are available in .051 cm (.020") oversize.

Piston pins must have a light interference fit in piston and a slip fit in the rod. Check fit of compression and oil rings in grooves of pistons and measure clearance. Position each ring in respective cylinder bore and measure ring gap as shown in Fig. 8. Refer to SPECIFICATIONS for ring gap limits and ring groove clearance. Rings must be replaced if not within specified limits.

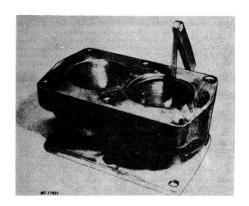


Fig. 8 Measuring Piston Ring Gap

CONNECTING RODS

Connecting rod bearing inserts must be free of scoring, pitting or any visible wear., Inspect rod bearing fit on crankshaft journals. Be sure to check connecting rod bearing side clearance on crankshaft (Fig. 9). Refer to SPECIFICATIONS for clearances.

If connecting rod bearing-to-crankshaft clearance is excessive, new inserts must be installed. If connecting rod side clearance is excessive, a new rod and bearing cap must be installed.

CYLINDER BLOCK

Check cylinder block for cracks and check inside of cylinder bores for scratches, scoring, pitting, out-of-round and taper.

Out-of-round should not exceed more than .00127 cm (.0005") or taper not more than .0025 cm (.001") from top to bottom of bore. If excessive taper or out of round is found, the cylinder must be rebored and honed oversize or replaced with a new cylinder block. Service pistons and rings are available in .0503 cm (.020") oversize.

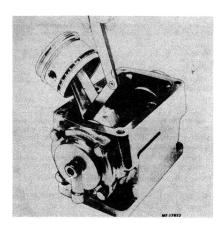


Fig. 9 Checking Connecting Rod Side Clearance

CRANKSHAFT

Bent or twisted crankshaft cannot be repaired. If rod journals are scored beyond repair or worn more than limits listed in SPECIFICATIONS, replace the crankshaft or regrind journals. New insert bearings are available in .0254 cm (.010"), .0508 cm (.020") and undersize.

If a main bearing journal has a sleeve and the journal is scored beyond repair or worn more than the limits, listed in the SPECIFICATIONS, the crankshaft must be replaced.

Threads, keyway, and all ground and machined surfaces must not be mutilated or worn.

Examine ball bearing for worn or damaged balls; rotate bearing by hand to detect roughness. If wear, roughness, or damage is evident bearing must be replaced.

CRANKSHAFT BEARING CAPS

Examine crankshaft front and rear bearing caps and replace if cracked. Check seal diameter of rear cap. If diameter is not within dimension listed in "Specifications" at end of this section, the rear cap must be replaced.

Only compressors which have ball rear main bearings and are oiled through the rear of the crankshaft have a seal and spring or bowed washer. If bowed washer or spring is worn, it must be replaced.

CRANKCASE

Inspect crankcase for damage and replace if any damage is noted. Also inspect front and rear bearing caps; if any cracks are noted, replace cap.

TRUCK SERVICE MANUAL

SEALS AND GASKETS

Replace all seals and gaskets. Never reuse any gaskets or seals.

REASSEMBLY

Apply a coat of engine oil to crankshaft, bearings, connecting rod bearings, pistons and cylinder block bore.

CRANKSHAFT AND BEARING INSTALLATION

- Position crankshaft in an arbor press supporting the crankshaft on front ball bearing shoulder of crankshaft. Install ball bearing on rear of crankshaft. Press bearing on crankshaft until inner race is seated firmly against shoulder on crankshaft (Fig. 7). Do not apply pressure to outer race only.
- Turn crankshaft over and position it in an arbor press supporting the crankshaft on inner race of the rear ball bearing. Install front ball bearing in the crankshaft. Press bearing on crankshaft until inner race is seated firmly against the shoulder on crankshaft.
- 3. Position the crankcase in the arbor press supporting the crankcase adjacent to the rear bearing bore. Install crankshaft and bearing assembly in crankcase by pressing the rear bearing through the front bearing bore of crankcase using the adapter as shown in Fig. 7. The bearing should extend past crankcase about .3929 cm (.135") on both ends.

CRANKSHAFT BEARING CAP INSTALLATION

- Press a new seal into front bearing cap. Seal of lip must face towards the crankcase when installed. The seal case must be flush to .0127 cm (.005") below the front of the cap.
- 2. Position a new gasket over crankshaft between crankcase and bearing cap.
- 3. Position bearing cap over end of crankshaft taking care not to damage oil seal.
- 4. Pull bearing cap into place by alternately tightening the four bolts. Torque bolts to specified torque (refer to TORQUE CHART).
- 5. Position new gasket over crankshaft between crankcase and rear bearing cap.
- 6. Place bowed washer or spring in bearing cap so that the outside diameter of washer contacts bottom of hole in bearing cap. Place seal in rear of end cap and lubricate with engine oil.
- Slide rear bearing cap over rear of ball bearing taking care that bowed washer or spring and seal do not fall out of cap.

8. Pull bearing cap into place by alternately tightening the four bolts. Torque bolts to specified torque listed in TORQUE CHART.

CYLINDER BLOCK INSTALLATION

Place a new cylinder block to crankcase gasket on crankcase; then position the cylinder block on gasket. Install six bolts and lockwashers. Torque two center bolts to 10.847 N.m (8 ft. lbs.) prior to tightening the four end bolts. Increase bolt torque to specified torque tightening center bolts first, then the four end bolts.

PISTON AND CONNECTING ROD REASSEMBLY

- 1. Position connecting rod in piston; then press piston pin in place. Install snap rings in piston at both ends of piston pin (Fig. 4).
- 2. Install two compression rings in each of the two grooves and two oil rails and expander in bottom groove (Fig. 4).
 - Compression rings must be installed with surface marked "TOP" facing top of piston. Some compression rings may have dots to indicate top of ring.
- Position connecting rod bearing inserts in rod and bearing cap, making sure that the locating lips on inserts engage the locking notches in rod and cap. Insure that arrows on caps and rod match as shown in Fig. 10. Also, make sure that the rod cap is installed on rod from which it was removed.

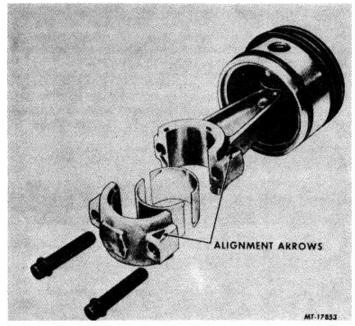


Fig. 10 Piston and Connecting Rod Assembly

PISTON AND CONNECTING ROD INSTALLATION

- Remove connecting rod bearing cap with insert from rod assembly. Stagger ring gaps in each ring groove by about 180 degrees. Use a ring compressor and insert piston so that the top of the piston is flush with top of block.
- Turn compressor assembly over and position connecting rod on crankshaft journal making sure that the inserts are in place. Install caps and inserts matching arrows on bearing cap and rod as shown in Figures 10 and 11.
 - Tighten connecting rod bolts to specifications.
- 3. Install the second connecting rod assembly in the same manner.

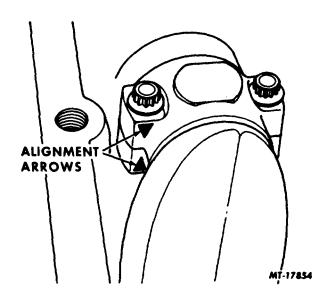


Fig. 11 Connecting Rod Alignment Arrows

CYLINDER HEAD REASSEMBLY

Assemble cylinder head as follows (refer to Fig. 4 for key numbers in parenthesis):

- Turn cylinder head upside down to insert slip in type exhaust valve stops (7) if removed, new washers (12), exhaust valve springs (9), exhaust valves (10) and exhaust valve seats (11). Tighten exhaust valve seats to specified torque.
- With head still positioned upside down, insert new washers (12), inlet valve seats (16), inlet valves (13), inlet valve springs (15) and inlet cages (14). Refer to Fig. 3. Inlet valves and inlet valve springs must be centered to insure the valve is not torqued between inlet valve seat and inlet valve cage.

- Torque valve cage to specified torque using special valve cage tool (SE-1613) as shown in Fig. 5.
- 3. Turn head over and insert unloader springs (6). Assemble the seals (5) on unloader pins (4) with seal lip towards short end of pin. Using Dow-Corning No. 33 or No. 55 lubricant (a silicone primarily for arease intended dvnamic lubrication between oil resistant rubber seals and metal parts which meets MIL-L-4343A requirements), apply lube to seals forming a 14 mm (9/16") diameter ball. Insert unloader pins Place unloader gasket (1) on into head. unloader cover (2). Assemble these two items to head as a unit compressing the unloader springs and hold firmly until unloader cover bolts (3) and lockwashers are installed. Tighten bolts to about 1.1298 N.m (10 in.lbs.) torque. Refer to TORQUE CHART for final torque after head bolts are torqued.

IMPORTANT

Cover bolts should be torqued after cylinder head bolts are torqued.

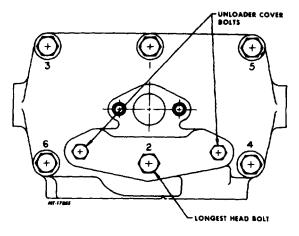


Fig. 12 Cylinder Head Bolt Tightening Sequence CYLINDER HEAD INSTALLATION

Position new cylinder head gasket on cylinder block; then place head on gasket assembling the six head bolts. The longer head bolt is inserted through unloader cover plate. Tighten head bolts in two steps. Torque bolts to first value listed in TORQUE CHART in order shown in Fig. 14; then retighten head bolts to torque value in second step in same sequence shown in Fig. 14; then retighten.

Torque unloader cover bolts to value listed in TORQUE CHART.

TORQUE CHART

Unloader Cover Bolts Cylinder Head Bolts - First Step - Second Step	11.3 - 15.3 N.m 24.4 - 29.8 N.m 36.6 - 44.7 N.m	100 - 135 in. lbs. 18 - 22 ft. lbs. 27 - 33 ft. lbs.
Bearing Cap Bolts Cylinder Block to Crankcase	13.6 - 18.1 N.m 23.0 - 28.6 N.m	120 - 160 in. lbs. 17 - 21 ft. lbs.
Connecting Rod Bolts Exhaust Valve Seats	20.9 - 25.4 N.m 94.9 - 122.0 N.m	185 - 225 in. lbs. 70 - 90 ft. lbs.
Valve Cage	94.9 - 122.0 N.m	70 -90 ft. lbs.

TROUBLE SHOOTING

Compressor Fails to Maintain Sufficient Pressure or Adequate Air Supply.

Dirty intake strainer.

Restriction in compressor cylinder head intake or discharge cavities on line.

Leaking or broken inlet or exhaust valves.

Excessive wear. Drive belt slipping.

Excessive system leakage or usage.

Defective governor.

Worn unloader seals.

Noisy Operation.

Loose drive pulley. Restrictions in cylinder head or discharge line.

Worn or burned out bearings.

Compressor not getting proper lubrication. Excessive wear.

Compressor Passes Excessive Oil.

Excessive wear.

Dirty air strainer (improper air strainer maintenance).

High inlet vacuum. Small or restricted oil return line flooding compressor.

Excessive oil pressure. Defective or worn oil seal in rear bearing cap.

Piston rings not properly installed.

Back pressure from engine crankcase.

Compressor Not Unloading (Excessive Pressure).

Defective unloader pins or seals.

Defective governor.

Reservoir line to governor restricted.

Unloader mechanism binding or stuck.



0.0	VE 01510 4 T10 N0	
	PECIFICATIONS	
TYPE CAPACITY (at 1250 RPM)	2-Cylinder	
EL-1300	.36 m ³ /min.	12.9 cu.ft./minute
EL-1600	.46 m ³ /min.	16.1 cu.ft./minute
AIR PRESURE SETTING		
Cut Out	861.75 kPa	(125 psi) Approx.
Cut In	710.0 - 744.5 kPa	(103 - 108 psi)
CYLINDER BORE	68.840 - 69.850 mm	(2.7495 - 2.7500")
PISTON AND CONNECTING ROD COMPONENTS:		
Piston Diameter Below Compression Rings Piston Pin Hole	69.70 - 69.72 mm 14.26 - 14.27 mm	(2.744 - 2.745") (.56155618")
Rod Pin Diameter	14.27 - 14.28 mm	(.56185620")
Connecting Rod Pin Hole	14.28 - 14.29 mm	(.56225624")
Piston Rings:		
Compression Ring Gap Oil Ring Gap Groove Clearance:	.051178 mm .381 - 1.40 mm	(.002007") (.015055")
Compression Ring	.0381114 mm	(.00150045")
Oil Rings	.012114 mm	(.00050045")
CYLINDER HEAD COMPONENTS		
Exhaust Valve Seat Valve Guide Diameter	29.08 - 29.24 mm	(1.145 - 1.151")
Top of Valve Seat to Seating Surface on Exhaust Valve	3.18 - 3.25 mm	(.125128")
Inlet Valve Spring Load @ 7.29 mm (.287")	.163281 kg	(.3662 Lb.)
Unloader Spring Load @ 10.03 mm	.153187 kg	(.338418 Lb.)
(.395") Exhaust Valve Spring Load @ 18.54 mm (.73")	1.50 - 1.68 kg	(3.30 - 3.70 Lbs.)
Exhaust Valve Stop Surface to Spring Seat Surface	18.29 - 18.80 mm	(.7274")



SPECIFICATIONS (Continued)

CYLINDER HEAD COMPONENTS (Continued) Inlet Valve Cage:		
Valve Guide Diameter	23.26 - 623.368 mm	(.916920")
Top of Cage to Valve Stop Inlet Valve Seat:	3.33 - 3.51 mm	(.131137")
Valve Seating Surface-to-Valve	0.596 - 0.673 mm	(.0235 - 0265")
Cage Contact Surface Unloader Pin Length	47.0 - 47.04 mm	(1.850 - 1.854")
CRANKCASE, CRANKSHAFT AND BEARING CAP Crankcase Bearing Bore	71.9938 - 72.0090 mm 89.9973 - 90.0176 mm	(2.8344 - 2.8350") (3.5432 - 3.5440")
Main Bearing (Sleeve Type)	55.0697 - 55.1078 mm	(2.1681 - 2.1696")
Ball Bearing: Outside Diameter	71.9861 - 71.9988 mm	(2.8341 - 2.8346")
Inside Diameter	35.0012 - 34.9885 mm	(1.3780 - 1.3775")
Outside Diameter	89.9998 - 89.9846 mm	(3.5433 - 3.5427")
Inside Diameter Crankshaft:	53.9859 - 55.0012 mm	(2.1648 - 2.1654")
Connecting Rod Journal Diameter	47.1147.0 mm	(1.855 - 1.850")
Connecting Rod Journal Width	32.1534.72 mm	(1.265 - 1.367")
Connecting Rod Bearing Clearance	0.0120.053 mm	(.00050021")
Connecting Rod Side Clearance	0.25 mm	(.010")
Main Bearing Journal Diameter Bearing Cap Seal Diameter	35.0114 - 34.9987 mm 55.0139 - 54.9986 mm 16.1316.15 mm	(1.3784 - 1.3779") (2.1659 - 2.1653") (.635636")
Seal Outside Diameter	16.0816.05 mm	(.633632")
Ocal Outside Diameter	10.0010.03 111111	(.000002)

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ANTILOCK AIR BRAKE SYSTEM

KELSEY-HAYES MARK IV

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CHAPTER II

MAINTENANCE, SERVICE CHECKS AND SPECIAL SERVICE HINTS

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CHAPTER I

COMPONENT OPERATION

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CHAPTER I COMPONENT-OPERATION

DESCRIPTION

During a brake stop the maximum point of deceleration occurs before wheel lockup. When wheel lock-up does occur, stopping distances increase and loss of directional control is the usual result.

To overcome wheel lock-up, a means of determining wheel speed was needed. This was done by installing an exciter ring in the rotating part of the brake system (wheel assembly) and a sensor installed on the stationary part of the brake system (backing plate).

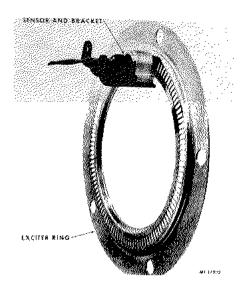


Fig. 1 Exciter Ring and Sensor

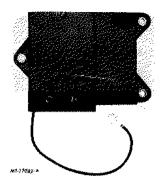


Fig. 2 Computer Module

As the wheel rotates, an electronic signal proportional to wheel speed is generated and fed to a computer module (Fig. 2) which records the rate of impulses. (There is one computer for each axle.)

During a brake application, if the wheel is about to lock up, the computer sends an electrical signal to the air control valve (Fig. 3). Within a fraction of a second the valve responds by exhausting air from the brake chamber to allow the wheel to speed up and then automatically reapplies air. The antilock system or computer brake control works only when a locked wheel is about to occur. Under normal braking, the antilock system will not be called upon. A warning (monitor) light installed in the truck cab indicates the system is working.

Vehicles which are not equipped with antilock on front axle will not have exciter rings, sensors, air control valve or a computer module.

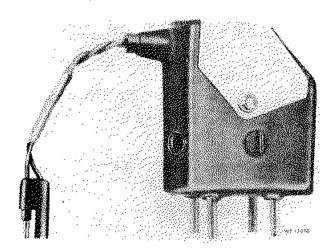


Fig. 3 Air Control Valve

The monitor light (Fig. 4) is mounted on the instrument panel of the vehicle and each time the ignition switch is turned on a half second illumination of the light followed by the light going out and remaining off indicates a satisfactory system. If the light should remain "on", a problem is indicated in the control system.

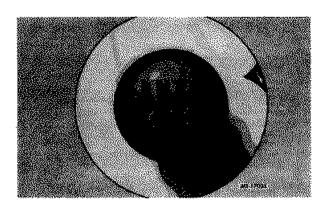


Fig. 4 Monitor Light

OPERATION

There are three basic components in the antilock system. They are:

- 1. Wheel (speed) sensor and exciter ring (Fig. 1).
- Electronic package or Computer Module (Fig. 2).
- 3. Air control valve or solenoid valve (Fig. 3).

Sensor and Bracket Assembly (Fig. 5)

The sensor is a permanent variable reluctance device which generates an electric signal proportional to the rate of wheel rotation of the computer module. The sensor is self-adjusting and is secured to the brake spider or backing plate.

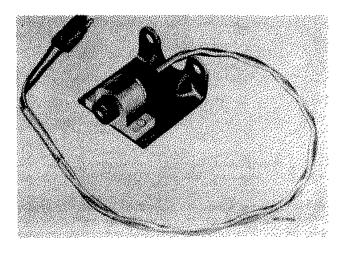
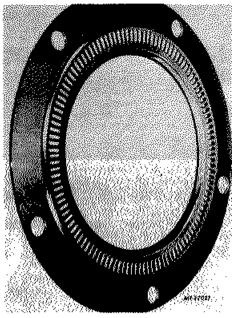


Fig. 5 Sensor and Bracket Assembly



Exciter (Fig. 6)

The exciter is attached to the hub utilizing the hub and drum mounting bolts. It is a one-piece unit in various sizes for installation to different hub and drum assemblies.

The exciter has 120 slots which pass by sensor creating an AC electrical signal. The electrical signal is then transmitted to the computer module.

Computer Module (Fig. 2)

Each axle which is equipped with antilock will have a computer module which receives electronic signals from the two wheel sensors on the axle and controls both brakes on axle at the same time.

The computer module analyzes wheel speed information and if it detects a rapid change in wheel speed, such as that caused during hard braking or extreme variation in wheel speed on either wheel of an axle, it will energize the air control valve momentarily to cause a reduction in air pressure to the service brakes on axle affected. This will allow the wheels on affected axle to roll more freely avoiding a complete brake lock up resulting in loss of vehicle control.

Just as soon as the wheels return to a controlled percentage of original speed the brakes are automatically reapplied.

This sequence of releasing and reapplying air pressure of the brakes is known as an antilock cycle and may be repeated several

times during a stop, depending upon initial speed, road surface and applied brake force.

Each cycle can be felt by the driver as a "lurch" or the same type of feeling that would be obtained when the brake pedal is rapidly pumped during a stop.

The computer module is a solid-state component using completed custom circuits, which are sealed. The module assembly must be replaced if a malfunction should occur inside the computer module.

Air Control Valve (Fig. 3)

There is one air control valve or modulator valve for each axle. It is an electrically actuated valve installed in series with service brake pressure lines. It functions to control air in the brake chambers upon command from computer module.

As the wheel rotates, an electronic signal proportional to wheel speed is generated which the computer module records the rate of impulses.

During a brake application the computer sends an electrical signal to the air control valve of the wheel which is about to lock up. When wheel lock-up is about to occur, the air brake chambers on the axle involved, dump a controlled amount of air and as the wheel or wheels speed up, air is automatically reapplied. This will occur as needed during a stop involving any or all vehicle's axles.

A two purpose valve has been introduced in the antilock system, which performs as a relay valve as well as an air control valve. The new version is called an antilock relay (AR) valve. Both types of valves are trouble shooted in the same manner.

For complete detailed operation, service checks and service of the air control valve or AR valve, refer to AIR BRAKE COMPONENTS Section (CTS-2673). The solenoid assembly portion of the air control valve is only serviced as a complete assembly.

Antilock Monitor (Warning) Light (Fig. 4)

The antilock warning light is not a necessary item in the antilock system for operation of the system but is required by law. The warning indicates to the driver or serviceman if the system is functioning properly or not.

Refer to CHAPTER II SERVICE CHECKS, ANTILOCK WARNING LIGHT CONDITIONS to assist in locating and correcting problems with the antilock system.

COMPUTER MODULE ELECTRICAL CONNECTORS

The electrical connectors are designed so they cannot be placed on the wrong terminals. They are a snug fit. In addition, the top of this connector is designed to make contact with the bottom side of the computer module cover or RFI filter. This will also aid in keeping the connector in position and tight. The connector can be easily removed by grasping the protrusion on top of the connector with long nose pliers and lifting off (Fig. 7).

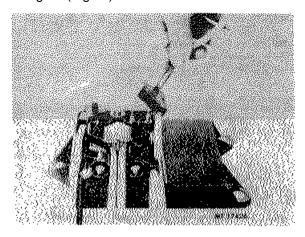


Fig. 7 Using Long Nose Pliers to Remove Connectors

The connectors and terminals (Fig. 8) are marked and identified as follows:

- A. Upper terminals in each upper corner of the computer module are identified as SENSOR and the connectors which are positioned are identified as SENSOR-R and SENSOR-L for the right and left sensors.
- B. The HOT terminals provide power to and from each module. A fuse on a fuse board is installed between these terminals on each module and the fuse board can be replaced if the fuse burns out. The F-2 and F-1 terminals provide for current flow of the antilock indicator circuit. The connectors positioned on these terminals are identified as POWER-L and POWER-R respectively.

The rearmost computer module is equipped with a jumper connector from HOT to F-1 terminals. The circuit diagrams (CHAPTER III) illustrates this jumper in the circuit (16 BK).

C. The terminals at the lower right hand corner are for the air control valve connections and are identified by AIR

VALVE. The connector installed is marked VALVE-R.

D. The terminals located in the lower left hand corner are marked SPEDOMETER which could be used for an electrical speedometer hook-up. On IH vehicles, these terminals are not used for this purpose. The lower terminal is used as a ground. A wire lead runs from this terminal to a ground on the frame of the vehicle and each module is grounded in t: his manner.

The connectors on modules are also designed for the installation and use of test equipment. There are holes in each connector large enough for the prongs of antilock tester cover to be inserted. The prongs of a volt-ohmeter can also be inserted in these holes.

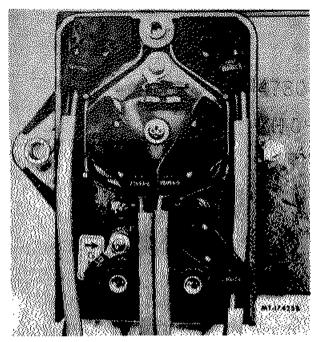


Fig. 8 Computer Module with Cover Removed WIRING SYSTEM

Refer to CHAPTER III for the Circuit Diagram for wiring system for the particular vehicle involved.

In most instances the antilock or computer brake control system at the key switch ignition terminal through a 15 amp fuse or circuit breaker and continues through junction block to HOT terminal on front axle computer module, through module to HOT terminal on forward rear axle on 6 x 4 chassis, or to HOT terminal on rear axle on 4 x 2 chassis. On 6 x 4 chassis the circuit continues through the

module for forward rear axle on to the rear axle module HOT terminal.

The circuit in most instances for the monitor or warning light also starts at the accessory terminal of key switch, then goes to antilock indicator light and on to the junction block. Then from the junction block, the circuit continues to F-2 terminal on front axle module, through module from F-i terminal to the next module F-2 terminal and on to the third module if chassis is a 6x4 design.

Note in the circuit diagrams there is a jumper on the rear most module (16 BK). This jumper is part of the wiring circuit and is incorporated in the connector on the rear most module only.

From each module there are wheel sensor leads with connections to each wheel per axle and air control valve leads. Also note the ground wire from ground terminal to frame.

IMPORTANT

Under no circumstances should the antilock circuits be used for auxiliary equipment. Positive identification of antilock wires can be made by looking for 16, 44, 71 and 94 circuits. Circuits may have suffix letters but are still part of the antilock system.

COMPUTER MODULE IMPROVEMENTS

Various improvements have been either added to the computer module or incorporated in the computer module. The following items describe briefly some of the improvements and identification of various components affected.

Black Module #457932-C91 (Fig. 9) was the first module released with the antilock system. A very low speed brake squeal could cause cycling of this module. This Black Computer Module should never be used on the rear most axle on a vehicle.

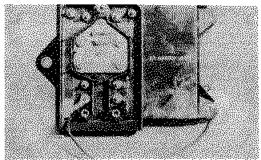


Fig. 9 Black Computer Module

are:

<u>Blue Gray Module</u> #473735-C91 (Fig. 10) was then used to overcome the cycling caused by brake squeal. It was then found that certain type radio transmitters could affect operation of the computer controlled antilock system.

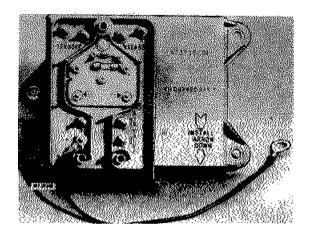


Fig. 10 Blue-Gray Computer Module

Radio Frequency Interference (RFI) Filter #8,900,003-R91 (Fig. 11) was then made available to overcome radio transmitter interference. Fig. 13 illustrates a module with an RFI Filter as an attachment.

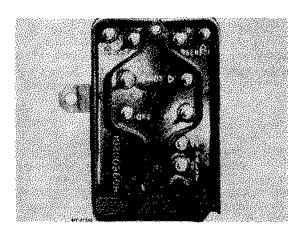


Fig. 11 RFI Filter

Green Module #476088C91 (Fig. 12) was then released which incorporated the radio transmitter interference protection. Since the release of the green module there have been some black modules used with the radio transmitter interference protection. These black modules can be identified by the part number 476088C91 on module body. DO NOT USE RFI Filter on any module with 476088-C91 part number on body.

IMPORTANT

Since modules may be painted the same color as the frame, scrape paint from module body (not cover) for color identification and part number.

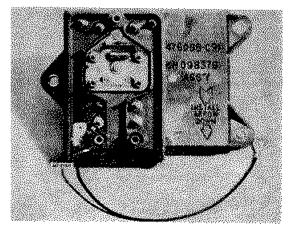


Fig. 12 Green Computer ModuleApplication of computer modules and RFI filters

Never use the original black module 457932-C91 on rear most axle on any vehicle.

When using the original black module (457932-C91) or blue gray module 473735-C91 always use an RFI filter.

Never use an RFI filter on green or black computer modules (476088-C91) since they have the built in RFI filtering.

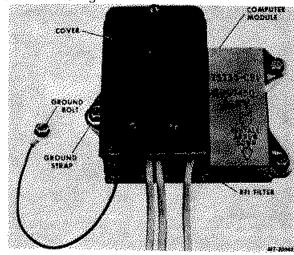


Fig. 13 Computer Module with RFI Filter Attachment.

Polar Fuse Boards

There have been three variations of polar fuse boards used in the computer modules.

The original polar fuse board (Fig. 14 released with the original black computer module and did not have any voltage spike protection which could damage the computer module.

The second version of the fuse board (Fig. 15) used in the computer modules incorporated one diode to protect the "HOT" circuit against a voltage spike which may occur.

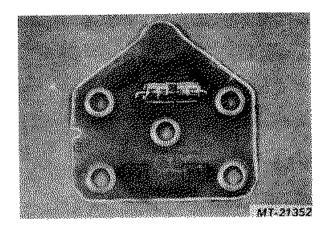


Fig. 14 Original Design Fuse Board

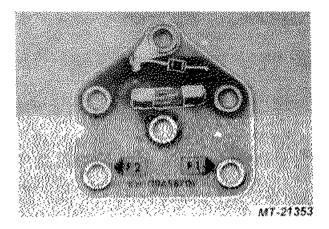


Fig. 15 Second Fuse Board with a Diode to Protect HOT Circuit

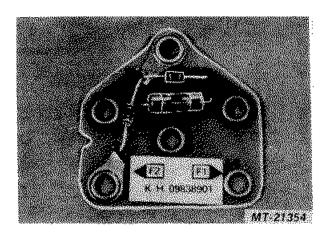


Fig. 16 Third Design Fuse Board With Two Diodes

In some instances a short lived voltage spike is generated by induction components, such as solenoids, relays and electric fuel pumps when the ignition switch is turned "OFF" from either "ON" or "ACCESSORY" positions, and could result in damage to a transistor in the front (steering) axle computer module.

To overcome possible shorting of the transistor, a third polar fuse board (Fig. 16) with two diodes is used and is identified by the wording "STEERING AXLE ONLY" in order to restrict its application.

The fuse boards used on the rear (nonsteering) axles may or may not have the wording "NON STEERING AXLE ONLY; " however, it can be identified since it will have one diode between the HOT and F-2 terminals (Fig. 15).

Application of fuse boards are as follows:

The black or green modules (476088-C91) will be equipped with fuse board without a diode, which has circuitry built in to protect them against voltage spikes. Both HOT and fail systems are protected. However, when replacing a fuse board in the green or black module (476088-C91), any one of the fuse boards may be used.

The original black or blue modules <u>must</u> use fuse board (476125-C1) with two diodes on front (steering) axle.

The original black or blue modules will use either fuse board 473025-C1 or 473025-C2 with one diode for non-steering (rear) axle applications.

ANTILOCK SPECIFICATIONS

Sensor Continuity 4000 to 6000 Ohms

Sensor Output Spin wheel 35 to 45 RPM

Spin wheel 35 to 45 RPM (1 revolution every 2 seconds) with minimum output of .3 volt.

Exciter Ring Runout (Installed on Wheel)

.635 mm (.025") Maximum



CHAPTER II

MAINTENANCE, SERVICE CHECKS AND SPECIAL SERVICE HINTS

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CHAPTER II

MAINTENANCE, SERVICE CHECKS AND SPECIAL SERVICE HINTS

MAINTENANCE

Air Control Valve

Once each year or every 160,000 (100,000 miles) the air control (modulator) valve should be removed and diaphragm replaced. Refer to AIR BRAKE COMPONENTS, CTS-2673, CHAPTER VIII for detailed information.

Exciter Ring and Sensor

When wheel bearings are being repacked or when any brake service is being performed, the exciter ring should be inspected for possible wear of slots. Wear of exciter ring is not probable since the sensor does not actually contact exciter in normal operation. Excessive wheel bearing looseness could cause wear; however, wear of sensor would be noted rather than exciter. Dirt or dust in slots of exciter will not affect its operations.

Exciter rings can become damaged during installation of wheel and hub assembly if the sensor is pulled out too far causing the sensor to cock.

Exciter can also become damaged if allowed to strike the ends of axle housing during installation.

Damaged exciter rings will cause a low voltage sensor output during part of the wheel revolution, resulting in false cycling during low speed operation below 32 km (20 mph), even without a brake application.

Excessive exciter ring runout will result in false cycling of the antilock system. Runout should not exceed .635 mm (.025").

Use SE-2581 Exciter Ring Runout Fixture with extensions and swivel sleeves from Dial Indicator Set SE-1848.

Damaged exciter rings must be replaced. In some instances excessive exciter ring runout can be corrected by repositioning in relation to drum. If repositioning of the ring will not cure the excessive runout, replace the ring.

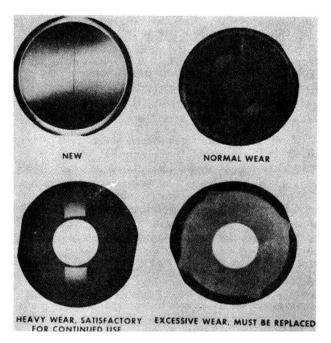


Fig. 1 Various Sensor Wear Patterns

Anytime an exciter ring is replaced, runout must be checked to verify runout is within specifications.

For complete details in replacing the exciter ring refer to AIR BRAKE SYSTEM Section CTS 2668, SERVICE INSTRUCTIONS.

It is recommended that the sensors be inspected for wear whenever the wheels and drums are removed for brake, bearing or seal maintenance. If sensor is excessively worn, it must be replaced as a complete assembly (sensor, adjuster and bracket assembly).

To inspect the sensor assembly, wipe the sensor end with a clean dry cloth and compare the wear to the examples of sensor ends shown in Fig. 1.

Check continuity of sensor only if condition is questionable (see Sensor Continuity Check in this section).

Always check sensor voltage output when hub and drum is removed for any reason (see Sensor Voltage Output Check in this section). If correct output is not obtained, wheel sensor is not adjusted properly.

Computer Module

No maintenance of computer module is required with the exception of inspecting the connectors on the module terminals. The computer module is a solid-state component completely sealed. If a malfunction should occur the complete module must be replaced. Refer to CHAPTER IV TROUBLE SHOOTING and SERVICE CHECKS of this Chapter. CHAPTER I of this section provides the improvements to the computer modules.

Wiring

Careful attention has been given to routing the wiring of the electrical wiring of the antilock system, especially at rear axles. You will find that studs are welded on rear axle housings and wiring clips are secured to these studs retaining the wiring. Special attention was given to the electrical connections. All connectors in the wiring system are water tight and secured with nylon straps to prevent accidental disconnect.

Refer to CHAPTER I for additional information regarding WIRING and COMPUTER MODULE CONNECTORS. You will also find some additional information pertaining to wiring in SERVICE HINTS in this CHAPTER.

SERVICE CHECKS

The brake antilock warning (monitor) light may be used to quickly trouble shoot the anitlock system. The warning light will indicate to the driver or serviceman that the system is functioning properly or not.

Satisfactory System

A satisfactory antilock system is indicated each time the ignition key switch is turned to either "ON" or "RUN" position with the antilock warning light momentarily illuminating, followed by the light going out and remaining off. This indicates that the computer modules are receiving power and the solenoid valves are properly connected to the computer modules.

Warning Light Will Not Illuminate

No light when the ignition key switch is turned on could be the result in no power to the antilock system or the light bulb is burned out. Check for bad fuse or light bulb.

Warning Light Remains On

If the warning light should remain "ON" a problem is indicated in the antilock control system. Should this condition occur the service brakes will function in the normal manner; however, the vehicle will not have the added safety and advantage of the antilock.

If the antilock warning light comes on and stays on, the antilock system should have an "Ignition Cycle Check" performed to determine if all or any computer modules and air control valves are operating satisfactorily. Refer to "Ignition Cycle Check".

Delayed Warning Light

This condition can be observed by closing the ignition switch while vehicle is stationary. The light will come on, then go out as it should, then come back on after a short delay and remain on.

If this is the condition, proceed to locate the module sending the failure warning signal.

Warning Light Illuminates When Vehicle is Operated

As the vehicle is driven about 24 km (15 mph) the antilock warning light should remain "OFF". If the light should come "ON" and remain on above 24 km (I5 mph), a wheel sensor problem may exist. Excessive spin on one drive wheel relative to the other on some axles may cause the monitor light to go "ON". To correct this condition, the ignition switch must be turned "OFF" and back "ON" to reset the system and correct the condition.

If wheel spin is not the cause of the light remaining on, one or more of the sensors could be the problem.

Most common problems found with the sensors are:

- 1. Vehicle brake hang-up and slow release of brakes (dragging brakes).
- 2. Loose-wheel bearings causing excessive exciter ring runout.
- 3. Insufficient voltage output of sensor or shorted sensor or sensor wires. Improper installation of wheel and drum assemblies could result in insufficient voltage output. Do not rock the hub and drum when installing as the sensor

may be pushed in too far. Do not forget to pull the sensor out to its maximum outward travel (away from center of vehicle) prior to installing the hub and drum assembly to assure that the sensor is properly adjusted.

Always check the sensor voltage output connector located at some point on the axle after performing any maintenance to brakes, wheel bearing or wheel seals.

A volt-ohm meter can be used for sensor voltage output check at sensor connector by spinning the wheel about one revolution every two seconds. Voltage should not be lower then .3 volt.

Whenever the wheels are removed for any reason and when you are resetting the sensor, visually inspect the sensor wear pattern and compare to that shown. Also inspect the exciter ring for unusual wear or excessive rubbing in one spot. This could mean excessive runout is present on the ring.

Ignition Cycle/Check

To ignition cycle the antilock system, turn the ignition switch "ON" to "OFF" several times prior to starting the ignition cycle check. Then with at least 551: kPa (80 psi) air in system, apply the brakes and turn the ignition switch to "ON" position. This allows all air valves to exhaust a small amount of air. Continue to turn the ignition switch "ON" to "OFF" with the brakes applied until all computer modules and air control valves have been checked. An assistant will be required to listen for the exhaust of air at each axle air control valve.

Remember that the antilock light on the instrument panel can lead you to the trouble spot in the antilock system. Refer to the particular condition in the TROUBLE SHOOTING GUIDE, CHAPTER IV in this section.

REMOVE AND REINSTALL

Air Control Valve Remove:

- 1. Apply parking brakes or block wheels to prevent vehicle from moving.
- 2. Tag or identify air line before disconnecting; then disconnect air lines.

- 3. Disconnect wiring to solenoid.
- 4. Remove mounting nuts and then remove control valve.

In some instances it may be necessary to remove the air control valve and relay quick release valve mounting bracket as an assembly to gain access to air control valve mounting nuts.

For complete details covering disassembly and reassembly of air control valve, refer to AIR BRAKE COMPONENTS, CTS-2673, CIHAPTER VIII.

Reinstall

- 1. If mounting bracket was removed from frame assemble control valve to bracket and tighten nuts.
- 2. Assemble hoses to air control valve.
- 3. Install air control valve to frame or mounting bracket to frame.
- 4. Connect wiring.
- 5. Perform SERVICE CHECKS as outlined in Chapter VIII of AIR BRAKE COMPONENTS, CTS-2673. Be sure to recheck antilock system operation.

Computer Module

Be sure to check the computer module as outlined in the TROUBLE SHOOTING GUIDE, CHAPTER IV and SERVICE CHECKS prior to removing.

Remove:

- 1. Remove module cover using a screwdriver (Fig. 2).
- 2. Remove wire connectors. Use a needle nose pliers grasping the raised end of connector.
- 3. If the computer module is equipped with a Radio Frequency Interference (RFI) filter the mounting bolt on the left side must be removed at this time; then the filter can be removed.
- 4. Disconnect ground wire at GRD terminal at module.
- 5. Remove module mounting bolts.

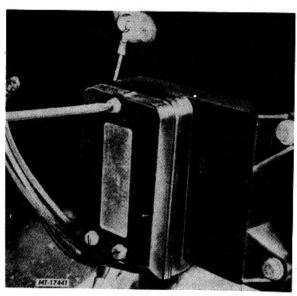


Fig. 2 Removing Computer Module Cover

There is no disassembly and reassembly of computer module since it is a complete replacement item.

Reinstall:

To install the computer module, reverse the foregoing module removing procedure.

Tighten module cover bolts to 2.26 Nm (20" lbs).

If the computer module with the RFI filter is being replaced, installation of the RFI filter will not be required since the new computer module (green) with integral filter will be installed.

Be sure to check antilock operation prior to returning vehicle to service.

Exciter Ring

For complete detailed instructions pertaining to replacing the exciter ring, refer to AIR BRAKE SYSTEM, General Information (CTS-2668) where special attention to removing hub and drum assembly, replacing exciter ring and adjusting wheel bearings will be found under SERVICE INSTRUCTIONS.

Sensor

Remove:

To remove sensor, the hub and drum assembly must be removed. Refer to AIR BRAKE SYSTEM, General Information (CTS2668) where special attention to removing and reinstalling hub and drum assembly and adjusting wheel bearings will be found under SERVICE INSTRUCTIONS.

For inspection of sensor for wear, refer to MAINTENANCE (Exciter Ring and Sensor) of this section.

1. Cut nylon strap around electrical connectors (Fig. 3),



Fig. 3

2. Disconnect electrical connector separating sensor wires from antilock harness (Fig. 4).

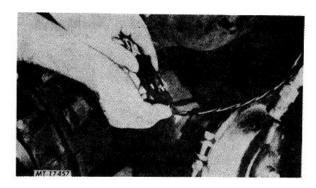


Fig. 4

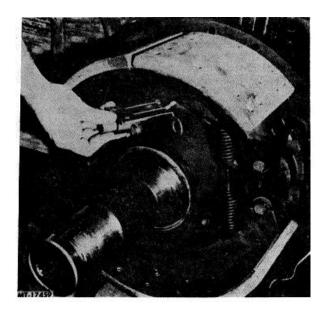


Fig. 5.

Remove sensor mounting bolts and remove sensor and bracket assembly (Fig. 5).

Reinstall:

The sensor is reinstalled by reversing the foregoing removal procedure. The nylon strap is used to prevent the connector working loose through normal road shock.

Torque sensor mounting bolts to: 1/2" bolts 102 to 115 N.m (75-85 ft. lbs.) 5/8" bolts 216 to 237 N.m (160-175 ft. lbs.)

Items which also require special attention whenever hub and drum are removed are checking "Continuity of Sensor" found in this section. All tests which are performed herein can be made with Antilock Tester SE-2575.

SENSOR CONTINUITY CHECK

The continuity check on the sensor may either be performed at the sensor connector, at the sensor leads or at the computer module (RFI filter if equipped). When performing the sensor continuity check, you are inspecting the sensor and wires to sensor for an open circuit.

Since the overall condition of sensor and wiring to the sensor may be in question, it is best to go directly to the computer module, thus eliminating disturbing the connection between the sensor leads and wiring harness.

The following instructions are performed using a volt-ohmmeter:

- 1. Remove computer module cover.
- 2. Remove connector from computer module for sensor in question.
- Connect ohmmeter leads to sensor wires as shown in Fig. 6

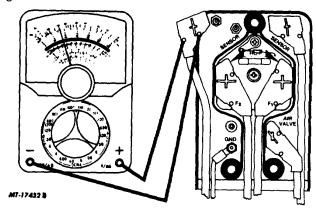


Fig. 6

- 4. Set ohmmeter on mid-range setting. Reading should be 4000 6000 ohms.
- 5. Check sensor for opposite wheel in same manner.

If no reading is obtained the sensor or wires are open. Inspect sensor wires by disconnecting connector at sensor lead. Check each wire for a possible open. If sensor is open, replace it.

SENSOR VOLTAGE OUTPUT CHECK

Since the sensor is a device which generates an electrical signal proportional to the rate of wheel rotation, it is dependent upon the exciter ring in creating this electrical signal.

When hub and drum assembly is removed for any reason, the voltage output of sensor must be checked to assure that the sensor is properly adjusted to the exciter ring. Fig. 7 illustrates a cross section of exciter ring to sensor installation.

Items which can effect sensor voltage output are improper installation of hub and drum assembly, wheel bearing adjustment or excessive exciter ring runout. The sensor

voltage output can be checked using either the Antilock Brake Tester (SE-2575) or Volt-Ohmmeter (SE-2579).

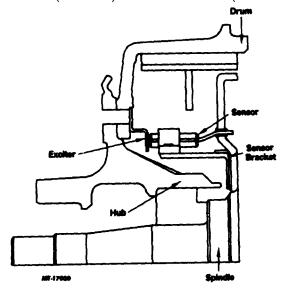


Fig. 7

Procedure for checking sensor voltage output using a volt-ohmmeter is as follows:

- 1. Remove computer module cover for sensor being checked.
- 2. Axle being inspected must be supported on floor stands and brakes released so that the wheels may be rotated by hand.
- 3. Position volt meter leads to the sensor terminals on computer

module of sensor being tested (Fig. 8). See SPECIAL HINTS, Incorrect Wiring Connections of Wheel Sensors to Computer Module.

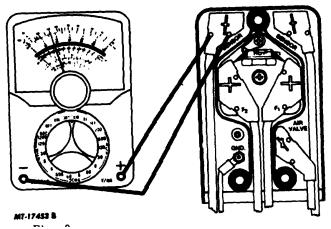


Fig. 8

4. Set volt meter on AC voltage. With ignition switch "OFF", spin

wheel about one (1) revolution every two (2) seconds, Voltage should be no lower than .3 volt. Test both sensors to be sure of adjustment.

If low or no voltage is measured, the following items should be checked.

1. When hub and drum assembly was installed, the sensor may

have been pushed in too far.

Use a wheel dolly to position wheel and hub assembly on spindle, only far enough to install outer bearing and bearing adjustment nut. When nut is tightened the hub and drum assembly with exciter ring will push the sensor into the bracket.

When the bearings are adjusted properly the sensor will be set correctly. Do not rock the hub and drum when installing as the sensor may be pushed in too far and correct sensor output will not be obtained.

Adjust wheel bearings as outlined in AIR BRAKE SYSTEM, General Section (CTS-2668) referring to Service Instructions, Wheel bearing Adjustment.

2. Wheel bearing adjustment is very important as stated in

foregoing item.

Excessive exciter ring runout may effect output. Runout should

not exceed .635 mm (.025") when installed with hub and drum assembly. Exciter ring runout can be checked using SE-2581 antilock exciter ring runout fixture and using attachments and swivel sleeves from SE-1848 dial indicator set.

SPECIAL SERVICE HINTS

Important precaution pertaining to antilock wiring is to remember that under no circumstances should the antilock circuits (16, 44, 71 and 94) be used for auxiliary equipment. Circuits may have suffix letters but are still part of antilock circuits.

Computer Module Improvement

Remember if you must interchange modules or are replacing modules be sure of the application by color and part number. Refer to CHAPTER I, COMPUTER MODULE IMPROVEMENTS for complete detailed improvements and application of modules Polar Fuse Board Application, CHAPTER I COMPUTER MODULE IMPROVEMENTS

explains the various improvements to the fuse boards and as well as the application to particular computer module.

Lubricant Sealer Used at Moulded Connectors

The moulded connectors for air control valves and sensors are treated with special lubricant/sealing compound (grease) which provides lubricant for metal surfaces and prevents entrance of moisture in connectors. This compound should not be cleaned from the connector terminals and should be applied to female cavities when service is performed on the antilock system.

Lubricant/sealer is available under part number 472141-C1.

Incorrect Wiring Connections of Wheel Sensor to Computer Module

This is to advise that there is no guarantee that the left sensor is connected to left terminals of computer module, likewise right sensor to right terminals of module, due to incorrect connection of the identical moulded connectors in the electrical wiring (Fig.

If you should check sensor output and you have no reading, remember that the moulded sensor connectors on the axle could be crossed (left sensor lead from module to right sensor and right sensor lead from module to left sensor). Do not condemn a sensor without visually checking the wiring routing from modules to sensors.

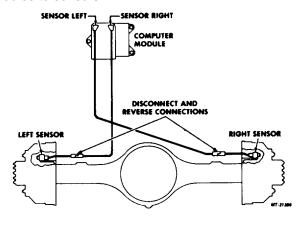


Fig. 9

Mixing of leads or connectors can do no harm to the antilock performance. However, servicemen must remember that the wires from sensors may be connected incorrectly at the moulded connectors in the wiring system.

This condition can be located by either spinning a wheel and checking sensor output or visually tracing the sensor wires to determine which sensor is connected to each of the computer module connections. Then the moulded connectors can be disconnected and installed in proper location.

Computer Module Cover Bolt Torque

Do not tighten module cover bolts over 2.26 N.m (20 in. lbs.) as this can cause damage to the module resulting in the threaded inserts being pulled from the module body.

It is even more important to exercise care when installing the cover bolts when an RFI filter is used as you are compressing three water tight seals.

If the inserts are pulled out of the module body exposing the serrations at bottom of inserts, they can be removed and disc inside the inserts must be pushed back towards top of the threads before epoxying insert back into module body. Hold insert in body while installing cover bolt to bottom disc into insert.

Green Computer Module

The green module is the most superior module, which has better RFI filtering and resistance against voltage spikes. The green module, therefore, does not require the RFI filter. This also applies to the intrum type black module with part number 476088-C91.

Welding on Chassis with Antilock

There have been reports where damage has been encountered to the computer modules on chassis in service with antilock air brake system due to electric welding.

To avoid possible damage to the computer module it is IMPORTANT that the ignition switch be turned to the "OFF" position when any electric welding is being performed on a chassis with antilock air brake system.

It is good practice to:

- 1. Disconnect the battery ground cable from chassis.
- 2. Keep welding ground clip as close as possible to work.

Do not allow the antilock computer module to be between welding area and ground clip.

Relocation of Antilock Components

When special conditions warrant relocation of antilock components the following items must be adhered to:

1. Solenoid Valve (Air Control Valve)

- a. Mount valve in same orientation as originally mounted.
- Make sure wires from valve exit downward from valve to prevent water entering the valve via wires.

2. Computer Module

- a. Mount with arrow on body pointing down.
- b. Do not mount in direct line of wheel splash.
- c. Spot face ground wire mounting hole to provide a good clean ground connection.
- d. Module body case is plastic and will not provide a ground path.

3. Splicing Wires

 a. Air Control Valve, Power and Failure Wires.

Resin core solder is the preferred splice connection; however, crimp connections which are applied with proper application tool are acceptable. Heat shrink tubing should be applied over either type of splice.

b. Sensor Wires.

<u>Do not</u> splice sensor wires to obtain longer leads than originally installed.



CHAPTER III

CHASSIS AND CIRCUIT DIAGRAMS

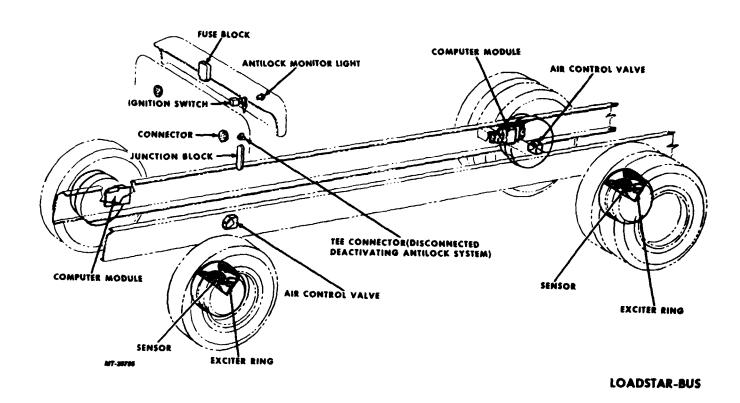
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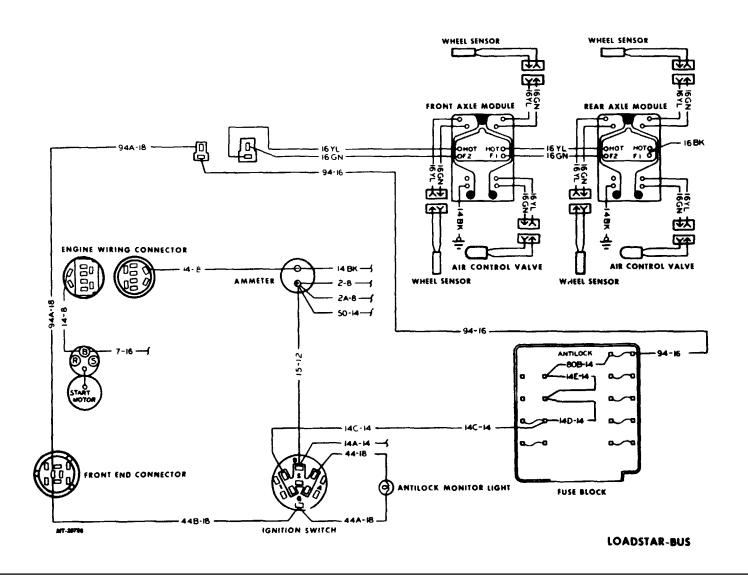
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PAYSTAR 5000	8,9
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CARGOSTAR	15,16

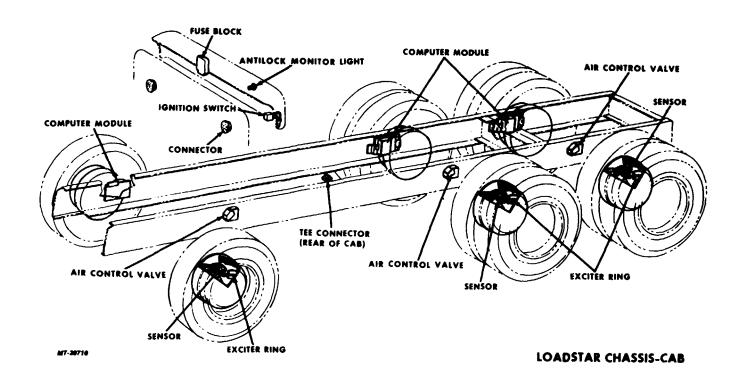
Contained herein are chassis and circuit diagrams which may prove useful in trouble shooting the antilock system. These diagrams have been prepared for each type of vehicle with antilock system to date, governed by FMVSS121 Regulations.

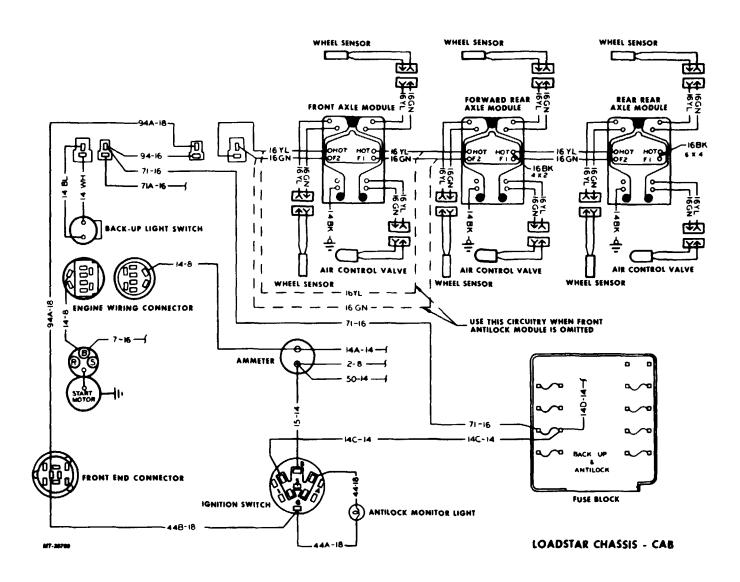
The chassis diagrams illustrate the location of major components as well as electrical connection points for the antilock system.

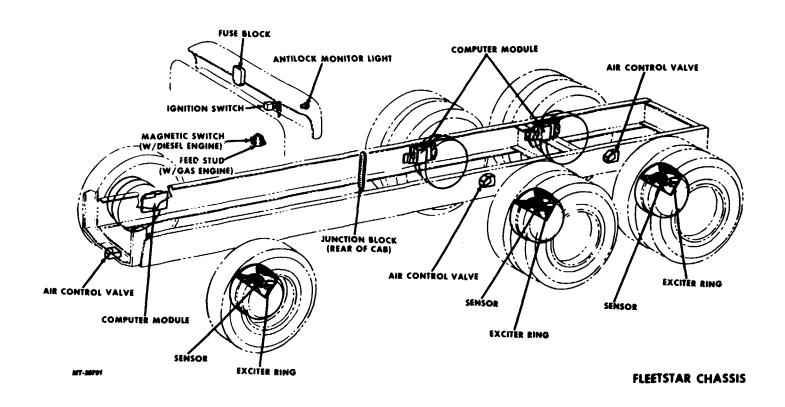
Circuit diagrams illustrate circuitry for each vehicle with antilock.



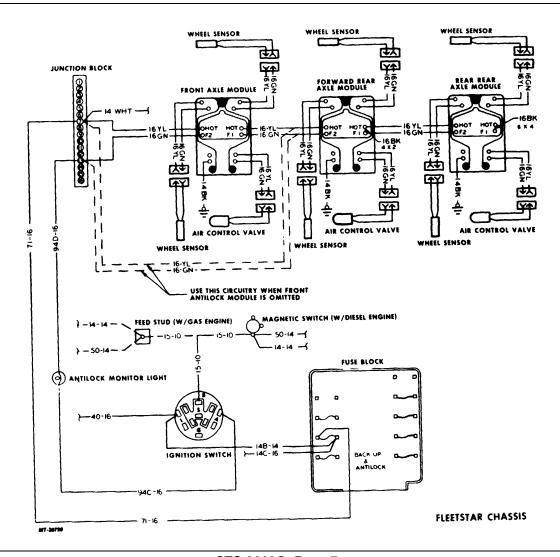




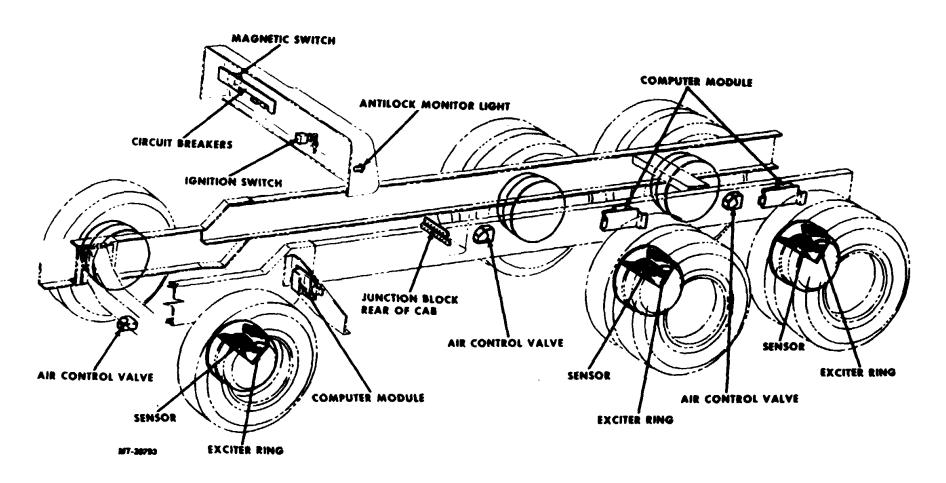






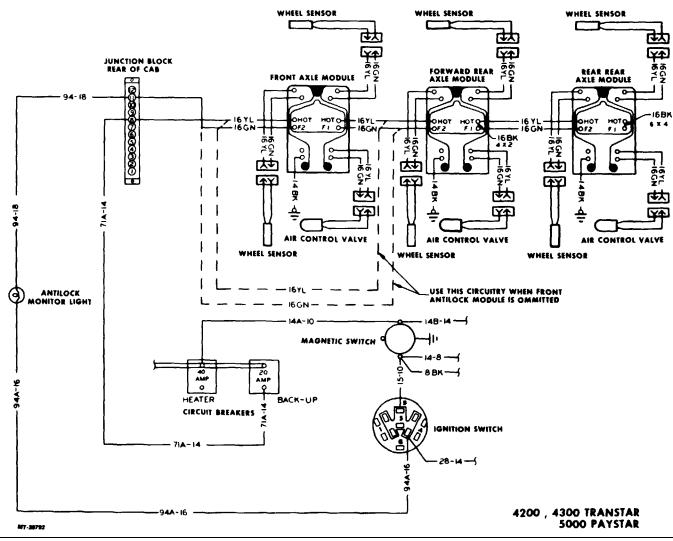




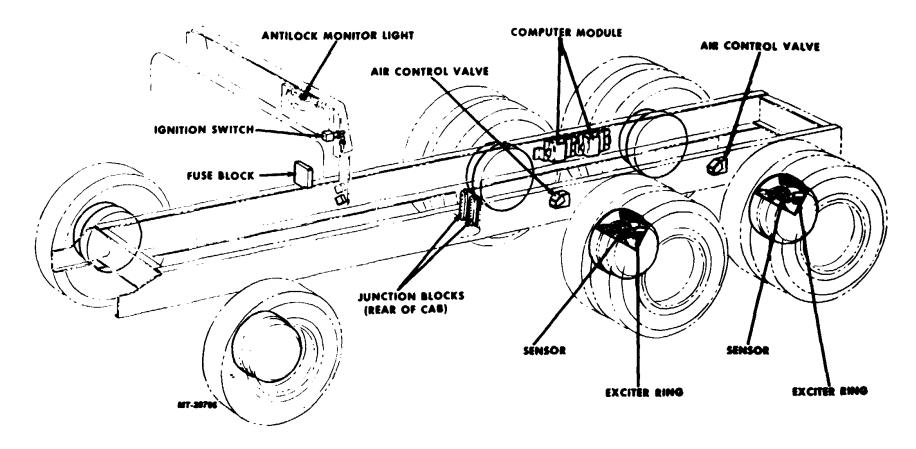


4200, 4300 TRANSTAR 5000 PAYSTAR



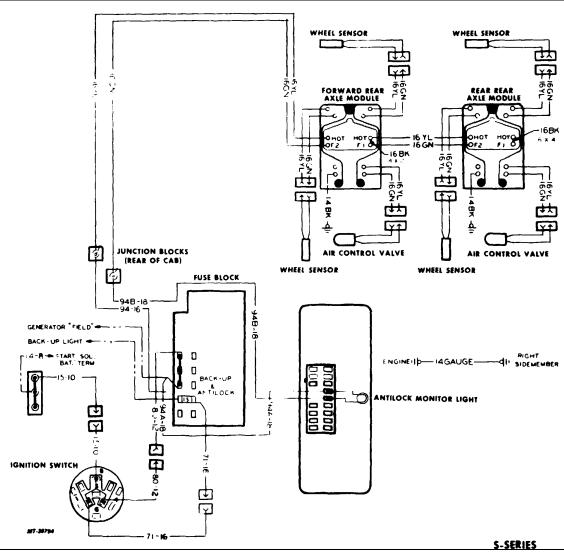




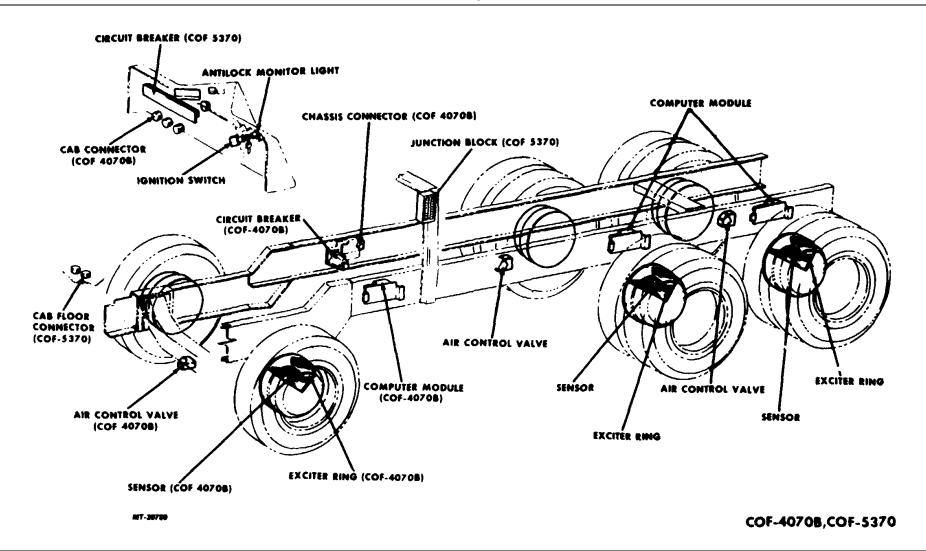


S-SERIES

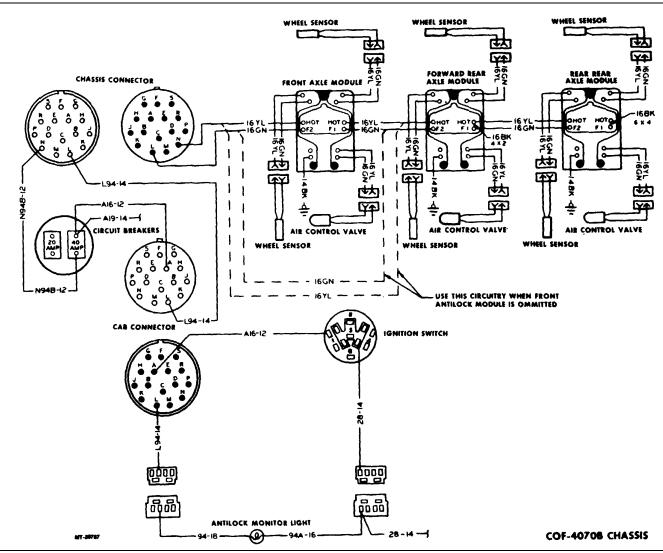






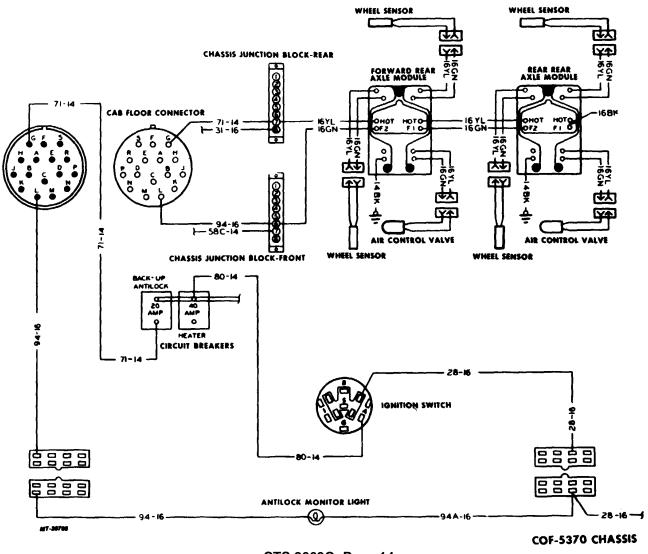






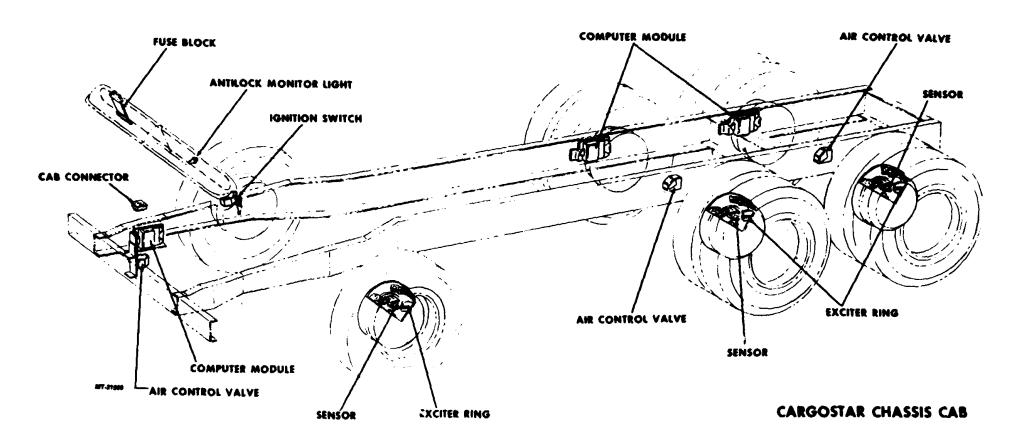
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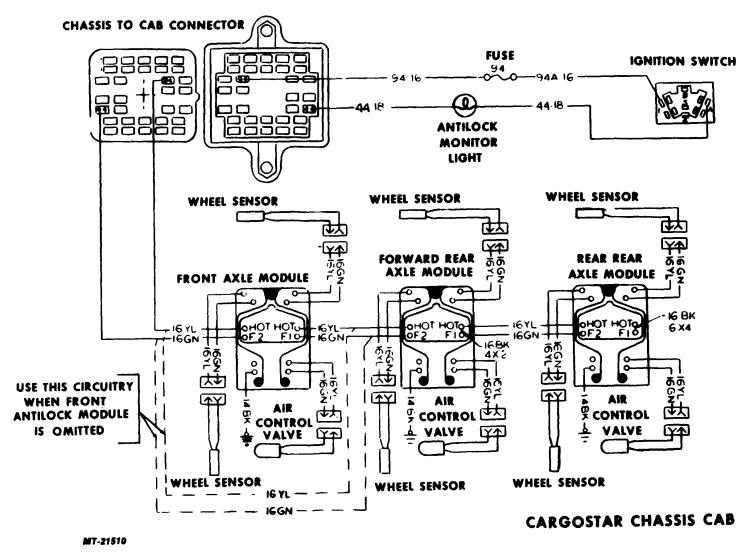
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CHAPTER IV

TROUBLE SHOOTING

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CTS-2669R Chapter IV



CHAPTER IV

TROUBLE SHOOTING

ANTILOCK TROUBLE SHOOTING

Two procedures have been established in the trouble shooting of the antilock control system.

The one procedure uses a portable test unit SE-2575 (Fig. 1) which is designed to simplify module tests by having an adapter which is installed in place of the computer module cover. This adapter is connected to the tester with an eight (8) foot cord allowing the mechanic to read the tester alongside the truck instead of under the truck. Instructions for trouble shooting the antilock system are provided with the tester.

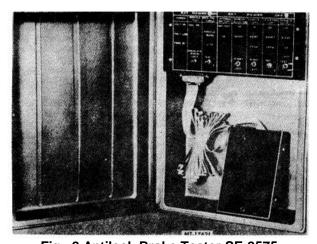


Fig. 2 Antilock Brake Tester SE-2575

The second method of trouble shooting the wheel lock control is to use a volt ohmmeter and a jumper wire. Use any good volt-ohmmeter with a minimum scale of 0-5 volts A. C. and the jumper wire should be about 12 inches long with test probes or small alligator clips at the ends. If jumper wire has alligator clips use small nails for test probes.

A step-by-step procedure has been prepared to assist in trouble shooting the antilock system using a volt-ohmmeter. The chart has a CONDITION, then follow through the instructions as directed for that condition you are correcting.

A diagnostic Trouble Shooting Guide (CTS1044) has been prepared to assist in quickly locating problems in the antilock system using the antilock warning light conditions individually and arranged in logical sequence.

Direct your attention to one of the appropriate light conditions you are going to diagnose. This pertains to the trouble shooting form as well as the Trouble Shooting Guide here in.

The procedures listed include checking the more logical items first always start with the first step and continue through each step until the final solution is reached.

DO NOT DEVIATE FROM PROGRESSIVE SEQUENCE LISTED IN GUIDE.

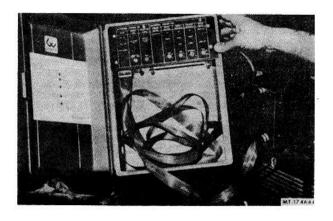


Fig. 2 Antilock Brake Tester Installed on Chassis

TROUBLE SHOOTING GUIDE

IMPORTANT

Always use same test connections as illustrated on both modules with RFI filter and green modules except where noted. When different connections are made between systems with and without RFI filters text will state same.

CONDITION -SATISFACTORY SYSTEM

Turn ignition switch to "on" position. The antilock monitor light located on instrument panel should come on momentarily; then go off and stay off.

CONDITION-NO MONITOR LIGHT

Possible Cause

- A. Bad monitor light bulb.
- B. No power (11 to 14 volts)

C. Open ground wire at front axle computer module.

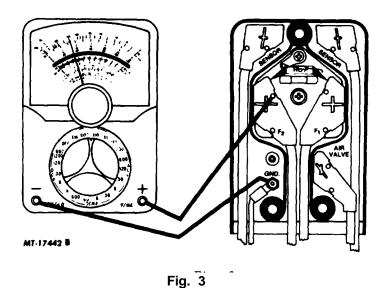
- D Open wiring from front axle computer module to monitor light.
- E. Computer module.

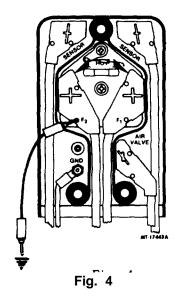
Corrective Procedure

- A. Replace light bulb and recheck monitor light.
- B. Remove monitor light bulb. Test both terminals in monitor light socket with one lead to ground (chassis). Turn ignition switch on; 11 to 14 volts D. C. should be measured. If correct voltage is measured proceed to test C. If no voltage is measured, repair wiring between ignition switch and light socket; then recheck monitor light operation.
- C. If module has RFI filter inspect check ground strap for broken, loose or corroded conditions. Remove cover from front axle computer module, Connect volt meter leads to "hot" and "ground" terminals (Fig. 3). Turn ignition switch on; 11 to 14 volts D. C. should be measured. If correct voltage is obtained proceed to test D. If no voltage is measured, repair the wire, clean connections and recheck the monitor light.
- D. Use a jumper wire and connect one end to "F-2" terminal and the other end to ground (chassis) (Fig. 4). If light comes on continue to test E. If monitor light remains off check for open wire from computer module to monitor light. Repair wire and recheck monitor light.
- E. If all preceding tests are correct and there is still no monitor light at engine start up, replace the front axle computer module and recheck the monitor light operation. Do not use RFI filler with green module,

THIS CONCLUDES NO MONITOR LIGHT TEST







CONDITION-MONITOR LIGHT STAYS ON

Turn ignition key to "on" position. If the monitor light located on instrument panel comes on and stays on, "Ignition Cycle" the system to determine if all computer modules and air valves are operating satisfactorily.

Ignition Cycle the Antilock System

Turn ignition switch "on" to "off" several times before starting to ignition cycle the system. With at least 552 kPa (80 psi) air in air system, apply the brakes and turn the ignition switch to "on" position. This will allow all air valves to exhaust a small amount of air. Continue to turn ignition switch "on" to "off" with the brakes applied until all computer modules and air valves have been checked.

If none of the computer modules and air valves ignition cycle, check Possible Cause listed under "No Computer Modules Ignition Cycle". If some computer modules and air valves will ignition cycle and some will not ignition cycle, check Possible Cause, listed under "Some Computer Modules Will Not Ignition Cycle" at the module which will not cycle. If all computer modules and air valves ignition cycle and monitor light remains on go directly to check for Possible Cause listed under All Computer Modules Will Ignition Cycle.

1. NO COMPUTER MODULES IGNITION CYCLE

Possible Cause

Open or shorted power wire to computer module.

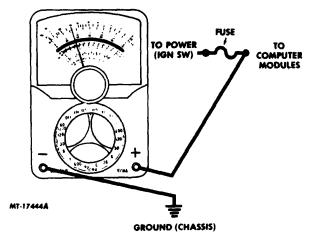
Corrective Procedure

Turn ignition switch "on." Use a volt meter to check circuit breaker or fuse to determine if it is open or closed (Fig. 5). If 11 to 14 volts D. C. is measured, the fuse is good or circuit breaker is closed; proceed to test "A". If no voltage is recorded the circuit breaker or fuse is open; proceed to test "B"

CONDITION-MONITOR LIGHT STAYS ON (Continued)

1. NO COMPUTER MODULES IGNITION CYCLE (Continued)

Possible Cause



Corrective Procedure

- A. Fuse or circuit breaker closed and no ignition cycle at any computer modules, check for an open in "hot" wire from fuse or circuit breaker to "hot" terminal on front axle computer module. Repair wiring and recheck ignition cycle.
- B. Fuse or circuit breaker open, check for shorted wire from fuse or circuit breaker "Hot" to first computer module. Repair wiring and recheck ignition cycle.

Fig. 5

THIS CONCLUDES NO COMPUTER MODULES IGNITION CYCLE

2. SOME COMPUTER MODULES WILL NOT IGNITION

Possible Cause

A. No power to computer module.

B. Open computer module ground wire.

Corrective Procedure

- A. Remove cover from forward most computer module which will not ignition cycle. Use a volt meter, connecting leads to the "hot" terminal and ground (chassis) (Fig. 6). Turn ignition switch "on"; 11 to 14 volts D. C. should be measured. If correct voltage is obtained, proceed to test "B". If no voltage is measured repair wiring and recheck ignition cycle.
- B. If computer module has a RFI filter inspect for broken, loose or corroded ground strap. Repair and recheck monitor light operation. On green computer modules connect leads of volt meter to "hot" and ground terminals on computer module which will not ignition cycle (Fig. 7); 11 to 14 volts D. C. should be measured. If correct voltage is obtained, proceed to test "C". If no voltage is measured, repair computer module ground and recheck ignition cycle.

CONDITION-MONITOR LIGHT STAYS ON (Continued)

2. SOME COMPUTER MODULES WILL NOT IGNITION (Continued)

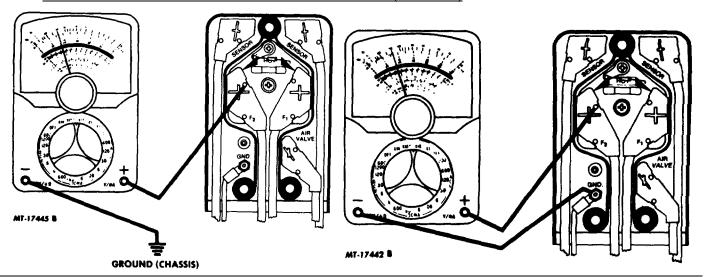


Fig. 6 Fig. 7

C. Blown computer module polar fuse.

IMPORTANT Never bypass fuse with a jumper wire as damage may result to computer, module.

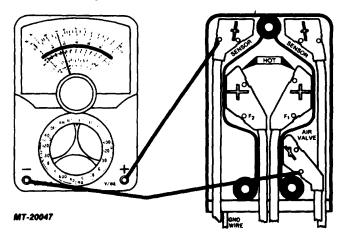


Fig. 8

C. Test Procedure for Blown Computer Module Polar Fuse

Using a voltmeter, connect the leads to the sensor "Lo" pin and the air valve "Lo" pin (Fig. 8). Approximately 3 volts DC should be measured. If correct voltage is measured replace module and recheck ignition cycle. Do not install RFI filter on green module. If no voltage is measured, proceed as follows:

- Remove the air valve wires from the computer module.
- b. Using an ohmmeter connect the leads to one of the valve wires and the other lead to the air valve body (Fig. 9). Set the ohmmeter on the highest ohm setting. Ohm reading should be more than 10,000 ohms. If a lower reading occurs, the air valve or air valve wires have a leakage (shorted) and proceed to check air valve wires for short and if shorted repair or replace.
- If air valve wires are satisfactory, replace air control valve.
- d. Remove RFI filter and replace polar fuse board; connect air valve wires, reinstall RFI filter, then recheck ignition cycle and monitor light operation.

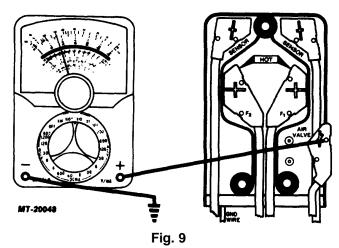
Modules With RFI Filter

CONDITION-MONITOR LIGHT STAYS ON (Continued)

2. SOME COMPUTER MODULES WILL NOT IGNITION (Continued)

Possible Cause

C. Blown computer module polar fuse (Continued)



IMPORTANT

Never bypass fuse with a jumper wire as damage may result to computer module.

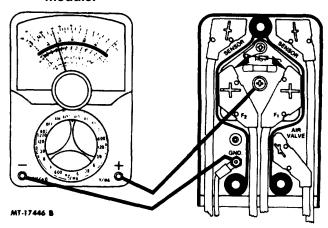


Fig. 10

Corrective Procedure

C. <u>Test Procedure for Blown Computer Module Polar</u> Fuse (Continued)

Modules with RFI Filter

- e. If ohm reading is correct, replace computer module and recheck ignition cycle check. Do not use RFI filter with green module.
- f. If all preceding tests are correct and still no ignition cycle, replace the computer module, recheck ignition cycle and monitor light operation. Do not use RFI filter on green modules.

THIS CONCLUDES TEST FOR MONITOR LIGHT STAYS ON - SOME MODULES WILL NOT IGNITION CYCLE FOR MODULES WITH RFI FILTER

Module Without RFI Filter

Connect leads of volt meter to polar fuse board attaching screw head and ground (Fig. 10); 11 to 14 is obtained, and still no ignition cycle, replace module and recheck ignition cycle.

If no voltage is measured proceed as follows:

- a. Remove air valve wires from computer module.
- b. Replace polar fuse board.
- c. Connect volt meter leads to air valve terminals on computer module (Fig. 11) with connector removed.
- d. Ignition cycle system several times observing volt meter for needle jump.
- e. If needle jump is indicated and fuse does not blow again, the problem is in the air valve or wiring. Repair wiring as required or replace air valve and recheck ignition cycle.

CONDITION-MONITOR LIGHT STAYS ON (Continued)

2. SOME COMPUTER MODULES WILL NOT IGNITION (Continued)

Possible Cause

C. Blown computer module polar fuse (Continued)

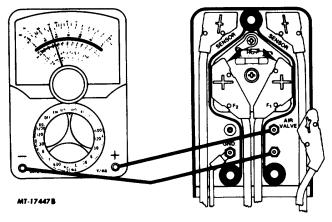


Fig. 11

3. ALL MODULES WILL IGNITION CYCLE

Possible Cause

Open fail wire between computer modules or problem in fail safe section at computer module.

IMPORTANT

Do not leave jumper wire connected more than two minutes while performing the following tests .

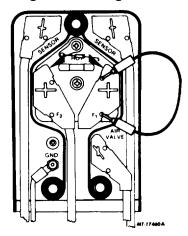


Fig. 12

Corrective Procedure

- C. <u>Test Procedure for Blown Computer Module Polar</u> <u>Fuse (Continued)</u>
 - f. If fuse blows in test "e", replace computer module and recheck ignition cycle. Do not use RFI filter on green module.

THIS CONCLUDES TEST FOR MONITOR LIGHT STAYS ON - SOME MODULES WILL NOT IGNITION CYCLE ON MODULES WITHOUT RFI FILTER

Corrective Procedure

Test to determine which computer module is sending failure warning signal.

CHASSIS

Two axle vehicles or three axle vehicles with antilock on rear axles only

Remove cover from rear axle computer module (rear, rear axle 6x4 vehicles). Using a jumper wire connect leads to "hot" terminal and "F1" terminal (Fig. 12). Turn ignition switch "on". If monitor light goes off, remove the connector from the "hot" pin and "F1" terminal. Inspect for missing, broken or loose jumper wire . within the connector. Replace or repair jumper w ire and recheck monitor light.

CONDITION-MONITOR LIGHT STAYS ON (Continued)

3. ALL MODULES WILL IGNITION CYCLE

Possible Cause

Open fail wire between computer module or problem in fail safe section at module (continued)

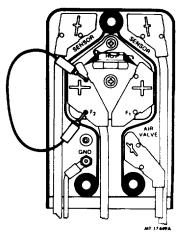


Fig. 13

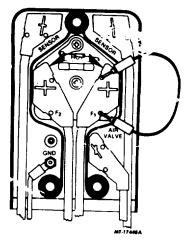


Fig. 14

Fig. 14.

Corrective Procedure

Test to determine which module is sending failure warning signal (continued)

If monitor light goes off:

Using a jumper wire connect leads to "hot" terminal and "F2" terminal (Fig. 13). <u>If monitor light goes off</u>, replace the computer module and recheck monitor light. Do not use RFI filter on green module.

If monitor light stays on:

Remove cover from front axle computer module (4x2 vehicles with antilock on both axles) or forward rear axle on 6x4 vehicles with antilock on rear axles only

Use a jumper wire, connect leads to "HOT" and "F1" terminals (fig. 14).

If light goes off check for open "F" wire between rear axle and front axle (4x2 chassis) module or "F" wire between forward rear and rear rear axle (6x4 with antilock on rear axles only) module. Repair "F" wire and recheck monitor light.

If monitor light stays on:

Pull connector from "hot" and "F2 " pins (Fig. 15).

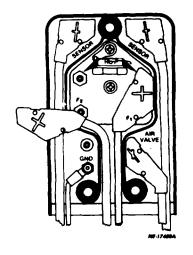
If monitor light stays on check for shorted wire from monitor light to "F2" terminal. Repair wire and recheck the monitor light operation.

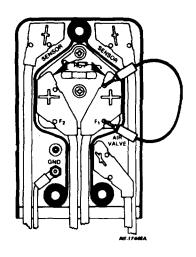
<u>If light goes off</u>, replace computer module and recheck monitor light operation. Do not use RFI filter on green module.

THIS CONCLUDES CHECKING CONDITION, MONITOR LIGHT STAYS ON - ALL MODULES WILL IGNITION CYCLE - Vehicles with antilock on two axles.

CHASSIS THREE AXLE VEHICLES WITH ANTILOCK ON ALL AXLES

On vehicles with antilock on three axles you will start trouble shooting at forward rear axle to determine if power is being fed to this module. If so, the front axle module is functioning properly. if forward rear axle module is not functioning properly you will





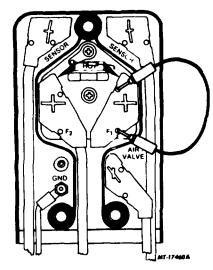


Fig. 15

Fig. 16

Fig. 17

CONDITION-MONITOR LIGHT STAYS ON (Continued)

3. ALL MODULES WILL IGNITION CYCLE (Continued)

THREE AXLE VEHICLES WITH ANTILOCK ON ALL AXLES

not have power go from this module. If the forward rear module is functioning properly you will have power from the module and your problem will be at module for rear rear axle.

Possible Cause

Open fail wire between computer module or problem in fail safe section at module (Continued)

Corrective Procedure

Test to determine which module is sending failure warning signal (Continued)

- A. Remove cover from forward rear axle computer module using a jumper wire connect leads to hot" terminal and "F1" terminal (Fig. 16'. <u>Turn</u> ignition switch on. <u>If monitor light goes off</u>, proceed to tests B and C. <u>If monitor light stays on</u>, proceed to tests D. E and F.
- B. Remove cover from rear rear axle module. Using a jumper wire connect leads to "hot" and "F-1" terminal (Fig. 17). <u>If monitor light stays on proceed to test C. If light goes off</u>, remove connector from "hot" and "F-1" pins. Check for missing or broken jumper wire. Repair or replace and recheck monitor light operation.

CONDITION-MONITOR LIGHT STAYS ON (Continued)

3. ALL MODULES WILL IGNITION CYCLE (Continued)

THREE AXLE VEHICLES WITH ANTILOCK ON ALL AXLES

Possible Cause

Open fail wire between computer module or problem in fail safe section at module (continued)

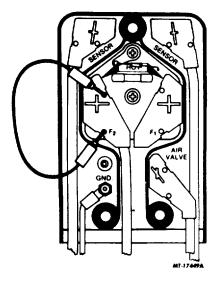


Fig. 18

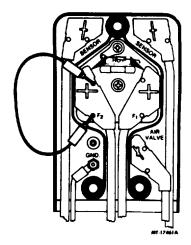


Fig. 19

Corrective Procedure

Test to determine which module is sending failure warning signal (continued)

- C. Use a jumper wire and connect leads "Hot" and "F-2" terminals trig. 18). <u>If monitor light stays on</u>, check for open "F" wire from rear rear axle module to forward rear axle module. Repair "F" wire and recheck monitor light operation. <u>If monitor light goes off</u>, replace module and recheck monitor light.
- D. Using a jumper wire connect leads to "hot" and "F2" terminals (Fig. 19). <u>If monitor light goes off</u>, replace computer module and recheck the monitor light.

If monitor light stays on:

E. Remove cover from front axle computer module. Using a jumper wire, connect leads to "hot" and "F1" terminals (Fig. 16) If monitor light goes off, check for an open "F" wire between the front axle computer module and forward rear axle module. Repair "F" wire and recheck the monitor light.

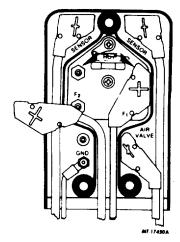


Fig. 20

If monitor light stays on:

F. Pull connector from "hot" pin and "F2" pin (Fig. 20). If monitor light goes

CONDITION-MONITOR LIGHT STAYS ON (Continued)

3. ALL MODULES WILL IGNITION CYCLE (Continued)

THREE AXLE VEHICLES WITH ANTILOCK ON ALL AXLES I

Possible Cause

Open fail wire between computer module or problem in fail safe section at module (Continued)

Corrective Procedure

Test to determine which module is sending failure warning signal (Continued)

off, replace computer module and recheck monitor light. If monitor light stays on, check for a shorted wire from monitor light to "F2" terminal. Repair shorted wire and recheck monitor light.

THIS CONCLUDES CHECKING CONDITION, MONITOR LIGHT STAYS ON, ALL MODULES WILL IGNITION CYCLE - Vehicles with antilock on three axles.

CONDITION-DELAYED MONITOR LIGHT

This condition is observed by turning on the ignition switch. The monitor will come on, then go out as it should. However, in delayed light conditions, the light will then come back on after a short delay and light will remain on.

1. LOCATE MODULE SENDING FAILURE SIGNAL

4x2 vehicles with antilock on rear axle only will not require the operation of locating module sending fail signal. Go directly to checking air valve solenoid.

WITH ANTILOCK ON TWO AXLES

Remove cover from first axle computer module. Using a jumper wire, connect leads to "hot" and "F1" terminals (Fig. 16). Turn ignition switch "on". If monitor light stays on, the front axle is sending failure warning signal. If monitor light goes off, the rear axle computer module is sending failure warning signal.

WITH ANTILOCK ON THREE AXLES

- A. Remove cover from forward rear axle computer module. Using a jumper wire, connect leads to "hot" and "F1" terminals (Fig. 21). Turn ignition switch "on". If monitor light remains on, proceed to test (B). If monitor light goes off, it indicates that the rear rear axle computer module is sending failure warning signal.
- B. Using a jumper wire, connect leads to "hot" and "F2" terminals on same module (Fig. 22). If monitor light remains on the front axle computer module is sending failure warning signal. If monitor light goes off, the forward rear axle computer module is sending failure warning signal.

NOW YOU HAVE LOCATED THE AXLE SENDING FAIL SIGNAL

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CONDITION-DELAYED MONITOR LIGHT (Continued)

1. LOCATE MODULE SENDING FAILURE SIGNAL (Continued)
WITH ANTILOCK ON THREE AXLES

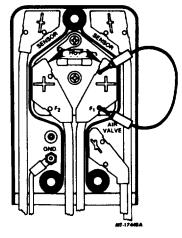


Fig. 21

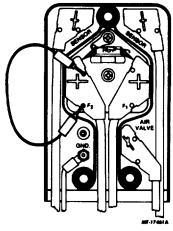


Fig. 22

Possible Cause 2. OPEN AIR VALVE SOLENOID

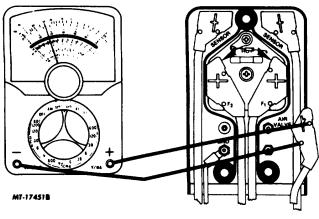


Fig. 23

Corrective Procedure

Remove cover from computer module sending failure warning signal. Remove air valve wires from computer module. Turn ignition switch "off". Using the ohmmeter connect leads to air valve wires (Fig. 23). Set ohmmeter to lowest setting. Reading should be 4 to 8 ohms. If ohm reading is correct, perform Test 3. If no ohm reading is observed, check wiring to air control valve. If wiring is good, the air valve solenoid is open. Replace air control valve and recheck monitor light.

3. With this check you are going to check for grounded or open sensor or sensor wires. When checking an original black module (457932C91) both right and left sensors must be checked for ground or open.

If you are checking an axle module which is blue or green, or late version of black module you only need to check the right sensor for ground This is due to some circuitry changes in these modules and only the right sensor will produce the fail signal. If you should happen to



CONDITION: DELAYED MONITOR LIGHT (Continued)

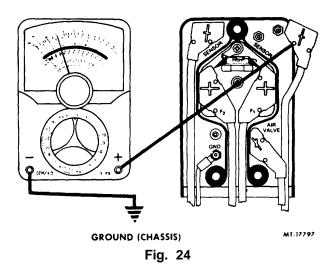
3. (Continued)

to perform the test on both right and left sensors no harm will be done and very little time would actually be lost.

One other thing to remember is that when you are checking the right or left sensor at module, the wires could be crossed at axle connectors. Always check the wiring to be assured of proper connections.

Possible Cause

A. Check for wheel sensor or sensor wire shorted to ground.



Corrective Procedure

A. Remove only the right sensor wires

from the blue, green or late version of the black computer module. Both right and left sensor connectors must be checked on the original black module (457932-C91).

Using an ohmmeter connect one lead to one of the sensor wires and the other lead to ground (chassis) (Fig. 24). Set the ohmmeter on the highest ohm setting. The ohm reading should be more than 10, 000 ohms. If lower reading occurs, the sensor has leakage (shortage). If the ohm reading is correct, proceed to check "B" if original black module is being checked. Or go directly to Step 4 of blue, green or late version of black modules are being checked. If lower reading occurs, check for shorted sensor wire. If found, repair the sensor wire and recheck the monitor light. If the sensor wires are satisfactory, remove the wheel and replace the sensor and recheck the monitor light.

CONDITION-DELAYED MONITOR LIGHT (Continued)

3. (Continued)

Possible Cause

B. Check for wheel sensor or open wheel sensor or open sensor wire (original black module only)

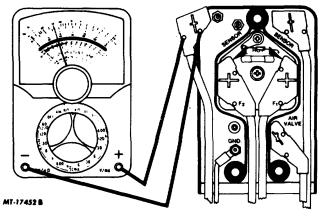


Fig. 25

4. Computer module THIS CONCLUDES TESTS ON DELAYED MONITOR LIGHT

Corrective Procedure

B. Remove sensor wires from computer module. Using an ohmmeter, connect leads to sensor wires (Fig. 25). Set ohmmeter on mid range setting. Reading should be 4000 to 6000 ohms. Check both sensors. If proper reading is obtained, proceed to test 4. If no resistance is measured sensor or sensor wire is open. Repair sensor wire or if sensor wire is in good condition, remove wheel assembly and replace sensor assembly.

If preceding tests are all correct and monitor light stays on, replace computer module and recheck monitor light.

CONDITION-MONITOR LIGHT COMES ON ABOVE 15 MPH AND STAYS ON

When trouble shooting this condition, the monitor light fail signal will be lost if the ignition switch is turned "off". If this should occur, road test vehicle at speed over 15 mph to reestablish the light fail condition.

Possible Cause

A. Excessive spin of one drive wheel relative to the other on some axles.

Corrective Procedure

A. Reset monitor light by turning ignition switch "off " and back "on " while operating vehicle. If light goes out no further test is required.

CONDITION-MONITOR LIGHT COMES ON ABOVE 15 MPH 15 AND STAYS ON (Continued)

Possible Cause

- B. Vehicle brake hang--up and slow release.
- C. Loose wheel bearings causing excessive wheel exciter ring runout.

Corrective Procedure

- B. Check brake for hang-up and slow release (dragging brake) at axle which computer module is sending failure warning signal. Repair brake and road test vehicle,
- C. Check for loose wheel bearings at axle which computer module is sending the failure warning signal. Readjust wheel bearings as outlined in AIR BRAKE SYSTEM, General Information (CTS-2668), under SERVICE INSTRUCTIONS for special attention in adjusting wheel bearings Road test vehicle

To determine which computer module is sending the failure warning signal, refer to the foregoing <u>CONDITION:</u> DELAYED MONITOR LIGHT and perform the tests for two and three axle truck or tractors.

D. Insufficient voltage

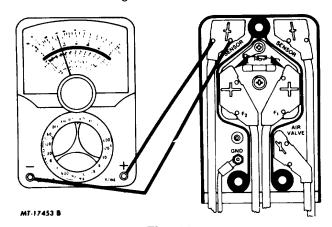


Fig. 26

D. Wheel Sensor Voltage Output Test.

Remove cover from computer module sending failure warning signal. Jack up wheels and release brakes so that wheels may be rotated by hand. Using volt meter, connect leads to sensor terminals of sensor to be tested (left or right sensor) (Fig. 26). Set volt meter on A.C. voltage. Turn ignition switch "off". Spin wheel about one revolution every two (2) seconds. Voltage should be no lower than .3 volt. Test both sensors to determine which sensor has insufficient voltage output.

If voltage output is correct, proceed to test "F" . If low or no voltage is measured proceed to test "E"

The sensor voltage output must be checked after any maintenance (brakes, seals, bearings) has been performed to assure of proper sensor adjustment.

E. Shorted wheel sensor or sensor wire

E. Check Sensor Resistance

Remove two sensor wires (with insufficient voltage output) from computer module. Using an ohmmeter, connect two leads to sensor wires (Fig. 27). Set ohmmeter on mid range setting. Reading should be 4000 to 6000 ohms.

CONDITION-MONITOR LIGHT COMES ON ABOVE 15 MPH AND STAYS ON {Continued}

Possible Cause

E. Shorted Wheel Sensor or Sensor Wire (Continued)

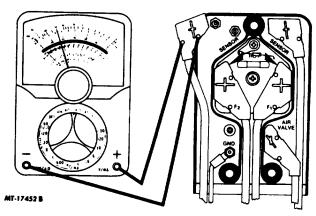


Fig. 27

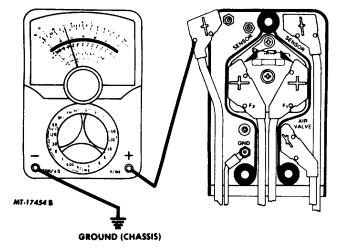


Fig. 28

F. Computer module.

Corrective Procedure

E. Check Sensor Resistance (Continued)

Test No. 2

Next set ohmmeter on highest setting (ohms). Connect one lead of ohmmeter to one of the sensor wires; the other lead to ground (chassis) (Fig. 28). The ohm reading should be more than 10, 000 ohms. If lower reading is obtained, sensor or sensor wire has leakage (shorted) .

If foregoing tests are correct, remove wheel and reset sensor. Refer to AIR BRAKE SYSTEM, General Information (CTS-2668), under SERVICE INSTRUCTIONS for special attention in removing and reinstalling hub and drum assembly and adjusting wheel bearings. Road test vehicle.

If either of the above tests are incorrect, inspect for shorted sensor wire if shorted wire is found, repair short and road test vehicle. If sensor wire is not shorted, remove the wheel and replace the sensor; then road test vehicle.

F. If foregoing tests are correct, replace computer module sending failure warning signal and road test vehicle.

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AIR BRAKE COMPONENTS

IMPORTANT MANUALLY OPERATED FRONT WHEEL LIMITING VALVE <u>MUST NOT</u> BE INSTALLED ON CHASSIS EQUIPPED WITH FMVSS-121 AIR BRAKE SYSTEM.

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GENERAL

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CTS-2673R Page 1

GENERAL INSTRUCTIONS

Air brake equipment on trucks and truck-tractors provides a means of controlling the brakes through the medium of compressed air. Air brake equipment consists of a group of devices; some maintain a supply of compressed air, some direct and control the flow of compressed air and others transfer the energy of compressed air into the mechanical force and motion necessary to apply the brakes. Different types and sizes of devices are in use on different types of vehicles to meet operating requirements.

Refer to AIR BRAKE SYSTEM, GENERAL INFORMATION (CTS-2668) for description of the dual air system used on vehicles covered by Federal Motor Vehicle Safety Standard 121 (FMVSS 121).

The components used to make up a typical dual air system on a chassis are listed in this section with a brief description, operation, service checks and maintenance procedures. Disassembly and reassembly instructions are provided for some components.

CAUTION

Whenever any component is serviced or removed from the air system, be sure to set the parking brake and/or block the vehicle to prevent it from moving while the service is being performed.

The various components which apply directly to the Antilock System, as well as trouble shooting the system, will be found in ANTILOCK (CTS-2669).

LUBRICANT SPECIFICATIONS

Throughout the text whenever reference is made to a particular lubrication note or a particular item number, refer to the following list of item numbers and use the lubricant specified.

Item 1

IH 251H EP grease or equivalent to NLGI #2 multi-purpose lithium grease (same as BW 226M and 204M lubricant).

Item 2

Bendix 239277 (57 g - 2oz) molybdenum disulfide lubricant in liquid carrier. A lubricant suited for O-ring

powder suspended in synthetic lubricant (polyalkylene glycol derivative) and rubber parts as well as metal lubrication, especially at low temperatures.

Item 3

Bendix 291126 (7.08 g - 1/4 oz) or BW 291127 (57 g - 2 oz) silicone grease intended primarily for dynamic lubrication between oil resistant rubber seals and metal parts. Meets MIL-L-4343A requirements. Can be used in serviceable range of -54 C (-65 F) to +426 C (+800 F). Causes less swelling and hardness change of rubber parts than normally encountered with petroleum based lubricants (approved source: Dow Corning Corporation --DC-55 pneumatic grease).

LEAKAGE TESTS

In some cases where leakage tests are performed on various components, a soap bubble test can be made to determine if the items need repairs. However, to assist in locating any leakage at connections or at any components, we suggest that a Leak Detector Tester (SE-2326) be used to locate any air leaks.

With special attachments contained in the tester a very small air leak can be detected easily; for example, in a confined area where a brush with soap is obstructed.

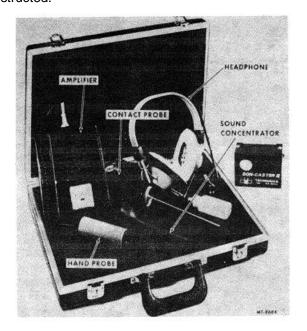


Fig. 1 Leak Detector Tester (SE-2326)



CHAPTER I

GOVERNOR

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BENDIX D-2 TYPE

DESCRIPTION

The air compressor governor along with the compressor unloader mechanism automatically limits system pressure to a predetermined range by opening unloading valves and stopping compression when system pressure has been built up to maximum pressure limit and by closing unloading valves and starting compression when system pressure has dropped to minimum pressure limit.

The D-2 governor has a piston upon which air pressure acts to overcome the pressure setting spring and control the inlet and exhaust valve to either admit or exhaust air to or from the compressor unloading mechanism.

Type D-2 governors can be attached to the compressor or mounted remotely. They are adaptable to either mounting. Connections in this system are to the reservoir and compressor unloading ports. They also have an exhaust port.

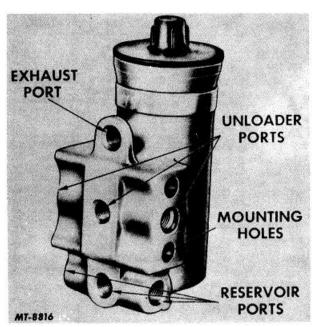


Fig. 1 Type D-2 Governor

OPERATION (Fig. 2)

Reservoir air pressure enters the governor at one of its reservoir ports and acts on the area of the piston and beneath the inlet and exhaust valve. As the air pressure builds up, the piston moves against the resistance of the

pressure setting spring. The piston and inlet and exhaust valve move up when the reservoir air pressure reaches the cut-out setting of the governor.

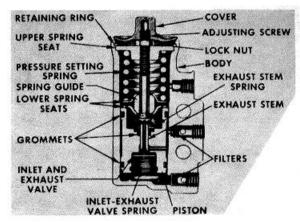


Fig. 2 Sectional View of Type D-2 Governor

The exhaust stem seats on the inlet and exhaust valve and then the inlet passage opens. Reservoir air pressure then flows by the open inlet valve, through the passage in the piston and out the unloader port to the compressor unloading mechanism. The air, besides flowing to the compressor unloading mechanism, also flows around the piston and acts on the additional area of the piston, assuring positive action and fully opening the inlet valve.

As the system reservoir air pressure drops to the cut-in setting of the governor, the force exerted by the air pressure on the piston will be reduced so that the pressure setting spring will move the piston down. The inlet valve will close and the exhaust will open. With the exhaust open the air in the unloader line will escape back through the piston, through the exhaust stem and out the exhaust port.

SERVICE CHECKS

Operating Tests

Start the vehicle engine and build up air pressure in the air brake system and check the pressure registered by a dash or test gauge at the time the governor cuts out, stopping the compression of air by the compressor. The cut-out pressure should be in accordance with the piece number of the governor. The more common cut-out pressures vary between 724.-862 kPa (105-125psi.)

With the engine still running make a series of brake applications to reduce the air pressure and observe at which pressure the governor cuts in the compressor. As in the case of the cut-out pressure, the cut-in pressure should be in accordance with the governor piece number. Common cut-in pressures vary between 552-690 kPa (80-100 psi). Never condemn or adjust the governor pressure settings unless they are checked with an accurate test gauge or a dash gauge that is registering accurately. If the pressure settings of the governor are inaccurate or it is necessary that they be changed, procedure is as follows.

First, unscrew the cover at the top of the governor. Next, loosen the adjusting screw lock nut. With a screwdriver the adjusting screw is turned counterclockwise to raise the pressure setting and the screw is turned clockwise to lower the pressure setting. After the adjustment is completed, the adjusting screw lock nut should be tightened to lock this adjustment.

Leakage Tests

Leakage checks on the D-2 governor are made at its exhaust port in both cut-in and cut-out positions. In the cut-in position check exhaust port for inlet valve leakage by applying a soap solution at the port. Leakage could also be past the bottom piston grommet. In the cut-out position check the exhaust port to determine leakage at the exhaust valve seat or stem grommet. In this position leakage could also be past the upper piston grommet.

Leakage in excess of 25 mm (1 in.) soap bubble in 3 seconds is not permissible in either of the foregoing tests. If excess leakage is found, the governor must be repaired or replaced.

REMOVE

Apply parking brakes or block wheels to prevent vehicle from moving.

Drain air brake system.

If governor is compressor-mounted type, disconnect reservoir air line. If remote-mounted governor, disconnect both the unloader and reservoir air lines.

Remove governor mounting bolts, then governor.

INSTALL

If compressor-mounted type governor, clean mounting pad on both compressor and governor block. Clean connecting line or lines. Also be sure compressor unloading port is clear and clean.

If the governor is being mounted remotely, it should be positioned so that its exhaust port points down. It should be mounted higher than the compressor so that its connecting lines will drain away from the governor.

Install governor.

If compressor-mounted type, use a new governor mounting gasket.

Connect air lines to governor. Test governor as outlined under SERVICE CHECKS.

DISASSEMBLY

Clean governor exterior of road dirt and grease using a good cleaning solvent and brush.

Unscrew the top cover.

With a pair of retaining ring pliers remove the spring assembly retaining ring.

Remove the adjusting screw and spring assembly.

Remove the lock nut, then the hex-shaped upper spring seat from the adjusting screw.

Remove the pressure setting spring, lower spring seat, spring guide and the other lower spring seat from the adjusting screw.

Remove the exhaust stem and its spring from the top of the piston.

With the body in the inverted position tap it lightly and the piston should fall out.

Remove the inlet and exhaust valve spring and the valve from the piston.

Remove the two piston grommets and with a hooked wire remove the exhaust stem grommet.

Clean or remove the unloader and reservoir port filters.

CLEANING AND INSPECTION

Clean all metal parts in a good cleaning solvent.

Wipe rubber parts dry.

Inspect body for cracks or other damage. Be particularly careful that the body air passages, the filters, exhaust stem and piston are not obstructed.

Check springs for cracks, distortion or corrosion.

Replace all parts not considered serviceable during these inspections.

SUBTITLE HERE!!!

REASSEMBLY, ADJUST AND TEST

Prior to assembly, lubricate the lower body bore, the top of the piston, the piston grooves, piston grommets, a piston setting spring guide and adjust screw using Item 1 in LUBRICANT SPECIFICATIONS.

Install the exhaust stem grommet in its groove in the stem bore of the piston.

Drop the inlet and exhaust valve into place at the bottom of the piston.

Install the inlet valve spring with its narrow end against the valve. Press the spring down until the large coiled end snaps into the groove inside the piston.

Position the exhaust stem spring over the exhaust stem. Then carefully press the stem into the stem bore of the piston.

Install the piston in the body.

Install one lower spring seat, spring guide, the other lower spring seat, pressure setting spring and the hexshaped upper spring seat on the adjusting screw, in that order. Screw the upper spring seat down until the dimension from the top of the seat to the bottom of the stem head is approximately 47.6 mm (1-7/8 in).

Install the lock nut.

Before placing the adjusting screw and stem assembly in the governor body, check to be sure the exhaust stem and its spring are in place in the piston.

Install the adjusting screw and spring assembly retaining ring.

At this point make the adjustment as outlined under SERVICE CHECKS.

After the adjustment is made, the top cover should be screwed on tightly until it seals the body against the entrance of any foreign matter.

If necessary, install new filters in the reservoir and unloader ports. These cup-shaped filters can be installed with head of a pencil.

Perform operating and leakage tests as outlined in SERVICE CHECKS section when checking rebuilt governor.

MAINTENANCE

40,000 km or 25,000 MILES

Clean or replace governor filters. If cleaning use a cleaning solvent which is known to have no detrimental effect on metal or rubber material.

160,000 km or 100,000 MILES

Disassemble the governor and clean and inspect all parts and replace as necessary.

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CHAPTER II

RESERVOIR, DRAIN COCK, SAFETY VALVE, PRESSURE GAUGE, LOW PRESSURE INDICATOR, STOP LIGHT SWITCH, RESERVOIR AUTOMATIC DRAIN VALVE

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CHAPTER II

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RESERVOIR

DESCRIPTION

The air reservoir (air tank) function is to provide a volume of compressed air used in braking the vehicle.

There are at least three reservoirs on trucks with the FMVSS 121 brake system. These tanks are supply reservoir and secondary and primary reservoirs. The primary reservoir is the air source for the rear brakes and the front brakes are supplied by the secondary air tank. In some instances, the supply reservoir and secondary reservoir may be in the same tank with a separation inside the tank (Fig. 1).

Another function of a reservoir is to provide a place where the air, heated during compression, may cool and cause the oil and water vapors to condense.

The combined volume of all service reservoirs and supply reservoirs are 12 times the combined volume of all service brake chambers at maximum travel of the pistons or diaphragms. The size of air tanks should never be altered without IH Engineering approval.

The reservoirs should be completely drained daily. If an automatic drain device is used, as shown in Fig. 1, the automatic drain should be checked periodically to determine if it is functioning properly. When manually draining tanks, satisfactory draining is only accomplished by leaving the drain cocks open after all air has escaped and all drainage has stopped.

Reservoirs are tested against a 2068 kPa (300 psi) and treated on the inside with a rust preventive.

SERVICE CHECKS

- Leakage Tests. With the air brake system charged, use Leak Detector Tester (SE-2326) to check for leakage on outside surfaces of reservoirs. If any leakage is found, replace the reservoir.
- Inspection. Inspect inside and outside surfaces for damage or corrosion. A small flashlight is helpful when inspecting the interior. If damage or corrosion is found that would weaken the reservoir, replace the reservoir.
- 3. Moisture taken in with the air through the compressor inlet valve collects in the reservoirs

and necessitates draining the reservoirs daily in cold weather and every week in warm weather by opening the drain cock located on the bottom. Be sure to close the drain cocks after all moisture has been removed.

MAINTENANCE

Drain air reservoirs regularly as required.

Local conditions govern frequency. In dry climates, for example, once a month may be sufficient, while in humid areas it may be necessary to drain reservoirs daily.

When draining the air reservoirs, open the drain cock and let the air bleed off. Be sure to leave the cock open until all drainage stops.

DRAIN COCK

DESCRIPTION

Drain cocks have a brass body fitted with a tapered brass key. The drain cock is open when the handle is parallel to the body and closed when the handle is at right angles to the body. Drain cocks are installed in the bottom of each reservoir (Fig. 1) in the air brake system to provide a convenient means of draining the condensation which normally collects in the reservoirs.

Always open a drain cock by hand. Never strike the handle with a hammer or any other instrument, as the cock will be damaged and leakage will develop.

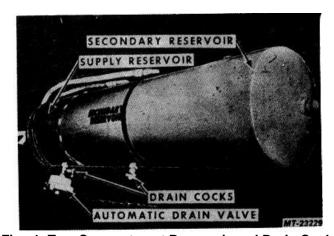


Fig. 1 Two Compartment Reservoir and Drain Cock

SERVICE CHECKS

- With air brake system charged, test with soap suds for leakage past the key. Also check for leakage through the body by coating the outside of the drain cock with soap suds. Leakage in excess of a 77 mm (3") soap bubble in 3 seconds is not permissible.
- Leakage is caused by dirty or scored key or body. Leakage due to dirt is corrected by cleaning parts and applying a thin coating of Item 1 in LUBRICANT SPECIFICATIONS on the key. Leakage due to a scored key or body cannot be repaired and the drain cock must be replaced.

SAFETY VALVE

DESCRIPTION

The purpose of the safety valve is to protect the air brake system against excessive air pressure. Should the air pressure in the air brake system rise above the setting of the safety valve at 934 kPa (150 psi), the valve opens and permits pressure above 934 kPa (150 psi) to be exhausted. It is located on the supply reservoir.

The safety valve is a piston type valve (Fig. 2). The piston is equipped with an O-ring type seal which seats in the body of the valve.

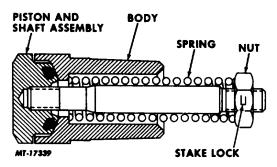


Fig. 2 Sectional View of Piston Type Safety Valve

MAINTENANCE

Once each year or every 160,000 km (100,000 miles), the safety valve should be removed and thoroughly cleaned.

SERVICE CHECK

Leakage Test

Leakage at the piston in the body should not exceed a 77 mm (3 in.) soap bubble in 3 seconds. If air leakage is excessive the valve must be replaced since it is only serviced as a complete component. The safety valve is preset to "blow off" at approximately 934 kPa (150 psi).

Since the safety valve must be removed to perform any adjustments, it is suggested that the valve be replaced when any defect is detected.

CAUTION

When replacing the safety valve be sure to drain all air from the supply reservoir, to prevent bodily injury when the valve is removed. Draining of the primary and secondary reservoirs is not required since they are protected by check valves.

AIR PRESSURE GAUGE

DESCRIPTION

The purpose of the air pressure gauge is to register the amount of reservoir air pressure in the air system. While air pressure gauges of this type are commercially accurate, they must never be confused with or substituted for test air gauges, which are intended primarily for accurately checking air pressure in the air brake system.

The air pressure gauge may be either two gauges or a single gauge with two indicators as illustrated (Fig. 3).

An air pressure gauge is located in both the primary and secondary brake systems so that the actual air pressure in both systems is indicated to the operator of the vehicle.

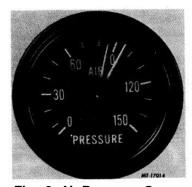


Fig. 3 Air Pressure Gauge

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Only test gauges known to be accurate are to be used for checking brake valve delivery pressures, governor pressure settings and other tests. Test gauges differ from ordinary dash gauges in respect to material and workmanship. Due to these differences they are more accurate over entire range and maintain their accuracy over longer periods.

After initial starting of engine, if air gauge shows that one circuit has no air pressure nor a noticeable increase in air pressure within a reasonable length of time (30 to 60 seconds) and the low pressure switch and low pressure light will not shut off, this indicates an open drain cock or a failure in the brake system.

It is not compulsory but it is advisable that vehicles be inspected to be sure that the air gauges are properly connected. The primary system should be connected to the green needle and secondary system to red needle. This can easily be checked by charging the air system, bleeding off the primary system (rear brake reservoir) and the green needle should drop. If the green needle does not drop the air lines on the gauge should be changed. All chassis would be assured that they are connected in the same manner and identification of both systems will be uniform.

SERVICE CHECKS

- Check the air gauge for accuracy. The simplest way do do this is to compare the pressures registered by the gauge over its normal pressure range with the pressure registered by a test gauge known to be accurate.
- A gauge which loses its accuracy must be replaced. The continued use of a dash gauge showing an error of more than 35 kPa (5 psi) is not recommended.

LOW PRESSURE INDICATOR(LP-3 TYPE)

DESCRIPTION

The low pressure indicator (Fig. 4) is a safety device designed to give an automatic warning whenever the air pressure in the primary or secondary air brake system is below approximately 483 kPa (70 psi). Operating as an air-controlled switch of an electrical circuit, the low pressure indicator automatically sounds a buzzer when the air pressure drops too low. The warning will be both visible (light) and audible (buzzer).

The nominal pressure setting of 483 kPa (70 psi) is subject to a tolerance of plus or minus 41 kPa (6 psi) so that the actual operating pressure of the low pressure

indicator may vary between 524 kPa (76 psi) maximum to 441 kPa (64 psi) minimum.

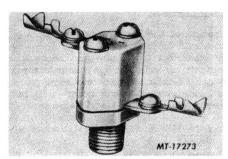
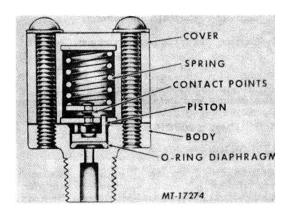


Fig. 4 Exterior View of Low Pressure indicator

OPERATION (Fig. 5)

To describe the operation, we shall assume the Low Pressure Indicator is set for 483 kPa (70 psi). Setting of indicator is marked on a label on valve body. When air pressure at supply port and under the diaphragm is above 483 kPa (70 psi), electrical contacts remain open because the force exerted by air pressure underneath the diaphragm overcomes force exerted by the spring above the diaphragm.

When air pressure below the diaphragm drops below 483 kPa (70 psi), the spring exerts a force which is greater than the force exerted by the air pressure below the diaphragm. This causes the piston to move and allow the electrical contacts to close. This completes or closes electrical circuit to warning device, warning driver of low air pressure in the system.



MAINTENANCE

Every three months or after 40,000 km (25,000 miles), check electrical connections.

Every year or 160,000 km (100,000 miles), perform SERVICE CHECKS. If diaphragm is ruptured, replace complete assembly.

SERVICE CHECKS

Operating Test

Operation of the low pressure indicator may be checked with ignition switch on, then by reducing the reservoir pressure and being sure that the contacts close when the reservoir pressure is between 524 kPa (76 psi) maximum and 441 kPa (64 psi) minimum. The contacts will be closed when warning light or electrical buzzer operates.

Leakage Test

A small vent hole is provided in the cover of the low pressure indicator to check the condition of the diaphragm. Cover the vent hole with soap suds or use Leak Detector (SE-2326); if a leak is indicated, it signifies a ruptured diaphragm. Replace complete assembly.

REMOVE

- 1. The ignition switch should be in the "off" position.
- 2. Drain the air from the system.
- 3. Disconnect the electrical connections at the Low Pressure Indicator.
- 4. Remove the Indicator from fitting.

REINSTALL

- Install indicator in fitting where old indicator was removed.
- 2. Connect electrical connections.
- 3. Charge air system and perform Leakage Test.

Disassembly and reassembly of Low Pressure Indicator is not recommended since it is only serviced as a complete assembly.

STOP LIGHT SWITCH

DESCRIPTION

The stop light switch (Fig. 6) is an electropneumatic switch which operates in conjunction with the brake valve and stop lights by completing the electrical circuit when a brake application of 35 kPa (5 psi) or more is made.

Both the primary and secondary brake systems are equipped with a stop light switch on a straight truck. If a

failure should occur in either the primary or secondary systems, the system which is functioning properly will provide stop lights when the brakes are applied.



Fig. 6 Stop Light Switch

On tractor-type vehicles a single stop light switch is mounted in a double check valve (Fig. 7) between the primary and secondary brake systems and tractor protection valve. When air is applied to both sides (primary and secondary systems) the air pressure will apply the stop light switch and at the same time pass air through the check valve assembly. If a failure should occur in either system the shuttle will shift closing off any air supply to the failed system at the same time the air pressure will close the stop light switch completing the electrical circuit for the stop lights.

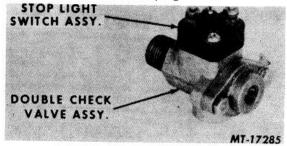


Fig. 7 Stop Light Switch Mounted On A Double Check Valve

Refer to Chapter III for detailed information pertaining to double check valve with stop light switch.

MAINTENANCE

Every three months or every 40,000 km (25,000 miles, check all electrical connections.

Every year of 160,000 km (100,000 miles), the stop light switches should be replaced.

SERVICE CHECKS

Operating Tests

1. Both stop light switches must be checked

- independently on a straight truck to be sure both are functioning. Disconnect one switch.
- 2. Apply brake valve and note that with first downward movement of pedal or treadle that the stop lights go on immediately.
- Release brake valve and note that stop lights of off.
- 4. If lights fail to go on use a test light at stop light connections. Test both terminals to determine if an electrical supply is available at switch; then "bypass" the switch with test light or jumper wire. Lights should go on. If not, a failure in the electrical circuit is the problem. However, if lights work, replace stop light switch.
- 5. Repeat item 4 to check second light switch.

Leakage Test

With brakes applied there should be no air leakage at stop light switch.

REMOVE

- Disconnect electrical connections. Be sure to keep electrical connections from frame, etc. Tape them.
- 2. Remove switch from air fitting.

INSTALL

- 1. Install stop light switch in air fitting.
- 2. Install electrical connections.
- After stop light switch is reinstalled, perform SERVICE CHECKS.

RESERVOIR AUTOMATIC DRAIN VALVE

DESCRIPTION

The DV-2 Reservoir Automatic Drain Valve ejects moisture and contaminants from the reservoir in which it is connected. It operates automatically and requires no manual assistance or control lines from other sources.

The reservoir automatic drain valve has a die cast aluminum body and cover and is normally mounted either in the bottom of the reservoir using the top port of the drain valve or in the end of an end drain reservoir using the side port of the valve.

For vehicles operating in subfreezing temperatures, the valve is also available with a heater and thermostat cast into the cover.

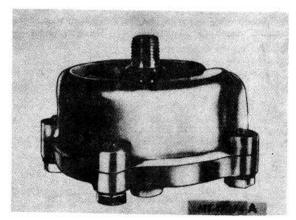


Fig. 8 Reservoir Automatic Drain Valve

OPERATION

With no air pressure in air system, the inlet and exhaust valves are closed (Fig. 9).

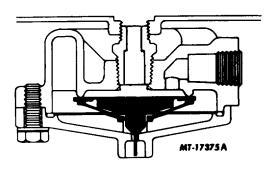


Fig. 9

When charging the air system, a slight pressure opens the inlet valve which permits air and contaminants to collect in sump (Fig. 10).

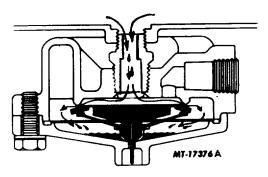
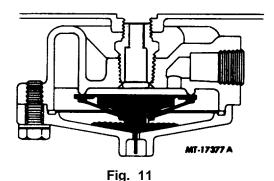
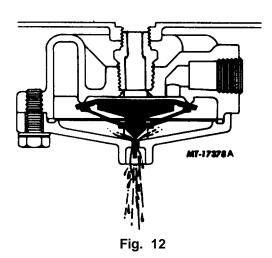


Fig. 10

The inlet valve remains open while pressure ascends in the system until maximum governor cut-out pressure is reached. The spring action of valve guide in sump cavity closes the inlet. The inlet valve and exhaust valve are now closed (Fig. 11).



When reservoir pressure drops slightly (approximately 13.8 kPa - 2 psi), air pressure in the sump cavity opens exhaust valve allowing moisture and contaminants to be ejected from sump cavity until pressure in sump cavity drops sufficiently to close the exhaust valve. The length of time the exhaust valve remains open and the amount of moisture and contaminants ejected depends upon the sump pressure and reservoir pressure drop that occurs each time air is used from the system.



Manual draining can be accomplished by inserting a tool in the exhaust port so that the wire in the port may be moved up and held until draining is completed.

The heated automatic drain valve will activate the heating element when the valve body is warmed to 30 C (85 F).

MAINTENANCE

Every six months or every 80,000 km (50,000 miles) the automatic drain valve should be removed, disassembled, cleaned and lubricated. Parts showing signs of wear or deterioration should be replaced.

IMPORTANT

Early production automatic reservoir drain valves were equipped with a filter.

Whenever service of any nature is performed on the chassis, this filter may be removed and discarded, if desired.

SERVICE CHECKS

Operating Test

With system charged, make several foot valve applications and note each time an application is made if an exhaust or air occurs at exhaust port of the drain valve. If no air comes out, push the wire stem. If no air comes out, the filter is plugged and valve should be removed and cleaned.

Leakage Test

With system charged and pressure stabilized in system, there should be no leaks at the drain valve exhaust. A constant slight exhaust of air at the drain valve exhaust could be caused by excessive leakage in the air brake system.

If the automatic drain valve does not function as described or if leakage is excessive, it is recommended that it be removed and repaired or replaced.

REMOVE

- 1. Set parking brake or block vehicle while service is being performed.
- 2. Drain air system.
- 3. Disconnect heater wire if valve is so equipped.
- Remove automatic reservoir drain valve.

REINSTALL

- Block and hold vehicle by means other than air brakes.
- 2. Drain air system.
- 3. Thoroughly flush and clean reservoir before installing drain valve.
- 4. Aerate any tank thoroughly if any solvents have been used in the cleaning process.

When installing the reservoir automatic drain valve equipped with a heater and thermostat, first determine if the vehicle electrical system is a 12-volt or 24-volt and that the heater/thermostat unit is of the same voltage. The No. 14 gauge lead wire on the valve should be connected to the "on" position of the engine control or ignition switch. Use an 8-amp fuse for one valve, a 15-amp fuse for two valves and a 20amp fuse for three valves. All electrical connections must be waterproof.

DISASSEMBLY

Refer to Fig. 13 for disassembly of valve and proceed as follows:

- 1. Remove four capscrews and lockwashers.
- 2. Remove cover and sealing ring.

If the heater or thermostat has failed, the entire cover must be replaced. Do not remove the thermostat cover plate. It is moisture sealed and removal could result in early thermostat failure.

- 3. Remove valve guide.
- 4. Remove inlet and exhaust valve.
- 5. Remove adapter assembly.
- If the automatic drain valve is equipped with a filter and retainer, they may be discarded if desired.

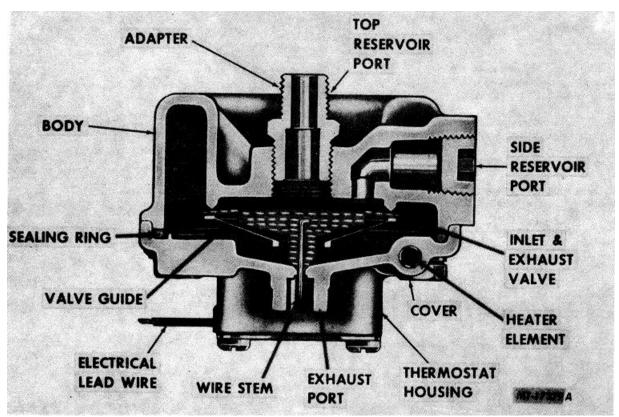


Fig. 13 Sectional View of Reservoir Automatic Drain Valve

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CLEANING AND INSPECTION

- 1. Cleaning solvent may be used on metal parts.
- 2. Rubber parts should be wiped clean.
- 3. Inspect all parts for wear or deterioration.

Replace all parts not considered serviceable during these inspections.

REASSEMBLY

For the assembly of valve, refer to Fig. 13 and proceed as follows:

Before assembling the valve, apply a light film of grease on inlet valve seat. Do not apply oil to the inlet and exhaust valves.

- 1. Place sealing ring in groove of cover.
- Place valve guide over inlet and exhaust valves.
- 3. Place valve guide and inlet and exhaust assembly into cover (wire will project through exhaust port).
- 4. Place body on cover and install capscrews and lockwashers.
- 5. Install adapter assembly in body and tighten.
- 6. Install drain valve in reservoir and reconnect heater wire if drain valve is so equipped.

Covers on the standard and heated drain valves can be interchanged.

Before returning the vehicle back to service, perform SERVICE CHECKS as outlined.

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CHAPTER III

CHECK VALVES, PRESSURE PROTECTION VALVE AND PRESSURE REDUCING VALVE

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CHAPTER III

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ONE WAY CHECK VALVE

DESCRIPTION

The one-way check valves (Fig. 1 and 2) are used to permit passage of air pressure through the valve in one direction only as indicated by the arrow on the side of the valve. They are installed in both primary and secondary reservoirs to maintain the air supply in both reservoirs if an air loss should occur ahead of the valve.

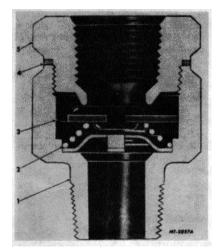


Fig. 1 Cross Sectional View of One-Way Check Valve.

Legend for Fig. 1

Key	<u>Description</u>	Key	<u>Description</u>
1	BODY, Valve	4	WASHER, Cap-to-Body
2	SPRING	5	CAP, Valve

3 SEAL, Assembly

The 900 angle check valve shown in Fig. 2 is used in applications where clearance conditions exist on various chassis.

OPERATION

Air flow in direction of arrow moves the seal from its seat and the air flow is unobstructed. Flow in reverse direction is prevented by seating of the seal by the upstream air pressure and assistance of spring.

MAINTENANCE

Once each year or every 160,000 km (100,000 miles) check operation (see SERVICE CHECKS).

SERVICE CHECKS

Depending upon installation, it may be easier or necessary to completely remove check valve so that the following checks may be made. If checking valves at primary and secondary reservoirs, bleed air supply reservoir and disconnect air inlet to valve and proceed as follows.

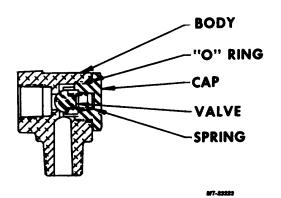


Fig. 2 90° Angle check Valve.

CAUTION

Be sure to set parking brake or block wheels to prevent vehicle from moving.

With air pressure present at outlet side of check valve and inlet open to atmosphere, use leak detector tester to test for leakage. Leakage should not exceed 25.4 mm (1 in.) soap bubble in 5 seconds, slight leakage is permitted. However, if valve leaks excessively, the valve should be repaired or replaced.

REMOVE

- 1. Apply parking brake or block wheels to prevent vehicle from moving.
- 2. Drain all air reservoirs.
- 3. Disconnect air lines and remove check valve.

REINSTALL

- Check and, if required, clean or replace air line to valve.
- 2. Install valve making certain that it is installed correctly. Arrow on outside of body indicates direction of air flow through valve.
- 3. Check valve for leakage.

DOUBLE CHECK VALVE

DESCRIPTION

Double check valves or two-way check valves (Fig. 3) are used in an air brake system where it is necessary to automatically direct the flow of air pressure into a common line from either of two other lines.

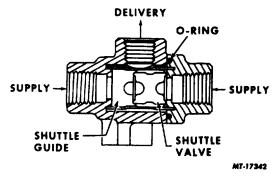


Fig. 33 Sectional View of Double check Valve Shuttle Type.

OPERATION

As air pressure enters either end of the double check valve (inlet port) the movable shuttle responds to the air pressure and seals the line on opposite inlet port, but permitting air pressure to flow out the delivery (outlet) port. The same action takes place if air pressure on one side of shuttle is higher than that on the other side'. It is not necessary for the cavity of one side of shuttle to be exhausted for valve to operate. Double check valves are designed so it is impossible for shuttle to block outlet port.

Refer to GENERAL Section, CTS-2668, (Figs. 1 through 5) for application of double (two-way) check valves.

MAINTENANCE

Once each year or every 160,000 km (100,000 miles) remove, disassemble, clean and inspect all parts. Install new parts if signs of wear or deterioration are apparent.

SERVICE CHECKS

Due to the various applications of double check valves it is best to bench test the valve using two separately controlled air supplies and connected to inlet ports.

- 1. Install an accurate test gauge in outlet port or in a line from outlet port.
- 2. Apply and release air to one inlet port and note that gauge registers application and release.
- 3. Repeat application and release of air to other inlet port.
- 4. Leakage check is performed at inlet ports by:
 - a. Disconnecting line from one inlet port.
 - b. Applying air to other inlet port. If soap solution is used to check leakage, leakage should not exceed 25.4 mm (1 in.) bubble in 5 seconds.
 - c. Repeat step "b" by applying air to other inlet port while checking opposite inlet port for leakage.
- 5. If check valve does not meet requirements, it should either be replaced or disassembled and repaired using new parts.

DISASSEMBLY

- 1. Remove end cap from valve.
- 2. Remove O-ring.
- 3. Remove shuttle (piston) and guide.

CLEANING AND INSPECTION

- 1. Clean all metal parts in cleaning solvent.
- 2. Inspect all parts for signs of wear or deterioration. Replace all parts not considered serviceable.
- 3. Replace all rubber parts.

REASSEMBLY

- 1. Install shuttle guide and shuttle.
- 2. Position new O-ring in end cap.
- 3. Install end cap.
- 4. Perform operating and leakage as described in SERVICE CHECKS.

DOUBLE CHECK VALVE WITH STOP LIGHT SWITCH (Fig. 4)

DESCRIPTION

A double check valve with stop light switch is used in tractor-type vehicles at a point where both primary and secondary supply lines from the brake valve will apply pressure to the tractor protection valve (refer to GENERAL section, Figs. 3 and 4).

The basic operation of the double check valve operation feature performs the same as the DOUBLE CHECK VALVE previously discussed. However, the stop light has been added to the valve.

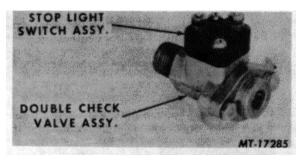


Fig. 4 Double Check Valve with Stop Light Switch.

MAINTENANCE

Every three months or 40,000 km (25,000 miles) check electrical connections.

Once each year or every 160,000 km (100,000 miles) remove, disassemble, clean and inspect all parts, including stop light switch. Install new parts if signs of wear or deterioration are apparent.

SERVICE CHECKS

Double Check Valve

Refer to SERVICE CHECKS pertaining to double check valve without the stop light feature. Stop Light Switch

- 1. Apply brake valve and note that with the first downward movement of pedal or treadle that the stop lights' go on immediately.
- 2. Release brake valve and the stop light should go off.
- 3. If lights fail to go on during brake application, use a test light at connections of switch. Test both terminals to determine if an electrical supply is available at switch. Then "bypass" the switch with a test light or jumper wire. Lights

should go on. If not, the failure is in electrical system. If lights "turn on," replace or repair stop light switch.

REMOVE

- 1. Disconnect electrical connections. Be sure to keep electrical connections from contacting frame, etc. Tape connections.
- 2. Disconnect air lines from check valve.

REINSTALL

- Before installing, perform SERVICE CHECKS (see DOUBLE CHECK VALVE without stop light switch).
- 2. Connect air lines to check valve.
- 3. Connect electrical connections.
- 4. Perform a service check of stop light switch.

DISASSEMBLY

- Remove two stop light screws; then remove cover.
- 2. Remove piston spring contact assembly, piston and diaphragm.
- Remove valve end cover.
- 4. Remove shuttle (piston) and shuttle guide from body.

CLEANING AND INSPECTION

- 1. Clean all metal parts in cleaning solvent.
- Inspect all parts for signs of wear or deterioration. Replace all parts not considered serviceable. Note contacts of stop light switch assembly and terminal screws.
- 3. Replace all rubber parts.

REASSEMBLY

- 1. Insert shuttle guide and piston on body.
- 2. With a new O-ring in end cover, install cover.
- 3. Position new diaphragm in body.
- 4. Position new gasket on valve body, then stop light switch piston. Note that the two notches are aligned with opposite corners of screw holes.

- 5. Position contact assembly on piston. Note the pin on piston aligns with contact assembly.
- Carefully position spring in cover and position cover and spring on valve body. Compress assembly and install screws.
- 7. Perform service checks on complete assembly as outlined in SERVICE CHECKS.

PRESSURE PROTECTION VALVE

DESCRIPTION

The pressure protection valve is designed to close off air supply to any air operated device as long as the air supply is below a specified rating.

The rating of the valve used in the FMVSS-121 air system is 448-517 kPa (65-75 psi).

It is important that this valve be installed when any auxiliary attachments are installed on a vehicle to avoid complete loss of air in the event of an air leak in any of the air operated attachments.

For information regarding the installation of the pressure protection valve, refer to the Body Builders Chassis Diagram Book, CT-732.

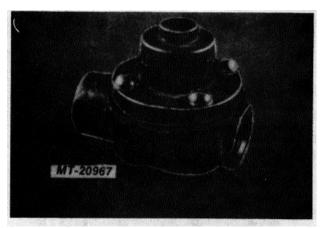


Fig. 5 Pressure Protection Valve.

OPERATION

As long as the air supply pressure is below 448-517 kPa (65-75 psi) the spring will hold the diaphragm on its seat restricting the air flow through the valve.

When the air supply pressure overcomes the spring force, the diaphragm will move off the seat and allow air to flow through the valve and to the auxiliary equipment used on the vehicle.

If air pressure should fall approximately 138 kPa (20 psi) below the opening pressure, the spring force will overcome the air pressure and force the diaphragm on it's seat closing off the air supply, protecting the air system from a complete loss of air through usage of the auxiliary equipment.

MAINTENANCE

Once each year or 160,000 km (100,000 miles) remove the pressure protection valve, disassemble it and clean all parts.

Replace the diaphragm if it is worn or deteriorated.

SERVICE CHECKS

Be sure the vent hole is not obstructed.

Bleed off main air supply.

Disconnect the air outlet side of valve, apply an air pressure gauge known to be accurate with a shut-off valve. Start engine and allow air pressure to build up. Observe gauge on instrument panel and at valve outlet.

You should not have air pressure at test gauge until main air reservoir pressure reaches 448-517 kPa (65-75 psi). Then the pressure protection valve opens and both test gauge and gauge on vehicle should record approximately the same.

Stop engine and open the shut-off valve at test gauge. Air should exhaust until air pressure on vehicle reaches a pressure at approximately 138 kPa (20 psi) below opening pressure then stop.

If the valve performs as described the valve is functioning properly.

Bleed off main air reservoir pressure and remove shut-off valve and test gauge. Reconnect line to the auxiliary equipment.

REMOVE

Be sure to bleed off air reservoir pressure.

Disconnect air line routed to auxiliary fixture.

Remove pressure protection valve from connector.

REINSTALL

Install the pressure protection valve on same fitting valve as was removed.

Connect air line routed to auxiliary fixture.

Build up air supply and check connections for air leaks.

DISASSEMBLY (Refer to Fig. 6)

 Remove the four screws retaining upper and lower body sections together. Care must be taken while removing screws as the spring force will separate the upper and lower bodies.

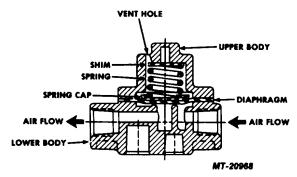


Fig. 6 Cross Section of Pressure protection Valve.

Remove diaphragm spring cap or diaphragm protector, spring and shim from upper body. Be sure to retain shim which is used to adjust the pressure regulation of the valve.

CLEAN AND INSPECTION

- Clean all parts in good cleaning solvent. Make sure vent hole in upper valve body is not obstructed.
- 2. Inspect diaphragm, especially at lower contact area.
- Replace any parts that show wear or spring if distorted.
- 4. Inspect the diaphragm seat for pitting or nicks. The seat should be smooth, if not, it may be dressed with emery cloth. Replace complete valve assembly if excessive pitting is found.

REASSEMBLY (Refer to Fig. 6)

- Position the shim if used in the upper body.
 The same number of shims should be used to obtain proper pressure adjustment.
- 2. Position spring, spring cap and diaphragm on upper body.
- 3. Place lower body over the assembly and force the two body halves together.
- 4. Turn assembly over and install screws.
- 5. Test repaired valve assembly.

TEST REPAIRED VALVE

Prior to installing the repaired valve assembly the valve should be tested for leakage and proper adjustment.

Assemble air gauge and shut-off valve at inlet and outlet of pressure protection valve then connect to shop air source. Open shut-off valve at outlet of pressure protection valve and slowly open shut-off valve at air source until air pressure reaches 379 kPa (55 psi). Check for air leakage with soap solution at outlet. Leakage must not exceed 90 cc per minute (1 in. soap bubble in 6 seconds).

Close the shut-off valve at outlet and increase air pressure at inlet side of pressure protection valve. No air pressure at outlet air gauge should be available until pressure re-reaches 448-517 kPa (65-75 psi) at inlet. Then both gauges should equalize.

If pressure protection valve opens prior to 448 kPa (65 psi) add shim to valve and if valve remains closed after 517 kPa (75 psi) is obtained remove shim After valve has been tested and meets requirements, it is ready to be installed on vehicle.

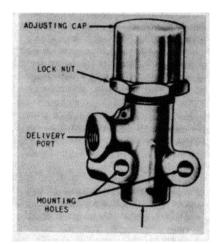


Fig. 7 Pressure Limiting Valve.

PRESSURE REDUCING (LIMITING) VALVE

DESCRIPTION

The pressure reducing (limiting) valve is used to reduce air pressure and maintain it at a constant specified pre-set pressure below that of the supply pressure (Fig. 7). The pressure reducing valve has a delivery port on the side and a supply port on the bottom. Two mounting holes are cast into the body. A lockwire and seal are optional for a tamper proof setting.

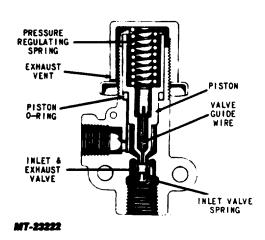


Fig. 8 Cross Section of Pressure Limiting Valve

OPERATION (Refer to Fig. 8)

The pressure setting of the pressure limiting valve is determined by the setting of the adjusting cap, which exerts a force on the spring on top of the piston. Compressed air enters the supply port and passes out the delivery port. When the air pressure on the bottom of the piston overcomes the force of the spring on top of the piston, the piston moves upward and the inlet valve spring forces the inlet valve on its seat, closing off the supply of air. As the pressure in the delivery line drops, the force of the spring above the piston becomes greater than the air pressure below the piston, allowing the piston to move downward, moving the inlet valve off its seat and allowing air to pass out the delivery port.

If pressure in the delivery line exceeds the pressure setting of the pressure limiting valve, the force exerted by the air pressure below the piston will be greater than the spring force above the piston. The piston will move up from the exhaust valve, permitting air to pass by the exhaust valve, through the hollow piston and valve guide and escape through the slot in the adjusting cap. When the force of the spring above the piston overcomes that of the air pressure below the piston, the exhaust valve is seated, and the pressure in the delivery line is the same as the setting of the pressure reducing valve.

MAINTENANCE

Every 6 months or 80,000 km (50,000 miles). Connect a test gauge to the delivery line and observe at what pressure the inlet valves closes, which is the

delivery pressure. If the pressure delivered by the pressure reducing valve varies delivered by the pressure reducing valve varies more than plus or minus 35 kPa (5 psi) from the pressure setting of the pressure reducing valve, the valve should be adjusted. The lock nut should be tightened after each adjustment and lockwire seal replaced if used.

Every year or every 160,000 km (100,000 miles) perform the SERVICE CHECKS.

SERVICE CHECKS

Operating Check

Connect an accurate test gauge to the delivery line and observe what pressure the inlet valve opens which is the delivery pressure. If delivery pressure varies more than 35 kPa (5 psi), adjust the valve to the specified setting. To raise the delivery pressure the adjusting cap should be turned clockwise. Tighten locknut after each adjustment and replace lockwire and seal if used.

Leakage Check

No leakage is permitted at the exhaust vent in the slot of the adjusting cap when making the operating check. Leakage at this point would indicate a leaking piston O-ring or a leaking exhaust valve seat.

If the pressure limiting valve does not function as described or leakage is excessive, it is recommended that it be replaced.

REMOVE

Apply parking brakes or block wheels to prevent vehicle from moving.

Drain service and isolated reservoirs.

Disconnect air lines from the pressure reducing valve.

Loosen valve mounting bolts and remove.

REINSTALL

Check and clean air lines to valve.

Mount valve securely with bolts and lockwashers.

Reconnect lines to the valve.

Disassembly and reassembly of Pressure Limiting Valve is not recommended as it is serviced as a complete assembly.



CHAPTER IV

BRAKE VALVE

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BENDIX TYPE E6 & E7

DESCRIPTION

Two types of Bendix brake valves are used; they are treadle type (E6) and suspended type (E7).

The brake valve is the control unit of the air brake system. It provides the operator of the vehicle a means of applying or releasing the vehicle brakes. The brake valve can either be treadle operated or fitted with a suspended pedal lever.

Both the treadle and suspended brake valves are equipped with two separate supply and delivery circuits for service and emergency braking, providing the driver with a graduated control for applying and releasing the vehicle brakes.

The primary circuit is that portion of the valve between the spring seat which contacts the plunger and

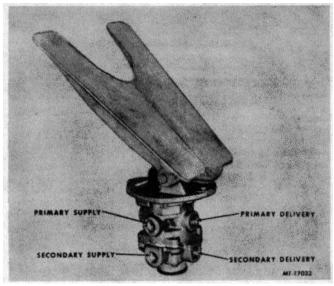


Fig. 1 Treadle Type Brake valve.

the relay piston. The secondary circuit is that portion between the relay piston and exhaust cavity.

The primary circuit is similar in operation to a standard single circuit air brake valve and under normal operating conditions the secondary circuit portion is similar in operation to the relay valve.

Both the primary and secondary circuits of the brake valve use a common exhaust check valve.

OPERATION

The text and illustrations contained herein actually pertain to the treadle type brake valve. The treadle and suspended type valves differ in that the suspended pedal valve is turned over and the valve body is equipped with an exhaust port at a 90 degree angle at the top to exhaust air out the side of the cab.

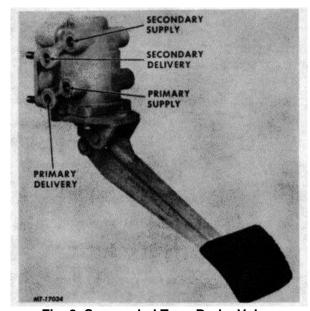


Fig. 2 Suspended Type Brake Valve.



Applying Normal Operation Primary Circuit Portion of Brake Valve (Fig. 3)

When the brake pedal is depressed, the plunger exerts force on the spring seat, rubber graduating spring and primary piston. The primary piston which contains the exhaust valve seat, closes the primary exhaust valve. As the exhaust valve closes, the primary inlet valve is moved off its seat allowing primary air pressure to flow out the primary delivery port.

<u>Applying Normal Operation Secondary Circuit Portion of</u> Brake Valve (Fig. 3)

When the primary inlet valve is moved off its seat, air is permitted to pass through the bleed passage and enters the relay cavity. The air pressure moves the relay piston and the relay piston, which contains the exhaust seat, closes the secondary exhaust valve. As the secondary exhaust valve closes, the secondary inlet valve is moved off its seat allowing secondary air pressure to flow out the secondary delivery port.

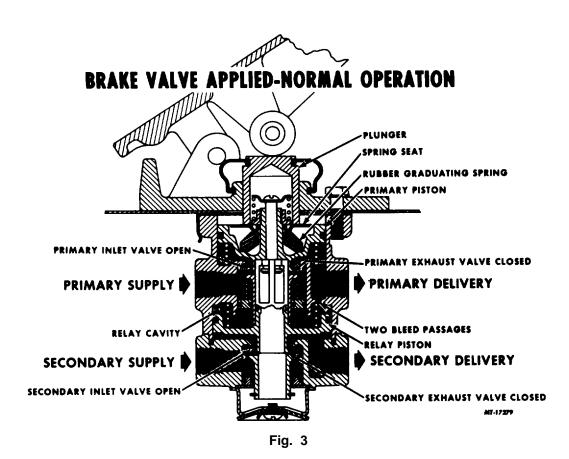
Because of the small volume of air required to move the relay piston, action of the secondary circuit portion of the valve is almost simultaneous with the primary circuit.

Application Loss of Air in Secondary Circuit (Fig. 4)

Should air be lost in the secondary circuit, the primary circuit portion will continue to function as described under "Normal Operation Primary Circuit."

Application Loss of Air in Primary Circuit (Fig. 5)

Should air be lost in the primary circuit, the function will be as follows. As the brake pedal is depressed and no air pressure is present in the primary circuit supply and delivery ports, the primary piston will mechanically move the relay piston allowing the piston to close the secondary exhaust valve and open the secondary inlet valve and allow air pressure to flow out the secondary delivery port.





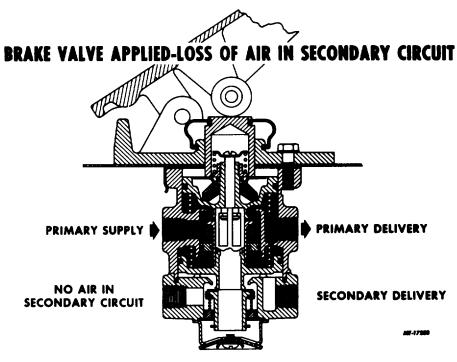


Fig. 4

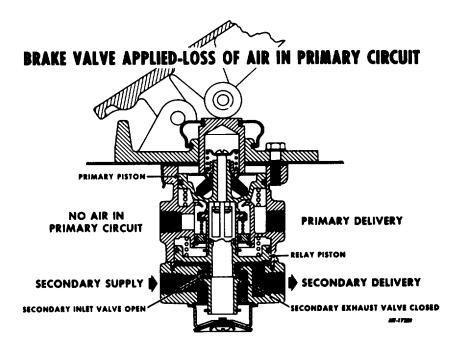


Fig. 5



Balanced Primary Circuit of Brake Valve (Fig. 6)

When air pressure delivered to the brake actuators and air pressure in the cavity of the delivery side of the primary piston equals the mechanical force of the brake pedal application, the primary piston will move and the primary inlet valve will close, stopping the further flow of air from the primary supply line through the valve. The exhaust valve remains closed preventing any escape of air through the exhaust port.

Balanced Secondary Circuit of Brake Valve (Fig. 6)

When the air pressure on the secondary side of the relay piston approaches that being delivered on the primary side of the relay piston, the relay piston moves closing the secondary inlet valve and stopping further flow of air pressure from the supply line through the valve. The exhaust remains closed as the secondary supply pressure balances the secondary delivery pressure.

When applications in the graduating range are made, a balanced position in the primary portion is reached as the air pressure on the delivery side of the primary piston equals the effort exerted by the driver's foot on the pedal or treadle.

A balanced position in the secondary portion is reached when air pressure on the secondary side of the relay piston closely approaches the air pressure on the primary side of the relay piston.

When the brake pedal or treadle is fully depressed, both primary and secondary inlet valves remain open and full reservoir pressure is delivered to the actuators.

Releasing Primary Circuit of Brake Valve (Fig. 7)

With the brake pedal released, mechanical force is removed from the spring seat, rubber graduating spring and primary piston. Air pressure and spring load move the primary piston, opening the primary exhaust valve, allowing air pressure in the primary delivery line to exhaust out the exhaust port.

Releasing Secondary Circuit of Brake Valve (Fig. 7)

With the brake pedal released, air is exhausted from the primary side of the relay piston.

Air pressure and spring load move the relay piston, opening the secondary exhaust valve, allowing air pressure in the secondary delivery line to exhaust out the exhaust port.

MAINTENANCE

Every Three Months or 32,000 km (20,000 Miles)

Clean any accumulated dirt, gravel or foreign matter away from heel of treadle, plunger boot and mounting plate.

Lubricate plunger, roller, roller pin and hinge pin using Item 1 in LUBRICANT SPECIFICATIONS.

Check rubber plunger boot for cracks, holes or deterioration and replace if required. Check mounting plate for integrity.

Free pedal travel should be checked as follows. Be sure plunger is in contact with spring seat.

The stop button should be adjusted so that the roller and plunger just contact.

Clean exhaust port.

Every Year or 10,000 km (100,000 Miles)

Disassemble brake valve; clean and inspect all parts. Install new parts where they are found to be worn or damaged.

SERVICE CHECKS

Operations

Check delivery pressure of both primary and secondary systems using test gauges known to be accurate. Depress pedal or treadle to several positions between the fully released and fully applied positions and check the delivered pressure on the test gauges to see that it varies proportionately with the movement of the brake pedal.

After a full application is released, the reading on test gauges should fall off to zero promptly. It should be noted that the primary system delivery pressure will be about 14 kPa (2 psi) greater than the secondary system delivery pressure with both supply reservoirs at the same pressure. This is normal for these valves.

IMPORTANT

A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake systems and, although vehicle should not be operated until necessary repairs have been made and both braking systems, including pneumatic and mechanical devices, are operating normally. Always check vehicle brakes after performing brake work and before returning the vehicle to service.

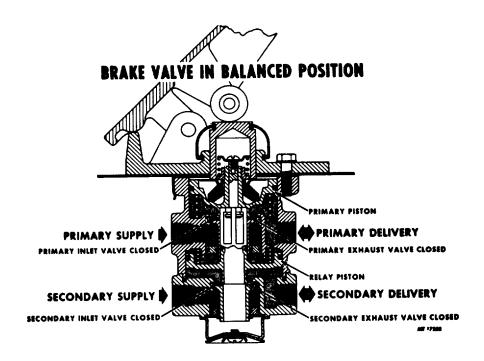


Fig. 6

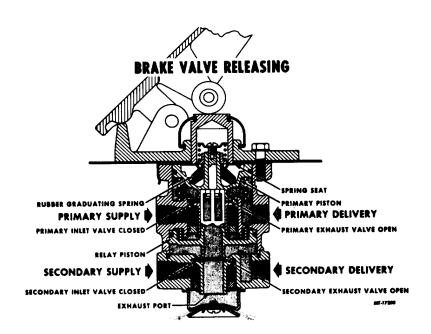


Fig. 7



Leakage Test

Make and hold a high pressure application. Check the exhaust port for leakage. Using a soap solution , a 25 mm (1") soap bubble in 3 seconds is permitted.

If the brake valve does not function as described, the valve should either be replaced or repaired.

REMOVE

- 1. Apply parking brake or block wheels to prevent vehicle from moving.
- Drain all air from all reservoirs.
- Disconnect all supply and delivery lines at brake valve. Mark all air lines in relation to valve to assist reconnecting lines.
- Remove fittings from valve. Mark these fittings also.
- 5. Remove valve from chassis.
 - a. <u>Suspended Pedal Valves</u> Remove nuts on exterior side of dash and remove valve assembly.
 - b. <u>Treadle Type Valves</u> Remove brake valve and treadle assembly by removing three capscrews on outer bolt circle of mounting plate. Basic valve alone may be removed by removing three capscrews on inner bolt circle.

REINSTALL

Installation of brake valve is basically the reverse of removal. Be sure to make service checks before returning vehicle to service.

DISASSEMBLY

Treadle Type Brake Valve (E6)

Refer to Fig. 8 for numbers in parenthesis.

- If the entire brake valve and treadle assembly was removed from the vehicle, remove the three capscrews securing the treadle assembly to the basic brake valve.
- 2. Remove screw (1) securing the exhaust diaphragm (3) and washer (2) to exhaust cover (4).
- 3. Remove four screws that secure exhaust cover (4) to lower body (10).
- Remove secondary inlet and exhaust valve assembly (items 5 through 9) from lower body. Disassembly of secondary inlet and exhaust

- valve assembly is not required since it is only serviced as an assembly.
- 5. Remove four hex head capscrews securing the lower body (10) to upper body (11) and separate the bodies.
- Remove the rubber seal ring (12) from the lower body.
- 7. Apply thumb pressure to primary piston (16), lift out and up on the three lock tabs of primary piston retainer (19).
- 8. Using a 10 mm (3/8") wrench, hold ENSA nut on threaded end of stem on top of primary piston. Insert a screwdriver in exhaust passage through center of valve and engage slotted head of the stem (23).

CAUTION

Before proceeding with the disassembly (refer to Fig. 8), note the ESNA nut and stem are used to contain primary piston return spring (17), stem spring (21) and relay piston spring (14). Combined force of these springs is approximately 222 N (50 lbf) and care must be taken when removing the ESNA nut as the spring forces will be released. It is recommended that primary piston and relay piston be manually or mechanically contained while nut and stem are being removed to prevent bodily injury.

- 9. Rotate the screwdriver counterclockwise and remove stem (23), stem spring (21), spring guide (22) and ESNA nut.
- 10. Remove relay piston (13), relay piston spring (14), primary piston and primary piston return spring from the upper body.
- Disassemble primary piston by rotating the spring seat nut (24) counterclockwise.
 Separate spring seat nut, spring seat (20), rubber spring (18) and remove piston O-ring.
- 12. Remove large and small O-rings from relay piston.
- 13. Remove retaining ring securing primary inlet and exhaust valve assembly (15) in upper body and remove valve assembly. Do not disassemble primary inlet as it is only serviced as an assembly.



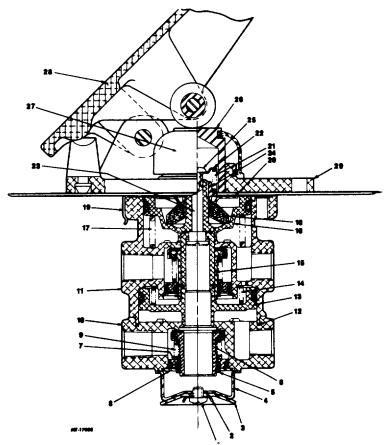


Fig. 8. Sectional View of E6 Brake Valve.

Legend for Fig. 8

<u>Key</u>	<u>Description</u>	Key	Description
1	SCREW	16	PISTON, Primary.
2	WASHER, Diaphragm	17	SPRING, Primary Piston Return
3	DIAPHRAGM, Exhaust	18	SPRING, Rubber
4	COVER, Exhaust	19	RETAINER, Primary Piston
5	RING, Retainer	20	SEAT, Spring
6	VALVE, Secondary & Exhaust	21	SPRING, Stem
7	RETAINER, "O" Ring	22	GUIDE, Stem Spring
8	WASHER	23	STEM
9	SPRING, Return	24	NUT, Spring Seat
10	BODY, Lower Valve	25	SCREW, Spring Guide (Not Used)
11	BODY, Upper Valve	26	PLUNGER
12	RING, Seal	27	BOOT
13	PISTON, Relay	28	TREADLE
14	SPRING, Relay Piston	29	PLATE, Mounting
15	VALVE, Primary Inlet & Exhaust		Š



CLEANING AND INSPECTION

Wash all metal parts in cleaning solvent and dry them. Inspect all parts for excessive wear or deterioration. Inspect valve seats for nicks or burrs. Check springs for cracks or corrosion. Replace all rubber parts and any part not found to be serviceable during inspeciton.

ASSEMBLY

Treadle Type Brake Valve (E6)

Prior to reassembling brake valve, lubricate all O-rings, O-ring grooves, piston bores and metal-to-metal moving surfaces with Item 1 in LUBRICANT SPECIFICATIONS.

Refer to Fig. 8 for numbers in parenthesis. All torques specified are assembly torques and can be expected to differ after assembly is accomplished. Do not retorque after initial assembly.

- 1. Position primary inlet and exhaust assembly in the upper body; then install retaining ring to secure it. Be sure the retaining ring is seated completely in its groove.
- 2. Install large and small O-rings on relay piston.
- 3. Replace primary piston O-ring in piston O-ring groove.
- 4. Position rubber spring (18), concave side down, in primary piston and place spring seat (20), flat side up, over rubber spring.
- 5. Install primary piston spring seat nut (24) with its hex closest to spring seat and rotate clockwise until top surface of spring seat is even with top surface of piston (16).
- 6. Position primary piston return spring (17) in the upper body piston bore.
- 7. Install primary piston, spring seat out, over return spring and press piston into body bore.
- 8. Place relay piston return spring (14) in the upper body and position relay piston over spring so that the concave side of the piston is against the spring (refer to Fig. 8).
- Compress both primary piston and relay piston into the upper body and hold them compressed, either manually or mechanically (see CAUTION under No. 8 in DISASSEMBLY).
- 10. Place stem (23) through exhaust passage of the lower body so that threaded portion is visible at primary piston.

- 11. Use a screwdriver to engage and hold the slotted head of stem; then position stem spring (21) and spring guide (22) over primary piston.
- 12. Install ESNA nut on stem and rotate clockwise to 2.3 3.4 N.m (20 30 in lbs) of torque.
- 13. Install primary piston retainer (19) over piston making certain all three lock tabs have engaged the outer lip of body.
- 14. Install secondary inlet and exhaust valve assembly in lower body.
- 15. Place exhaust cover (4) on lower body and install four #10-24 machine screws with lockwashers; torque screws to 2.3 3.4 N.m (20 30 in lbs).
- 16. Install exhaust diaphragm (3) and diaphragm washer (2) to exhaust cover using Phillips head screw and lockwasher.
- Install seal ring (12) in lower body and secure lower body to upper body using four hex head capscrews and lockwashers; torque capscrews to 7.9 11.3 N.m (70 100 in lbs).
- 18. Install treadle assembly to basic brake valve using three 5/16-18 hex head capscrews and lockwashers; torque to 9 11.3 N.m (80 100 in lbs).
- Test the rebuilt E6 dual brake valve by performing operation and leakage tests outlined in SERVICE CHECKS.

DISASSEMBLY

Suspended Pedal Type Valve (E7) Refer to Fig. 9 for numbers in parenthesis.

- 1. Remove three capscrews and pedal assembly.
- 2. Apply force on retainer, disengage locking tabs from body and remove retainer (7).
- 3. Grasp lock nut (5) of lower static piston assembly (10) with pliers and pull piston assembly from body (12).
- 4. Fasten a hook from a 152 mm (6") piece of .125 mm (1/8") diameter wire (approx.), bending one end 90 degrees at a length 12.7 to 19.mm (1/2" to 3/4") from end of wire. Insert hook end in bore of body and through secondary inlet valve exhaust bore hooking onto valve. Pull firmly and remove upper static piston (15) assembly with secondary inlet and exhaust valve (16).

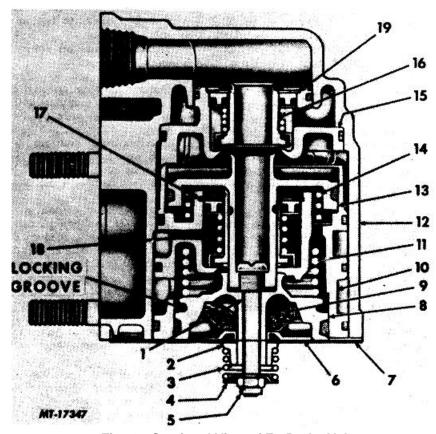


Fig. 9 Sectional View of E7 Brake Valve

Legend for Fig. 9 K<u>ey</u> Key Description Description STEM SPRING, Primary Piston Return 11 1 2 NUT, Spring Seat 12 **BODY** SPRING, Stem 3 13 PISTON, Relay SPRING, Relay Piston Return 4 GUIDE, Stem Spring 14 5 PISTON, Upper Static NUT, Lock 15 6 SEAT, Spring 16 VALVE, Secondary Inlet & Exhaust 7 RETAINER 17 RING, Retaining VALVE, Primary Inlet & Exhaust 8 PISTON, Primary 18 9 SPRING, Rubber 19 RING, Retaining 10 PISTON, Lower Static

- Apply firm pressure on spring seat (6) which will compress primary piston spring (11). Locking groove in piston is now accessible through rectangular opening in body. Insert wire on screwdriver into locking groove, thus holding primary piston spring (11) in compressed position.
- Insert blade of screwdriver through exhaust passage of secondary and primary pistons and into slot of stem (1). Back off locking nut (5).
- 7. Remove locking nut (5), spring stem guide (4) and stem spring (3).
- 8. Remove spring seat nut (2), spring seat (6) and rubber spring (9) using same type procedure as item 6.
- Removal of screwdriver or wire from locking groove will permit spring load to push out primary piston (8) and relay piston (13). Care should be used when removing tool from locking ring because of spring load.

- 10. Remove primary piston (8) and return spring (11), and relay piston (13) and return spring (14).
- 11. Remove stem (1) and O-rings from relay and primary pistons.
- 12. Remove O-rings from upper static piston (15) and lower static piston (10).
- 13. Remove large retaining ring (17) from lower static piston and remove primary inlet/exhaust valve assembly (18). Disassembly of inlet and exhaust valve is not required since it is only serviced as an assembly.
- 14. Remove large retaining ring (19) from upper static piston assembly (15) and remove secondary inlet/exhaust valve assembly (16).

CLEANING AND INSPECTION

Wash all metal parts in cleaning solvent and dry them. Inspect all parts for excessive wear or deterioration. Inspect valve seats for nicks or burrs. Check springs for cracks or corrosion. Replace all rubber parts and any part not considered to be serviceable.

REASSEMBLY

Suspended Pedal Type Valve (E7)

Before starting to reassemble brake valve lubricate all O-rings, O-ring grooves, piston bores and metal moving parts with Item 1 in LUBRICANT SPECIFICATIONS.

Refer to Fig. 9 for numbers in parenthesis.

- Install new secondary inlet/exhaust valve assembly (16) in upper static piston (15) and secure with retainer ring (19) making certain retaining ring is engaged in groove of upper static piston bore.
- 2. Install O-ring on upper static piston assembly and install in body of valve.
- 3. Install primary inlet/exhaust valve assembly (18) in lower static piston (10) and secure with retainer ring (17) making certain retaining ring is engaged in groove in lower static piston (10).
- 4. Install three O-rings in grooves of lower static piston assembly (10).

- The larger diameter O-ring is installed in groove nearest to bottom of piston assembly.
- 5. Install O-rings on relay piston (13) and primary piston (8).
- 6. Position rubber spring (9), concave side down, in primary piston (8) and place spring seat (6), flat side up, over rubber spring.
- 7. Install spring seat nut (2) on primary piston with hex head closest to spring seat and rotate nut clockwise until top surface of spring seat is even with top surface of piston (8).
- Position relay piston spring (14), which is lighter of the two piston return springs, relay piston (13), primary piston spring (11) and primary piston (8) in lower static piston (10). Compress both primary and secondary pistons in lower static piston. Hold them manually or mechanically.
 - A screwdriver may be used by inserting it through a rectangular opening in static piston into locking groove in primary piston.
- Insert stem (1) through exhaust passage of relay and primary pistons and engage a screwdriver with slot in head of stem; then position stem spring (3), spring guide (4) on spring seat nut (2).
- 10. Compress guide spring assembly and install lock nut (5) on stem. Torque nut to 2.3 -3.4 N.m (20 30 in lbs).
 - Torque is a specified value for assembly; after assembly, torque value will fall off. <u>Do not retorque nut</u>.
- 11. Remove screwdriver from lower static piston assembly.
- 12. Install lower static piston assembly in valve body. Then install retainer (7) making certain locking tabs engage on valve body bosses.
- 13. Install pedal assembly using three capscrews. Check to be certain plunger is in contact with spring seat. The stop button should be adjusted so that the roller and plunger contact after adjustment; roller should be able to be turned freely by thumb.
- 14. Test rebuilt brake valve by performing operation and leakage tests as outlined in SERVICE CHECKS.

MIDLAND-ROSS

DESCRIPTION

The Midland-Ross dual air control valve is a foot operated type brake valve. The valve may be floor mounted with a treadle assembly or it may be firewall mounted with a bracket assembly for a suspended pedal.

The valve has two separate reservoir and delivery circuits which consist of two separate piston type compensating valves. The primary section of the valve responds to mechanical force from the operator and the function is similar to a single-circuit foot operated valve. The secondary section of the valve resembles a relay valve and responds to air pressure delivered from the primary section. During normal operation, similar pressure levels are delivered to both circuits of the dual air brake system which are supplied from separate air pressure reservoirs. When the valve is released, air from both circuits is exhausted at the exhaust port. During a condition of insufficient air supply in the primary section the secondary section function is similar to a foot operated valve.

Both primary and secondary sections of the brake valve use a common exhaust valve.

OPERATION

Refer to Fig. 10 for numbers in parenthesis. Fig. 10 illustrates the normal position of the brake valve components with the vehicle service brakes in the fully released position. Basically, the same operational illustrations (Figs. 3, 4, 5, 6 and 7) which apply to the Bendix brake valve will apply to the Midland-Ross brake valve.

Application of Primary Section - Normal Operation

When the foot valve actuator (treadle or pedal) is depressed, the plunger exerts force against the spring retainer (1), compensator spring (32) and the primary piston (31). The primary piston moves and its exhaust seat "B" seals against the rubber face of seal assembly (29). Further piston movement causes the retainer and seal assembly (8 and 29) to move away from the inlet seat of valve body (4) allowing primary reservoir pressure "D" to enter cavity "A" and flow out the primary delivery port. As air pressure builds up in cavity "A," it acts against piston (31) causing it to move upward. When the resultant forces on the piston approach a balanced position, the piston moves upward until the seal assembly (29) seals against the inlet seat of valve body (4). The exhaust seat "B" of piston (31) remains closed and air is blocked from exhausting into cavity "C." The valve has then reached a balanced or "lap" condition.

<u>Application of Secondary Section - Normal</u> <u>Operation</u>

When the primary delivery port is pressurized, air passes through the bleed hole "E" into the control portion of the secondary section "F." The air pressure causes the secondary piston (23) to move and its exhaust seat "G" seals against the rubber face of seal assembly (16). Further piston movement causes the retainer and seal assembly (8 and 16) to move away from the inlet seat of the valve body (21) allowing the secondary reservoir pressure "J" to enter cavity "H" and flow out the secondary delivery port. As air pressure builds up in cavity "H," it acts against secondary piston (23) causing it to move upward. When the resultant forces on the piston approach a balanced condition, the piston moves upward until the seal assembly (16) seals against the body (20). The exhaust seat "G" of piston (23) remains closed and air is blocked from exhausting into cavity "K." The valve has then reached a balanced or "lap" condition. The delivery pressure of secondary section is then approximately equal to the delivery pressure of primary section.

<u>Application - Loss of Secondary Section Air</u> <u>Pressure</u>

When air pressure is lost in the secondary section, the primary section functions as described in the "normal operation" of the primary section.

<u>Application - Loss of Primary Section Air</u> Pressure

When air pressure is lost in the primary section, depressing the valve actuator (treadle or pedal) causes the plunger to exert force against the spring retainer (1), compensator spring (32) and the primary piston (31). The primary piston exerts force against the upper stem of the secondary piston (23) and its exhaust seat "G" seals against rubber face of seal assembly (16). Further piston movement causes the retainer and seal assembly (8 and 16) to move away from the inlet seat of valve body (21) allowing the secondary reservoir pressure "J" to enter cavity "H" and flow out the secondary delivery port.

Release of Primary Section

When force is removed from the foot valve actuator (treadle or pedal), force is removed from the spring retainer (1), compensating spring (32) and the primary piston (31). The primary piston moves upward due to air pressure in cavity "A" and a force of return spring (7). This allows the rubber face seal (29) to seat against valve body (4) and causes the primary piston exhaust seat "B" to move away from the rubber face of

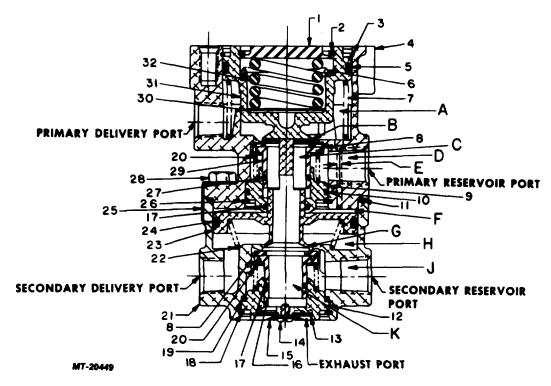


Fig. 10 Cross Section of Midland-Ross Brake Valve

		Legend for Fig. 10	
Item No.	<u>Description</u>	<u>Item No.</u>	<u>Description</u>
1	RETAINER, Spring	17	O-RING
2	RING, Retaining	18	RING, Retaining
3	RING, Retaining	19	O-RING
4	BGDY, Valve (Primary)	20	SPRING
5	O-RING	21	BODY, Valve (Secondary)
6	RING, Reaction	22	SPRING
7	SPRING	23	PISTON, Secondary
8	RETAINER, Seal	24	O-RING
9	BODY, Exhaust Valve	25	TAG, Name
10	O-RING	26	RING, Retaining
11	O-RING	27	O-RING
12	BODY, Exhaust Valve	28	SCREW
13	DIAPHRAGM	29	VALVE AND SEAL
14	SCREW	30	SHIM
15	RETAINER, Washer	31	PISTON, Primary
16	VALVE AND SEAL	32	COMPENSATOR, Spring

seal (29). This allows primary delivery air pressure to exhaust through cavity "C" and "K" out to atmosphere around the exhaust port diaphragm (13).

Release of Secondary Section

When air pressure is exhausted from primary delivery section, air pressure is also exhausted from the bleed hole "E" and cavity "F." The secondary piston (23) moves upward due to air pressure in cavity "H" and a force of the return spring (22). This allows the rubber face of seal (16) to seat against the valve body (21) and causes the secondary piston exhaust seat "G" to move away from the rubber face of seal (16). This allows the secondary delivery air pressure to exhaust through cavity "K" and to atmosphere around the exhaust port diaphragm (13).

MAINTENANCE

Every Three Months or 32,000 km (20,000 Miles)

Clean any accumulated dirt, gravel or foreign matter away from heel of treadle, plunger boot and mounting plate.

Lubricate plunger, roller, roller pin and hinge pin using Item 1 in LUBRICANT SPECIFICATIONS.

Check rubber plunger boot for cracks, holes or deterioration and replace if required. Check mounting plate for integrity.

Free pedal travel should be checked as follows. Be sure plunger is in contact with spring retainer. The stop button should be adjusted so that the roller and plunger just contact.

Clean exhaust port.

Every Year or 160,000 km (100,000 Miles)

It is recommended that inlet and exhaust valves, exhaust diaphragm, O-rings and graduating spring be replaced if they show signs of wear or deterioration.

Every Two Years or 322,000 km (200,000 Miles)

Disassemble brake valve, clean and inspect all parts. Install new parts where they are found to be worn or damaged and install repair kit parts.

SERVICE CHECKS

Operation

Check the delivery pressure of both primary and secondary systems using test gauges known to be

accurate. Depress the pedal or treadle to several positions between the fully released and fully applied positions and check the delivered pressure on the test gauges to see that it varies proportionately with the movement of brake pedal.

After a full application is released, reading on the test gauges should fall off to zero promptly. It should be noted that the primary system delivery pressure will be within 35 kPa (5 psi) of the secondary system delivery pressure with both supply reservoirs at the same pressure. This is normal for these valves.

IMPORTANT

A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake systems, and although the vehicle air brake system may continue to function the vehicle should not be operated until the necessary repairs have been made and both braking systems, including the pneumatic and mechanical devices, are operating normally. Always check the vehicle brakes after performing brake work and before returning vehicle to service.

Leakage Test

Make and hold a high pressure application. Check exhaust port for leakage. Using a soap solution, a leakage of a 25 mm (1") soap bubble in 3 seconds is permitted.

If the brake valves does not function as described, the valve should either be replaced or repaired.

REMOVE

- 1. Block wheel to prevent vehicle from moving.
- 2. Drain all air from all reservoirs.
- 3. Disconnect all supply and delivery lines at brake valve. Mark all air lines in relation to valve to assist reconnecting lines.
- Remove fittings from valve. Mark these fittings also.
- 5. Remove valve from chassis.
- Remove brake valve and treadle assembly by removing three capscrews on outer bolt circle of mounting plate. Basic valve alone may be removed by removing three capscrews or nuts on inner bolt circle.

REINSTALL

Installation of brake valve is basically the reverse of removal. Be sure to make service checks before returning vehicle to service.

DISASSEMBLY

Refer to Fig. 10 for numbers in parenthesis. After valve is disconnected and removed from the vehicle, remove treadle assembly or mounting bracket. Inspect valve for damage. If a valve body casting is broken or shows cracks, replace valve.

- Mark relative location of primary and secondary valve bodies (21 and 4) for alignment purposes at reassembly.
- 2. Remove four screws (28) and separate secondary valve body (21) from primary valve body (4).
- 3. Remove piston (23), spring (22) and O-ring (11) from secondary valve body (21).
- 4. Remove retaining ring (18) which secures exhaust valve body (12) in secondary valve body (21).
- 5. Remove exhaust valve body (12), spring (20), valve (16) and O-ring (19) from valve body.
- 6. Remove O-ring (24) from secondary piston (23).
- 7. Remove screw (14), washer (15) and diaphragm (13) from exhaust valve body (12).
- 8. Remove O-ring seal (17), seal retainer (8) and rubber seal from valve (16).
- 9. Remove retaining ring (26) from primary valve body (4).
- 10. Remove exhaust valve body (9), spring (20) and valve (29) from primary valve body (4).
- 11. Remove O-rings (17 and 10) from exhaust valve body (9).
- 12. Remove O-ring (27), seal retainer (8) and rubber seal from valve (29).
- 13. Depress primary piston (31) and remove retaining ring (3). Then remove piston (31) and spring (7) from primary valve body (4).
- 14. Remove O-ring (5) from piston (31).
- 15. Place piston (31) in a suitable fixture so that spring retainer (1) which is spring loaded can be depressed approximately 267 N (60 lbf). Be sure to protect primary piston exhaust seat "B" from damage.

- 16. Remove retaining ring (2) from piston (31) and carefully release force on spring retainer (1).
- 17. Remove spring retainer (1), spring (32), reaction ring (6) and shims (30) from piston.

CLEANING AND INSPECTION

Wash all metal parts in cleaning solvent and then dry. Wipe all rubber parts clean for inspection.

Examine rubber seals, O-ring, reaction ring and exhaust port diaphragm. O-ring seals must not be cut or show surface nicks or gouges. Diaphragm (13) should be flexible and show no cuts, tears or distortion. Rubber seals for inlet valves (16 and 29) must be smooth on valve face area. There must not be any nicks, cuts, dents or imperfections visually evident in the rubber. Reaction ring (6) must not be cut, distorted or show nicks or gouges.

Examine exhaust valve bodies (12 and 9), pistons (23 and 31) and valve bodies (4 and 21). Castings must be free of cracks and voids. All surfaces for O-rings must be smooth, round and free of deep scratches, dents or gouges. There must be no evidence of metal-to-metal galling of aluminum surfaces. Valve body flanges, threads and retaining ring grooves must not be distorted. Inlet seats in valve bodies (4 and 21) and exhaust seats "B" and "G" on pistons (31 and 23) must be smooth and free from cracks or gouges.

Examine springs, spring retainer (1), retaining rings and screws. Parts should be free of distortion and corrosion.

Replace any parts that are not considered serviceable. It is recommended that parts supplied in the service repair kit be used.

REASSEMBLY

Lubricate the inside diameter of primary piston (31), where spring retainer (1) is guided, with Item 1 in LUBRICANT SPECIFICATIONS, as well as all other seals and sliding surfaces.

- 1. Install diaphragm (13), washer (15) and screw (14) to exhaust valve body (12). Tighten screw to .6 .9 N.m (6 8 in lbs) torque.
- 2. Install new rubber seal onto new valve (16).

- Install new O-ring (17) onto valve (16) and place seal retainer (8) over tube and around valve seal.
- Position valve and seal assembly (16) into secondary valve body (21) such that valve seal rests on exhaust seat in body.
- 5. Install spring (20) over tube to rest on seal retainer. Then place O-ring (19) over exhaust valve body (12). Align exhaust valve body to spring and push exhaust valve body firmly into valve body (21) and hold to prevent the spring from pushing the exhaust body out. Install the retaining ring (18) into valve body (21) making sure ring seats properly in groove.
- 6. Install new O-ring (27) on new valve (29) and seal assembly.
- Place seal retainer (8) over tube and around valve seal.
- 8. Place valve and seal assembly (29) into primary valve body (4) so that valve seal rests on exhaust seat in valve body.
- 9. Install spring (20) over tube to rest on seal retainer.
- 10. Install new O-rings (10 and 17) on exhaust valve body (9). Then align exhaust valve body to spring and push exhaust valve body firmly into primary valve body (4) and hold to prevent spring from pushing exhaust body out. Install retaining ring (26) making sure it seats properly.
- 11. Install O-Ring (24) on secondary piston (23).
- 12. Position spring (22) into secondary body (21); then install piston (23) into body (21).
- 13. Position O-ring (11) on primary body (4) and align valve body (4) with piston (23) and valve

- body (21). Push the two valve bodies together and align with original alignment marks. Install four screws (28) and tighten to 5.7 6.8 N.m (50 60 in lbs) torque.
- 14. Install shims (30) and reaction ring (6) into primary piston (31) as shown in Fig. 10. Then install spring (32) in piston (31). Place spring retainer (1) on top of spring and apply force to depress retainer beyond the retaining ring groove. Be sure to support the piston (31) in a fixture (press) so that exhaust seat "B" will not be damaged and install retaining ring (2) properly in primary piston. Check force required to start movement of spring retainer away from retaining ring (2). Use a hydraulic press to support piston so that exhaust seat "B" will not be damaged'. Then press spring retainer and record pressure required to move retainer.
 - If force is less than 218 N (49 lbs), disassemble piston assembly, add required number of shims and reassemble. If force is more than 258 N (58 lbs), disassemble piston assembly, remove required number of shims and reassemble.
- 15. Install O-ring (5) onto primary piston (31). Place spring (7) into primary valve body (4). Align piston to spring and push piston (31) firmly into valve body (4) and hold to prevent spring from pushing piston out. Install retaining ring (3) making sure it seats properly in valve body.
- 16. Test rebuilt brake valve by performing operation and leakage tests as outlined in SERVICE CHECKS.



CHAPTER V

QUICK RELEASE VALVE AND SPRING BRAKE EXHAUST VA 'E

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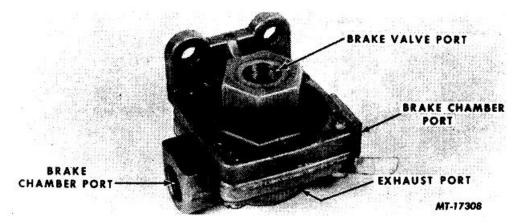


Fig. 1 QR-1 (Quick Release) Valve

DESCRIPTION OF QUICK RELEASE VALVE

The purpose of the quick release valve is to reduce the time required to release the brakes by hastening the exhaust of air pressure from the brake chambers. When a brake valve application is released, the exhaust of the quick release valve opens and the air pressure accumulated in the brake chamber is exhausted through the quick release valve rather than exhausting back through the brake valve.

The quick release valve is usually mounted on the frame close to the brake chambers it controls. The line connected to the top port is the delivery line from the brake valve. The two side ports are the brake chamber connections, and the bottom port is the exhaust.

BENDIX QR-1 TYPE

OPERATION

When a brake valve application is made air pressure enters the top (brake valve) port of the QR-1 valve, moves the diaphragm down, closing the exhaust port. At the same time this air pressure forces the edges of the diaphragm down and flows into the brake chambers.

As soon as the brake chamber pressure beneath the diaphragm equals the air pressure being delivered in the brake valve, the outer edges of the diaphragm will seal against the cover seat. The exhaust port is still sealed

by the center portion of the diaphragm. When the brake valve is released, air pressure above the diaphragm is exhausted, allowing the diaphragm to raise, opening the exhaust port and allowing brake chamber pressure to release.

In some special applications a spring and spring seat will be found in quick release valves.

MAINTENANCE

Every year or 160,000 km (100,000 mi.) remove the quick release valve, dismantle it and clean all parts.

The diaphragm should be replaced if worn or deteriorated.

SERVICE CHECKS

Operating Tests

Apply the brakes and observe that when the brakes are released, air pressure is quickly exhausted through the exhaust port of the valve. Be sure the exhaust port is not restricted in anyway.

Leakage Test

The valve must be tested at regular invertals for leakage using Leak Detector Tester (SE-2326) at exhaust port with the brakes applied. On releasing

the brakes see that the valve releases immediately with the corresponding return movement of the foot pedal. Leakage may be caused by dirt in the valve or a defective diaphragm. Leakage in excess of a 25.4 mm (1") soap bubble in 1 second is not permissible. If excessive leakage is found, the relay valve must be repaired or replaced.

REMOVE

- 1. Disconnect air lines from quick release valve.
- 2. Remove mounting bolts and valve.

INSTALL

- Mount quick release valve with mounting bolts and lockwashers with its exhaust port pointing down.
- 2. Connect brake valve to top port and brake chamber lines to side ports.
- 3. Make sure exhaust port is not restricted.
- After the new or rebuilt valve is installed, perform tests as outlined under SERVICE CHECKS.

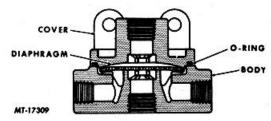


Fig. 2 Section View of QR-1 (Quick Release) Valve

DISASSEMBLY

- 1. Remove four screws.
- 2. Remove spring and spring seat, if so equipped.
- 3. Remove diaphragm.
- 4. Remove cover O-ring.

CLEANING AND INSPECTION

1. Clean all parts in good cleaning solvent.

- Inspect diaphragm, especially the lower part that contacts the exhaust seat and cover O-ring, for wear or deterioration. Replace if necessary.
- Check the cover exhaust seat for pitting or nicks. This seat should be smooth and sharp. If not, use a fine piece of emery cloth to dress the seat
- 4. Check the spring and spring seat (if valve so equipped) for wear or corrosion.
- 5. Clean or replace as necessary.

REASSEMBLY

- 1. If valve is equipped with spring and spring seat, position spring in body.
- 2. Position diaphragm over spring seat.
- 3. Place O-ring in groove.
- 4. Assemble cover and body.
- 5. Install four screws and tighten evenly.

MIDLAND-ROSS

OPERATION

When a brake application is made the compressed air from the foot valve enters the top or inlet port. This compressed air forces the diaphragm against the valve cover blocking the exhaust port. At the same time the edges of the diaphragm are lifted and permit air to pass out through the two delivery ports. When the inlet pressure is reduced, the diaphragm closes the inlet port and the center section of the diaphragm is forced away from the exhaust port and the compressed air escapes through the open exhaust.

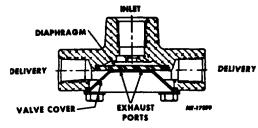


Fig. 3 Sectional View of Midland-Ross Quick Release Valve



MAINTENANCE

Every year or 160,000 km (100,000 miles) remove the quick release valve, disassemble it and clean all parts.

The diaphragm should be replaced if worn or deteriorated.

SERVICE CHECKS Operating Tests

Apply the brakes and observe that when the brakes are released, air pressure is quickly exhausted through the exhaust port of the valve. Be sure the exhaust port is not restricted.

Leakage Test

Leak Detector Tester (SE-2326) may be used to determine if air is leaking through the exhaust port when the brakes are applied. When the brakes are released be sure the valve releases immediately with the corresponding return movement of foot pedal. Leakage could be caused by dirt on valve seat or a defective diaphragm. Leakage in excess of a 25.4 mm (1") soap bubble in 6 seconds is not permissible. Repair or replace valve if excessive leakage is found.

REMOVE

- 1. Disconnect air lines from quick release valve.
- 2. Remove mounting bolts and valve.

INSTALL

1. Mount quick release valve with mounting bolts

- and lockwashers with its exhaust port pointing down.
- Connect brake valve to top port and brake chamber lines to side ports.
- 3. Make sure exhaust port is not restricted.
- After the new or rebuilt valve is installed, perform tests as outlined under SERVICE CHECKS.

DISASSEMBLY

- 1. Remove four capscrews and valve cover.
- 2. Remove diaphragm.
- 3. Remove cover O-ring.

CLEANING AND INSPECTION

- 1. Clean all parts in good cleaning solvent.
- Inspect diaphragm, especially the lower part that contacts the exhaust seat and cover O-ring, for wear or deterioration. Replace if necessary.
- Check the cover exhaust seat for pitting or nicks. This seat should be smooth and sharp. If not, use a fine piece of emery cloth to dress the seat.
- 4. Clean or replace as necessary.

REASSEMBLY

- 1. Position diaphragm in valve body.
- 2. 'Place O-ring in ledge provided in valve body.
- 3. Assemble valve cover on body.
- 4. Install capscrews and tighten to 5.7 6.8 N.m (50 60 in. lbs.).

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DESCRIPTION OF SPRING BRAKE EXHAUST VALVE

The Spring Brake Exhaust Valve (Fig. 4) delivers and retains all reservoir supply pressure offered to hold spring brakes in their "OFF" position. This valve may at times be referred to as a Holding-Quick Release Valve.

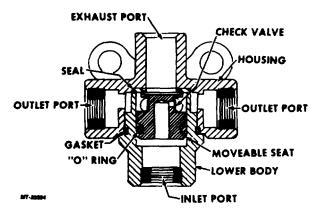


Fig. 4 Cross Section of Spring Brake Exhaust Valve

SEALCO BRAKE OPERATION

When reservoir pressure is reduced, the spring brake exhaust valve permits no "easing in" of the spring brakes until tractor pressure is reduced to less than 310 kpa (45 psi), at which time this valve will start to vacate the line to the spring brakes allowing spring brake application. Refer to the following chart.

INLET PE	RESSURE		SURE IN G BRAKES
KPA	PSI	KPA	PSI
758	110	758	110
310	45	758	110
276	40	724	105
207	30	538	78
138	20	345	50
69	10	166	24
35	5	83	12
0	0	0	0

In case of a rapid loss of inlet pressure the exhaust valve will exhaust the air in the spring brakes as rapidly as a quick release valve. For example: If the spring brake control valve which automatically dumps the inlet pressure at 276 kpa (40 psi), the remaining 690 kpa (100 psi) in the spring brakes would exhaust rapidly.

When tractor air supply is built up the spring brake control valve is opened to release spring brake application. The spring brakes may be applied for parking by closing the spring brake control valve.

If tractor reservoir pressure is reduced to an unsafe level, under 310 kpa (45 psi), the line to the spring brakes is exhausted automatically through both the spring brake exhaust valve and the spring brake control valve causing full spring brake application. Refer to Chapter IX for information pertaining to the spring brake control valve.

REMOVE AND REINSTALL

- 1. Set parking brake.
- Disconnect air lines from spring brake exhaust valve.
- 3. Remove mounting bolts.
- Installation of spring brake exhaust valve is the reverse of the removal.
- 5. After installing the valve, block wheels to prevent vehicle from moving and release the parking brakes. Check for air leaks at all connections. Leakage in excess of 25.4 mm (1") soap bubble is not permissible.

The spring brake exhaust valve should not be disassembled since repair kits are not available for rebuild.



CHAPTER VI

RELAY VALVE AND ANTILOCK RELAY VALVE AND SPRING BRAKE CONTROL VALVE

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CHAPTER VI

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MIDLAND-ROSS RELAY VALVE DESCRIPTION

The Midland Ross air relay valve is a piston type, air operated valve used to deliver and exhaust air being supplied to brake chambers. It is also designed to provide a quick means for applying and releasing the service brakes. The valve is remotely controlled by air pressure from the foot valve.

When the brake valve is applied the relay valve permits direct air pressure, supplied from the air reservoir, to pass and apply the air chambers. When the brakes are released the relay valve also permits the air chamber pressure to exhaust out the valve into the atmosphere.

The air pressure from brake valve is also influenced by the action of modulator valve in the antilock control.

OPERATION

The relay valve is mounted on the frame close to the brake chambers it serves. Fig. 2 illustrates the relay valve when the service brakes are fully released.

When the brake valve is applied air pressure enters the relay valve at the control port and into cavity

"A." Air pressure above piston moves it down and seats the exhaust valve against modulation tube closing off exhaust passages. Further downward movement of piston forces modulation tube down and opens inlet valve by moving away from valve seat of body. Reservoir air pressure enters cavity "B" through reservoir port and then passes through delivery ports (not shown) and to service brake chambers.

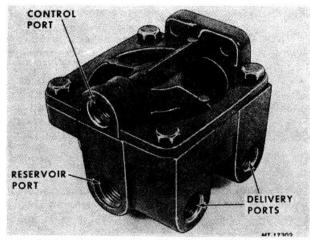


Fig. 1 Midland Ross Relay Valve

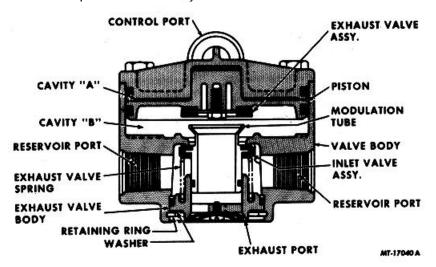


Fig. 2 Cross Section of Midland Ross Relay Valve

Air is blocked from exhausting through modulation tube center. As air pressure builds in cavity "B," it tends to move piston upward. When the air pressure above and below piston approaches a balanced condition, piston moves upward until inlet valve closes against valve body seat.

If air pressure coming into the control port is held momentarily at braking condition, the relay valve attains a "lap" position. Lap position implies that both inlet and exhaust valves are seated simultaneously. When the valve is in this "lap" position it is instantly responsive to any change in pressure from the brake control valve to increase or decrease vehicle braking, Air pressure outputs of relay valve are directly proportional to the signal air pressure at control port.

When the brake valve is released, air pressure acting above piston is removed. Air pressure in cavity "B" continues to move the piston upward and opens the exhaust valve seat. Air pressure from service brake chambers returns through the delivery ports (not illustrated in Fig. 2) into cavity "B" and exhausts through modulation tube passage and out exhaust port.

MAINTENANCE

Once each year or every 160,000 km (100,000 miles) remove the relay quick release valve, disassemble it and clean all parts. It is recommended that all rubber parts be replaced.

SERVICE CHECKS

Leakage Test

Use an air pressure source with an in-line shut-off valve, gauge and connection. A second air source connection will also be required with a shut-off.

Install a pipe plug in one delivery port and one reservoir port. Connect air source with gauge to control port. Open manual valve slowly to build up 689 861 kPa (100 125 psi) to control port and shut manual valve. No air leakage is permissible through cover and body casting surfaces, around capscrews or joined flanges. No air leakage is permissible that is passing through valve and evident at reservoir port or out exhaust port or around the snap ring. Slowly disconnect air line to release air pressure from control port.

Connect air source to reservoir port and open manual valve slowly to build up 689 861 kPa (100 125 psi) pressure. Shut off manual valve. No air leakage is permissible through casting surfaces or at exhaust port or around snap ring area.

Operation Test

Open manual valve to build up 689 681 kPa (100 125 psi) pressure at reservoir port. Connect air line with gauge to control port. Open shut-off valve to allow 69 103 kPa (10 15 psi) to control port and close valve. Delivery port pressure indicated will be within +21 kPa (3 psi) of that shown at control port. Permissible leakage at exhaust port is a 25 mm (3") soap bubble in 3 seconds.

Open shut-off valve to allow 655 689 kPa (95 100 psi) to control port and close valve. Repeat observation of delivery port: pressure and exhaust port leakage. Delivery port pressure should be 696 765 kPa (101 111 psi). Permissible leakage at exhaust port is a 25 mm (3") soap bubble in 3 seconds.

If relay quick release will not perform as described, it should either be replaced or repaired.

REMOVE

- 1. Disconnect air lines from relay valve.
- 2. Remove mounting bolts and remove valve.

INSTALL

- Mount relay valve with mounting bolts and lockwashers with exhaust port pointing down.
- 2. Connect air lines.
- 3. Make sure exhaust port is not restricted.
- Make sure new or rebuilt valve is tested as outlined in SERVICE CHECKS prior to installation.

DISASSEMBLY

After the relay valve is removed from vehicle, inspect it for damage. If valve body is fractured replace complete valve. Mark exterior of valve cover and body for alignment.

- 1. Remove four cover capscrews.
- Remove valve cover, piston assembly and piston spring, if equipped, from valve body.
- Remove retaining ring from valve body, using a snap ring pliers. Then remove washer, exhaust valve body spring and modulation tube from valve body.
- 4. Remove O-ring seal from valve body.
- 5. Remove capscrew exhaust valve seal and piston O-ring seal from piston.
- Remove screw, washer and exhaust port diaphragm from exhaust valve body.



- 7. Remove O-ring seal, inlet seal retainer and inlet valve seal from modulation tube.
- 8. Remove O-ring seal from valve cover.

CLEANING AND INSPECTION

Wash all parts in clean mineral spirits or equivalent and dry. Castings must be free of nicks or burrs. All Oring surfaces must be smooth, round and free of deep scratches, dents or gouges. There should be no evidence of metal-to-metal galling of aluminum surfaces.

Valve body flanges, threads and snap ring groove should not be distorted. Valve body seat must be flat and smooth, with no cracks or nicks.

Examine modulation tube. Flange for valve seal must not be dented or bent. Seal at end of tube must be flat and smooth with no dents or distortion.

Examine springs, snap ring, retainer, washers and screws. Parts should be free of distortion and corrosion.

Replace parts that show any defects.

It is recommended that all rubber parts be replaced with new.

ASSEMBLY

Lubricate O-rings, valve seals, O-ring sealing surfaces and bearing surfaces of piston, valve body and modulation tube with Item 3 of LUBRICANT SPECIFICAT'IONS.

- Install exhaust port diaphragm, washer and screw to exhaust valve body. Tighten screw 1.7 2.3 N.m (15-20 in lbs) torque.
- Install inlet valve seal and O-ring on modulation tube. Place seal retainer over tube and around valve seal.
- Carefully place modulation tube assembly into valve body so that inlet valve seal rests on body seat.
- Install exhaust valve spring over tube to rest on seal retainer.
- 5. Position exhaust valve body O-ring over body.
- Align exhaust valve body to spring, push body into relay valve body firmly and hold to prevent spring from pushing exhaust body out.
- Install washer and retaining ring into valve body groove properly.
- 8. Position exhaust valve seal on piston (refer to Fig. 2 for proper position of valve faces).

- 9. Install capscrew in piston and tighten to 4.9 6.0 N.m (43-53 in lbs) torque.
- Install one O-ring on piston and the other in valve cover.
- 11. Position piston assembly in cover.
- 12. It is not required that piston spring be reinstalled in valve body. Align piston, cover and spring. Push both piston and cover into valve body; install four capscrews and tighten to 12 17 N.m (110-160 in lbs) torque.

WAGNER ELECTRIC RG TYPE RELAY VALVE

DESCRIPTION

The Wagner Electric type relay valve (Fig. 3) is a piston type valve which provides a rapid means of applying and releasing the spring actuated parking brakes. The configuration of this valve is smaller than the valve used with the service brakes since there is no specified time requirements for releasing the spring brakes.

Since a constant air source is required to release the spring actuated parking brakes, the relay valve will have a constant air pressure through the valve at all times when the spring brakes are released. When the spring brake control valve is used to apply the parking brakes, air is exhausted through the spring brake control valve, closing the inlet valve in the relay valve and opening the exhaust valve, allowing air pressure in the spring brake chambers to exhaust.

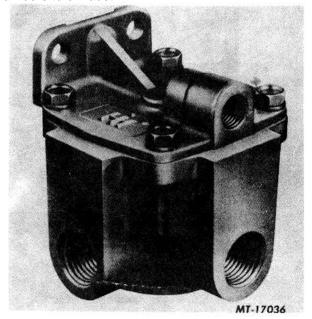


Fig. 3 Wagner Electric Type Relay Valve

OPERATION

The relay-valve, service (control) port and delivery port are tapped into the service (control) air line and the reservoir ports are connected into the emergency (supply) air line which is a direct air source from air reservoir. A small volume of controlling air pressure applied through the spring brake control valve to the relay valve service (control) port forces the relay reaction piston down to a seat on the inlet-exhaust valve, sealing off exhaust port (Fig. 4 valve applied). Further downward movement of piston also opens the inlet valve, allowing a larger volume supply air pressure to enter and pass through the delivery ports (Fig. 4, valve applied) and relatively short air lines offering less restriction to passage. As pressure below the reaction piston becomes equal to controlling pressure above the piston returns to a balance and allows the inlet valve spring to close the inlet-exhaust valve. The relay valve is now in the holding position for future applying or releasing action.

When the spring brake control valve is released the small volume of air pressure above the reaction piston rapidly escapes, unbalancing the piston (Fig. 4, valve released). It moves away from the inlet-exhaust valve, opening the exhaust port and larger volume of air in the spring brake system is released, thus applying the spring parking brakes.

Some valves will be equipped with a restriction in the control port which is a cup type plug and should not be removed.

MAINTENANCE

Once each year or every 160,000 km (100,000 miles) remove the relay quick release valve, disassemble it and clean all parts. It is recommended that all rubber parts be replaced.

SERVICE CHECKS

Operation Test

The valve is tested each time brakes are applied or released. Should valve operation be slow or hesitant the valve should either be replaced or repaired.

Leakage

Test An internal leak can be detected at the valve exhaust port. With the valve applied (spring brakes released with full air pressure), a leak indicates the inlet-exhaust valve is not sealing the exhaust. Leakage in excess of 25 mm (1 in.) soap bubble in 3 seconds is excessive.

REMOVE

- 1. Apply spring brake control valve exhausting air in spring brake system.
- 2. Disconnect air lines from relay valve.
- 3. Remove mounting bolts and remove valve

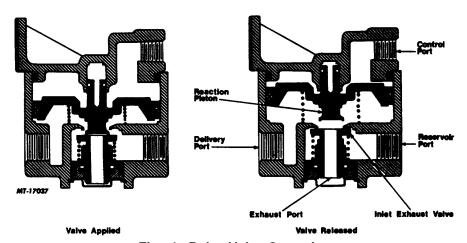


Fig. 4 Relay-Valve Operation

INSTALL

- 1. Mount relay valve with mounting bolts and lockwashers with exhaust port pointing down.
- 2. Connect air lines.
- 3. Make sure exhaust port is not restricted.
- Before releasing vehicle to service, per form SERVICE CHEČKS as outlined.

DISASSEMBLY

Refer to Fig. 5 for numbers in parenthesis.

- 1. Remove the retaining ring (15) and shield (14) from exhaust port. Valve guide seal (11) friction tends to hold the parts together; however, the spring (9) will gradually force parts out exhaust port.
- Remove retainer (13), valve guide seal (11), inlet-exhaust valve guide (10), spring (9) and inlet-exhaust valve (8).
- 3. Remove O-ring (12) from retainer (13).
- 4. Remove four capscrews (2) and remove cover (1).
- 5. Remove seal (3) from cover.
- 6. Pull reaction piston (5) from body. Piston return spring (6) can then be removed. Not all valves will have a return spring (6).

CLEANING AND INSPECTION

- 1. Clean all parts in good cleaning solvent.
- 2. Castings must be free of nicks and burrs. Oring surfaces must be smooth, round, free of deep scratches or gouges. The restriction in the control port which is a cup type plug need not be removed.
- 3. If any damage to valve body is noted, the valve assembly must be replaced.
- 4. Examine springs and snap ring. All parts should be free of distortion and corrosion. Replace any parts showing defects.
- 5. It is recommended that all rubber parts be replaced.

ASSEMBLY

Refer to Fig. 5 for numbers in parenthesis. Apply a thin film of Item 1 of LUBRICANT SPECIFICATIONS TO SEALS, O-rings and bearing surfaces. production valves were equipped with piston return spring. Whenever the valve is disassembled for any reason the spring may be discarded.

1. Position new quad ring seal (4) on piston (5).

- 2. With a new cover seal (3), install cover (1) with capscrews (2).
- 3. Position new O-ring seal (12) in retainer (13).
- 4. Install new inlet-exhaust valve (8) in body. Then position spring (9), valve guide (10) and retainer (13) with new valve guide seal (11).
- Position shield (14) in exhaust port and install retaining ring (15).
- Be sure to perform SERVICE CHECKS after installing valve on chassis.

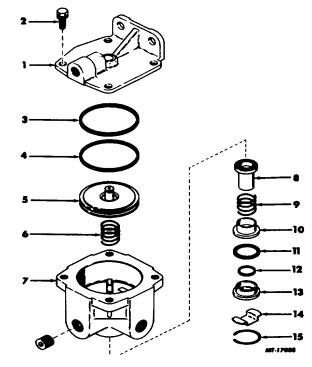


Fig. 5 **Exploded View of Relay Valve** Legend for Fig. 5

Valve

<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
	COVER	9	SPRING, Return
2	SCREW, Cap	10	GUIDE, Ínlet/Ex-
3	SEAL, Cover		haust Valve
4	SEAL, Ring, Quad	11	SEAL, Valve Guide
	PISTON	12	"O" RING, Inlet/
6	SPRING, Piston		Exhaust Valve
	Return *	13	RETAINER
7	BODY	14	SHIELD, Exhaust
8	VALVE, Inlet/		RING, Retainer

^{*} Not used in all valves.

Exhaust

KELSEY HAYES ANTILOCK RELAY VALVE

DESCRIPTION

The Antilock Relay (AR) valve is a two purpose valve which performs as a relay valve as well as an air control valve (Fig. 6).

The relay portion of the valve is used to quickly deliver direct air pressure from the air reservoir to the service brakes. It is remotely controlled by air pressure from the foot valve. When the service brakes are released the relay portion of the valve also permits the service brake air pressure to exhaust into atmosphere.

The AR valve also has the ability to modulate the service brakes during brake applications when wheel lock up is about to occur and as the wheel or wheels speed up the air is automatically reapplied to the service brakes again.

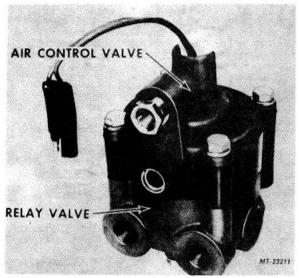


Fig. 6 Antilock Relay (AR) Valve MAINTENANCE

Once each year or every 160,000 km (100,000 miles) the control valve and bearing assembly in the antilock relay valve should be replaced.

SERVICE CHECKS

Leakage and Service Checks

With air system charged with air, apply the service brakes and using the Leak Detector Tester (SE-2326) check for air loss at the valve. If any air leakage is detected at the air control valve portion the complete

valve must be replaced. If air leakage is noted at the relay valve portion of valve, particularly at the exhaust port, the valve must either be repaired or replaced.

Service is limited to replacement of the control valve and bearing assembly.

For detailed information pertaining to trouble shooting the air control portion of valve refer to ANTILOCK CTS-2669 Service Manual Section.

REMOVE

- 1. Apply parking brakes or block vehicle to prevent vehicle from moving.
- 2. Mark or identify air lines before disconnecting any lines. Then disconnect air lines.
- Cut nylon strap around the electrical connector and disconnect wiring separating control valve wires from antilock harness.
- 4. Remove AR valve mounting bolts.

REINSTALL

Reinstallation of AR valve is basically the reverse of the removal. Moulded electrical connectors are treated with a special lubricant sealing compound (grease) which provides lubricant for metal surfaces and prevents entrance of moisture in connectors. This compound should not be cleaned from connector terminals and should be applied to female cavities when service is performed.

Be sure to check antilock operation referring to CTS-2669 Antilock manual section. Also make sure that a nylon strap is reinstalled at the electrical connector.

DISASSEMBLY

- 1. Remove the two cap screws from the exhaust cover assembly and remove cover (Fig. 7).
- 2. Remove the control valve and bearing assembly from the AR valve (Fig. 8).

CLEAN AND INSPECTION

Clean valve body with clean mineral spirits or equivalent. Cover all openings to prevent entrance of solvent in valve body. Wipe valve seat with a clean cloth. Inspect control valve seat, if any distortion is found the complete valve must be replaced.

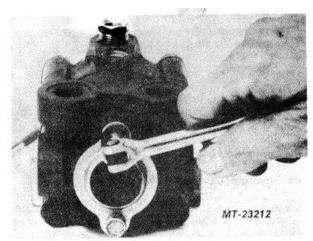


Fig. 7 Removing Exhaust Cover Cap Screws

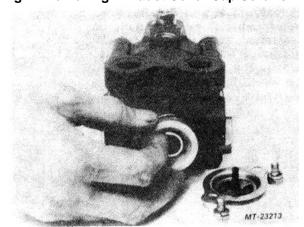


Fig. 8 Removing Control Valve and Bearing B Assembly

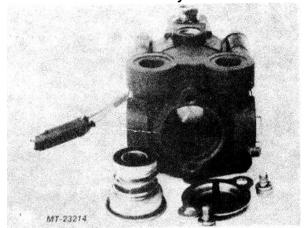


Fig. 9 New Control Valve and Clean Valve Body

REASSEMBLY

- 1. Install a new control valve and bearing assembly (Fig. 9) in valve body.
- Install exhaust cover assembly and two capscrews. Tighten cover cap screws to 9.5 Nm (84 in. lbs.).

MIDLAND-ROSS SPRING BRAKE CONTROL VALVE

DESCRIPTION

The Midland-Ross spring brake control valve is a relay valve which has a double check valve incorporated in its cover, which eliminates a separate double check valve required elsewhere in the spring brake control circuit.

The double check valve like any double check valve, automatically directs air pressure flow from two control sources into one common opening in the relay valve portion of the valve assembly (Fig. 10).

The relay valve portion of the spring brake control valve assembly is a piston-type air operated valve used to deliver and exhaust air being supplied to the spring brake chambers (Fig. 10).

The configuration and operation of this valve is the same as the Midland-Ross relay valve previously described in this chapter with the addition of the double check valve. Keep in mind that air pressure retains the spring brakes in the released position and exhausting of air in the system will apply the spring brakes.

When air pressure enters the control ports, at the double check valve, the exhaust port is closed in the relay valve and direct air pressure supplied from either the primary or secondary air reservoirs will pass the relay valve and release the spring brakes. When the spring brake controls shut off the air supply to the control ports or the air source is depleted at the control ports, the relay valve will close off the air inlet at the reservoir ports and at the same time the exhaust valve will open and allow air pressure from the spring brake chambers to exhaust into the atmosphere, applying the spring brakes.

MAINTENANCE

Once each year or every 160,000 km (100,000 miles) remove the spring brake control valve, disassemble it and clean all parts. It is recommended that all rubber parts be replaced.



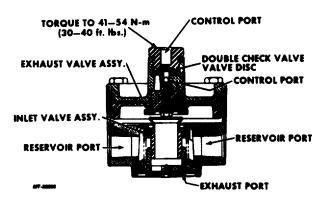


Fig. 10 Cross Section of Midland-Ross Spring Brake Control Valve

SERVICE CHECKS

The leakage test and operation test outlined in the Midland-Ross relay valve portion of this chapter may be used to check the spring brake control valve. The Leakage and Operational Tests must be performed at both control ports in order to be assured that the check valve is functioning. When air is applied to each of the control ports, be sure to check the opposite control port for leakage. Leakage at the control ports should not exceed a 25.4 mm (1") soap bubble in 5 seconds.

REMOVE

- Disconnect air lines from spring brake control valve.
- 2. Remove mounting bolts and remove valve.

INSTALL

- Mount spring brake control valve with mounting bolts and lockwashers with exhaust port pointing down.
- 2. Connect air lines.
- 3. Make sure exhaust port is not restricted.
- New or rebuilt valve is to tested as outlined in SERVICE CHECKS prior to installation.

DISASSEMBLY, CLEAN, INSPECT AND REASSEMBLY

The disassembly, clean, inspect and reassembly for the spring brake control valve is the same as the Midland-Ross relay valve found elsewhere in this chapter, with the exception of the double check valve seat and disc assemblies. When the valve assembly is reassembled, use the torque values found in Midland-Ross relay valve. The torque value for the valve seat is 41-51 Nm (30-40 ft. lbs.).



CHAPTER VII

INVERSION VALVE

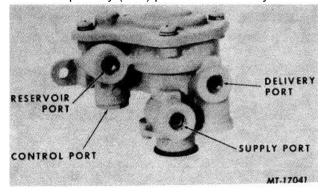
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BENDIX SR-I TYPE

DESCRIPTION

The inversion valve is used only on a straight truck with dual air brake system. Its purpose is to allow a modulated spring brake application if air loss should occur in the primary (rear) portion of the air system.



braking effort alone to stop the vehicle quickly to meet the FMVSS 121 requirements for emergency stopping.

The secondary (front) brakes cannot supply enough

The inversion valve senses the loss of air in the primary. system, allowing the spring brakes on the rear axle to be applied or released in a modulated manner at the same time the front service brakes are applied or released by the operator. The inversion valve also permits air pressure to enter the parking brake chamber releasing the spring brakes.

The inversion valve is not required on tractor applications due to the fact the trailer brakes, being supplied with air from both the primary and secondary tractor systems, provide necessary braking required to meet FMVSS 121 emergency stopping requirements.



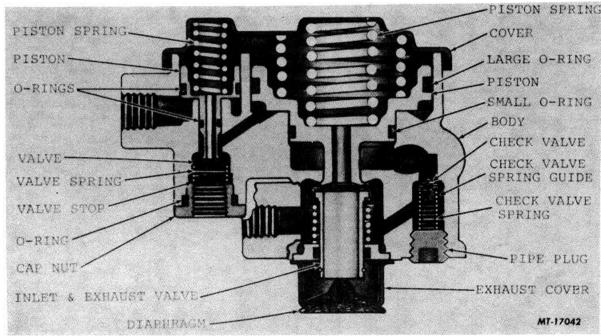


Fig. 2 Sectional View of Inversion Valve

OPERATION

Initial Air Charge (Fig. 3)

Initial air charge from the primary and secondary reservoirs flows through the spring brake control valve and enters the supply port of the inversion valve. Air entering the support port flows past inlet and exhaust valve "B" to the underside of piston "B" and out delivery port to the emergency air connection on the spring brake chamber. Note that the springs above piston "B" force it into contact with inlet and exhaust valve "B." In the position shown the exhaust is closed and the inlet is open.

Only air flowing from the primary reservoir enters the reservoir port on the inversion valve. This air remains under piston "A" as system pressure builds up. With primary reservoir pressure approximately below 379 kPa (55 psi) the spring above piston "A" forces it into contact with inlet exhaust valve "A" causing the exhaust to seal and inlet to open.

System Fully Charged (Fig. 4)

When the air pressure builds up past the approximate 379 kPa (55 psi) in both the primary and secondary reservoirs, piston "A" has moved against the force of the spring above it permitting the inlet of valve "A" to close and open the hollow exhaust passage through piston "A." When air pressure under piston "B" is about 655 kPa (95 psi), piston "B" raises alightly against the force of springs above it allowing the inlet of valve "B" to close. The exhaust through valve "B" remains closed. The closing of inlet portion of valve "B" traps about 655 kPa (95 psi) in the hold-off cavity of the spring brake actuators while allowing full air system pressure to build elsewhere.

Normal Brake Application with Primary and Secondary Reservoirs Charged (Fig. 5)

When the service brakes are applied by actuating the dual brake valve, air from the secondary system is delivered from the brake valve to the control port where it is stopped at the closed inlet valve "A." No further movement of internal components of the inversion valve takes place. Air from the primary delivery system of the brake valve actuates the service brakes of the spring brake chambers.

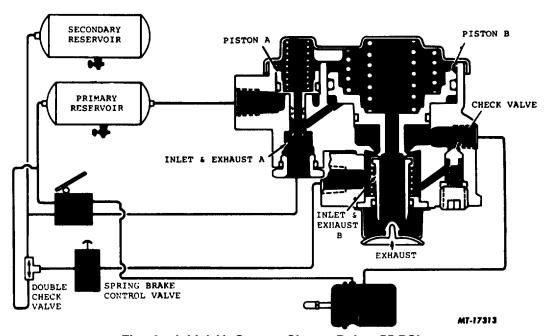


Fig. 3 Initial Air System Charge Below 55 PSI



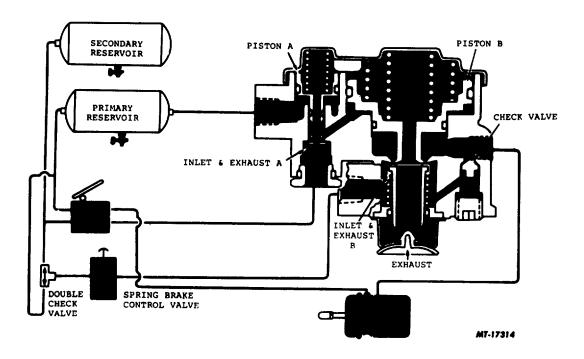


Fig. 4 Air System Fully Charged

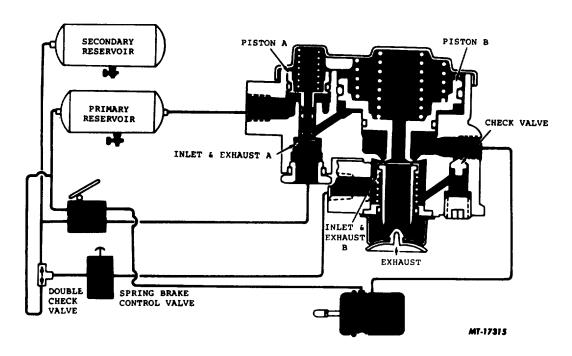


Fig. 5 Normal Brake Application, Primary and Secondary Systems Charged

Brake Application with Loss of Air in Secondary System (Fig. 6)

If air pressure is lost in the secondary reservoir, the primary reservoir as well as the spring brake control valve is protected against air loss through action of single check valve (air source to primary reservoir) and double check valve (Fig. 6). A brake application at brake valve in this situation results in little or no air being delivered from the secondary system to the control port of inversion valve. No movement of the internal components of the valve takes place. Braking is assured since the primary reservoir is protected and the primary delivery system of the brake valve will apply the service brake portion of the spring brake chambers.

Brake Application with Loss of Air in Primary System (Fig. 7)

If air pressure in the primary reservoir should fall below approximately 379 kPa (55 psi), the pressure below piston "A" is insufficient to resist spring force above and piston "A" moves into contact with valve "A". Initial contact between piston "A" and valve "A" closes the hollow exhaust passage of piston "A". Continued movement of piston opens the inlet valve "A".

The secondary reservoir and spring brake control valve is protected from air pressure loss by action of check valve.

When brake application is made through the brake valve, air delivered from the secondary system of the brake valve enters the inversion valve control port. Air enters control port, moves past the inlet of valve "A" and is conducted through a passage in the body to the underside of piston "B." The added force of air pressure below piston "B" moves up, opening the exhaust valve "B." When exhaust of valve "B" opens, air pressure trapped in the emergency section of the spring brake chamber is allowed to escape resulting in a brake application by emergency section. The amount of air pressure released from spring brake is proportional to the amount of air pressure delivered to the control port of the inversion valve by delivery of brake valve secondary system.

Parking (Spring) Brake Application (Fig. 8)

When both primary and secondary systems are charged with air and spring brake control valve is placed in "apply" or exhaust position, the inversion valve air supply and air pressure in the spring brake chambers will be exhausted. The single check valve in the inversion valve assists the exhaust of air from the spring brake by allowing air below piston "B" to flow back out the open exhaust of spring brake control valve. When air pressure below piston "B" has dropped enough, piston "B" moves down opening the inlet of valve "B" thus providing an additional exhaust passage for air exhausting through the inversion valve from spring brakes.

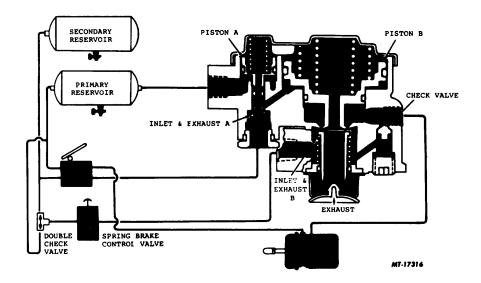


Fig. 6 Brake Application, Loss of Air in Secondary System



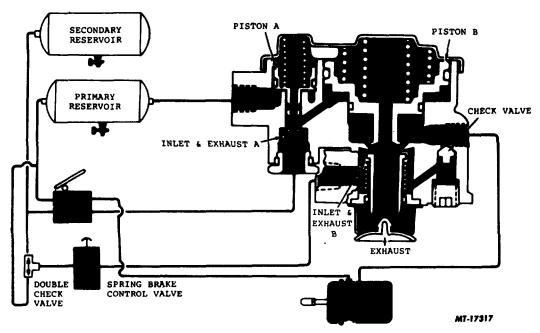


Fig. 7 Brake Application, Loss of Air In Primary System

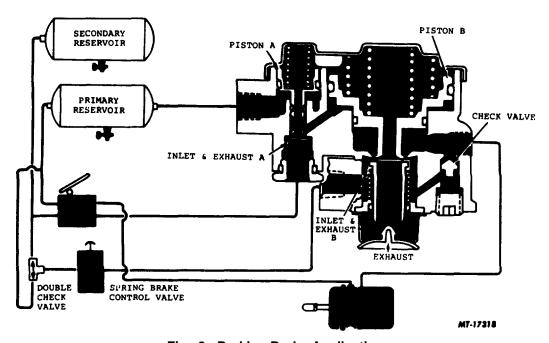


Fig. 8 Parking Brake Application



MAINTENANCE

Every 160,000 km (100,000 miles) or every year, remove, disassemble, clean and inspect all parts. If signs or wear or deterioration are found, install new parts. It is recommended all rubber parts be replaced.

SERVICE CHECKS

Operation Test

Block vehicle and hold by means other than vehicle brakes. Charge air brake system to governor cut-out pressure.

- Place parking control valve in the "apply" position. Observe that the spring brake actuators apply promptly. In the delivery port of the inversion valve install a test gauge known to be accurate. Place the parking control valve in the "release" position. Observe that the spring brake actuators release fully.
- With the parking control valve in the "release" position, note the gauge pressure reading (should be approximately the same as gauge on instrument panel). If the pressure reading is incorrect, the valve must be repaired or replaced.
- 3. Place the parking control valve in the "apply" position, the gauge reading should drop to zero promptly. A slow release of pressure could indicate faulty operation of the single check valve (within the Modulating Valve). At approximately 48-241 kpa (7-35 psi) the spring parking brakes should be fully applied.
- 4. Place the parking control valve in the "release" position. Locate the number one service reservoir and drain it completely.
- 5. Apply the foot brake valve several times and note that the pressure reading on the gauge decreases each time the foot brake valve is applied. After the foot brake valve has been applied several times, pressure on the gauge will drop to the point where release of the spring brake actuators will no longer occur.

Leakage Test

With air system fully charged and parking brake control valve in "release" position, use the Leak Detector Tester around valve cover and exhaust port to detect air leakage. A slight leakage is permitted.

If inversion valve does not function as described above or leakage is excessive, it is recommended that the valve either be replaced or repaired.

REMOVE

- 1. Apply parking brakes and drain all air reservoirs.
- 2. Mark or identify all air lines before disconnecting from inversion valve. Then disconnect air lines.
- Remove the two mounting bolts from valve and remove valve.

INSTALL

- Install inversion valve using the two mounting holts
- 2. Connect air lines. Make sure they are installed at the same ports.
- 3. Before releasing vehicle '.r service, perform SERVICE CHECKS as outlined.

DISASSEMBLY (Refer to Fig. 2)

- 1. Remove socket head pipe plug at check valve.
- Remove check valve spring, spring guide and check valve.
- 3. Remove two Phillips screws and remove exhaust cover.
- 4. Separate exhaust diaphragm from cover.
- 5. Remove inlet and exhaust valve assembly.
- 6. Remove inlet and exhaust valve cap nut and separate cap nut O-ring.
- 7. Remove valve stop, valve spring and inlet and exhaust valve.
- 8. Remove four Phillips head screws and lockwashers that secure cover to the body.

CAUTION

Cover is under a spring load and should be held while removing screws to prevent bodily injury. 9. Remove cover and three piston springs.

- Remove small piston and small and large Orings.
- 11. Remove large piston and large and small Orings from it.



CLEANING AND INSPECTION

Wash all metal parts in cleaning solvent and dry them. Inspect all parts for excessive wear or deterioration. Inspect the valve seats for nicks or burrs. Check the springs for cracks or corrosion. Replace all rubber parts and any part not found to be serviceable during inspection.

ASSEMBLY

Prior to reassembly of the SR-1 Spring Brake Valve, lubricate all O-rings, O-ring grooves, piston bores and metal-to-metal moving surfaces with the silicone base lubricant packaged in the repair kit or Item 3 in LUBRICANT SPECIFICATIONS.

The torque values listed in assembly procedure are assembly torque values and can be expected to fall off after assembly. <u>Do not retorque</u> after initial assembly torques fall.

- 1. Assemble check valve, valve spring guide and valve spring and insert them in body.
- Apply a pipe sealant to the socket head pipe plug and install it in body. Tighten to 15-19 Nm (130-170 inch-pounds) of torque.

- 3. Place inlet and exhaust valve assembly into valve body.
- 4. Install exhaust diaphragm in exhaust cover.
- 5. Position exhaust cover on body and secure cover with two Phillips screws. Tighten screws to 2.3-3.4 Nm (20-30 inch-pounds) of torque.
- 6. Place inlet exhaust valve in body and install valve spring and valve stop.
- Install O-ring on the cap nut and install the cap nut in body. Tighten to 12-13 Nm (100125 inchpounds) of torque.
- 8. Position small and large O-rings on small diameter piston and insert piston in body.
- 9. Install large and small O-rings on large diameter piston and insert the piston in body.
- 10. Position piston springs in their respective pistons.
- 11. Secure cover to body using four 1/4" 20 Phillips head screws and lockwashers. Tighten four screws to 5.7-9 Nm (50-80 inch-pounds).

Be sure inversion valve is checked as outlined in SERVICE CHECKS before chassis is returned to service.

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CHAPTER VIII

AIR CONTROL VALVE

Refer to. Chapter VI for information pertaining to the Kelsey-Hayes Antilock Relay (AR) Valve. Remember that both valves are trouble shooting in the same manner. When trouble shooting the Antilock System refer to CTS-2669.

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KELSEY HAYES

DESCRIPTION:

An air control valve or modulator valve (Fig. 1) is part of the antilock system. There is one valve mounted on the chassis per axle with antilock. As the wheel rotates, an electrical signal proportional to wheel speed is generated which a computer module records the rate of impulses.

There is one computer module per axle with antilock. During a brake application the computer sends an electrical signal to the air control valve when wheel lock-up is about to occur, the air chambers on the axle involved dump a controlled amount of air and as the wheel or wheels speed up, air is automatically reapplied.

OPERATION (Fig. 2)

The modulator valves are basically connected in series in the air system between the brake valve and air chambers. However, there will also be a quick release valve or a relay quick release valve located in the air system. There is one modulator valve per axle.

During a normal brake application, the poppet at the electric solenoid is open and air passes by the poppet closing the upper diaphragm and at the same time opening the lower diaphragm. Air from brake valve is then permitted to pass through the modulator valve onto brake chambers .

If one or both brakes on an axle that the modulator valve controls are about to lock up, the computer module sends an electrical signal to the solenoid on the modulator valve, the poppet closes and the valve is then in operating position.

In operating position the poppet is closed, air from the brake valve is also closed off at the lower diaphragm since air passes through the outer edge of the diaphragm forcing it up and sealing the inlet seat. At the same time the upper valve is moved up permitting air from brake side of valve to exhaust out the exhaust ports.

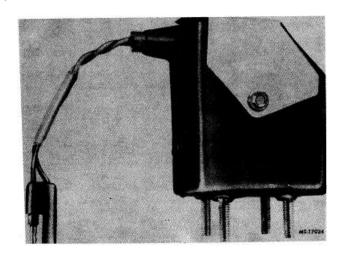


Fig. 1 Modulator Valve

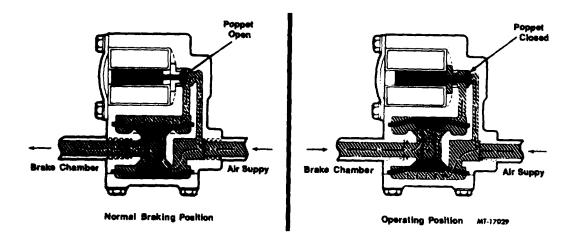


Fig. 2 Modulator Valve Operation



MAINTENANCE

Once each year or every 160,000 km (100,000 miles) valve should be removed and diaphragms replaced.

SERVICE CHECKS

Leakage and Operation Tests

Apply air brake system and check control valve for leaks using Leak Detector Tester (SE-2326). If any air leaks are detected replace valve or repair it.

If any air leaks are detected in the solenoid area, remove computer module cover for valve in question. Disconnect valve "Hi" wire from computer module. Apply vehicle brakes. Connect a jumper wire from hot connection on computer to air "Hi" wire which was removed. This will operate control valve solenoid. Then check for air leaks. If any air leakage is detected using the leak detector tester either repair or replace valve.

For detailed information pertaining to the antilock system refer to ANTILOCK, C'iS-2669.

REMOVE

- Apply parking brakes or block wheels to prevent vehicle from moving.
- 2. Tag or identify air line before disconnecting; then disconnect air lines.
- 3. Disconnect wiring to solenoid.
- 4. Remove mounting nuts and then remove control valve.

In some instances it may be necessary to remove the air control valve and relay quick release valve mounting bracket as an assembly to gain access to air control valve mounting nuts.

INSTALL

- 1. If mounting bracket was removed from frame, assemble control valve to bracket and tighten nuts.
- 2. Assemble hoses to air control valve.

- 3. Install air control valve to frame or mounting bracket to frame.
- 4. Connect wiring.
- Prior to returning vehicle to service, perform SERVICE CHECKS as outlined in ANTIL'OCK Service Manual Section CTS-2669.

DISASSEMBLY

Refer to Fig. 3 and proceed as follows.

- 1. Remove two valve cover bolts.
- 2. Remove valve cover.
- 3. Remove valve boot. Slide solenoid wires through boot neck; then slide boot from the valve.
- Remove four hex mounting bolts; this will allow removal of the valve assembly from the solenoid assembly.
- 5. Remove small O-ring.
- 6. Remove lower diaphragm from connecting rod. This will allow removal of upper diaphragm, connecting rod and spacer from the valve body.
- 7. Slide diaphragm spacer off connecting rod.
- 8. Remove upper diaphragm from connecting rod.

CLEANING AND INSPECTION

Wash all metal parts in cleaning solvent. Inspect all parts for excessive wear or deterioration. Inspect valve seats for nicks or burrs. Replace all rubber parts.

ASSEMBLY

- Coat diaphragm liberally with <u>Item 3</u> of LUBRICANT SPECIFICATIONS and assemble upper diaphragm (solid diaphragm) to the connecting rod.
- 2. Position diaphragm spacer (large end up) over connecting rod and push into the valve body.
- Assemble lower diaphragm (diaphragm with 6 equally spaced holes) onto other end of connecting rod.



- 4. Install small O-ring into solenoid body.
- 5. Position lower diaphragm so one of the holes is in line with "air in" port.
- 6. Reassemble the valve body to the solenoid assembly being sure that the small O-ring lines up with solenoid air inlet.
- 7. Assemble base plate to bottom of valve assembly and install four mounting bolts. Tighten mounting bolts to 7.9 9.3 N.m (71 84 in lbs) torque.
- 8. Install the valve boot, valve boot cover and valve boot bolts.

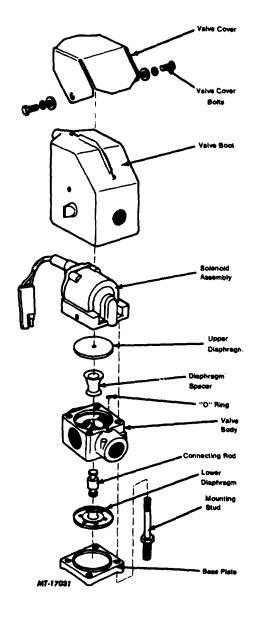


Fig. 3 Exploded View of Modulator Valve



CHAPTER IX

SPRING BRAKE, TWO WAY AND MODULAR CONTROL VALVES

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SPRING BRAKE CONTROL VALVE (MIDLAND ROSS)

DESCRIPTION

The spring brake control valve is a manually operated valve of push-pull type. When the valve is pushed "in" the valve is open to supply air. The "out" position closes off supply air and allows delivered air to exhaust to atmosphere, applying the spring brakes. Valve also features a plunger pressure sensing arrangement which provides automatic return to "out" position when brake system air pressure approaches low energy levels.



Fig. 1 Spring Brake Control Valve

OPERATION

The spring brake control valve serves to apply and release the spring actuated parking brakes. The valve is in the "in" position under normal operation on either a straight truck or tractortrailer. Air supply passes through the valve delivering system pressure to retract and hold parking brakes in released position. Manual pull "out" closes off air supply and vents delivered air to atmosphere, applying the parking brakes.

When valve is pushed "in," it will remain in as long as supply line is 48-241 kPa (7-35 psi) or more. During normal operation the air control valve will automatically apply, moving "out," if air pressure should drop to 48-241 kPa (7-35

psi). The automatic application will result when both primary and secondary systems have depleted air supply to 48-241 kPa (7-35 psi).

Refer to Fig. 2 for following operational description. Fig. 2 illustrates valve in applied (out) position.

Pushing piston in moves valve assembly off body seat until contacting end cap seat. Air pressure at inlet has free passage to outlet and is blocked from exhausting to atmosphere.

Pulling piston out moves valve assembly away from end cap seat and contacts body seat. Air pressure at inlet is blocked from entering either outlet or exhaust passages. Air pressure in outlet has free passage to exhaust to atmosphere.

The spring in the valve assists to move piston out automatically if inlet pressure drops and effective opposing force across the valve seat is overcome.

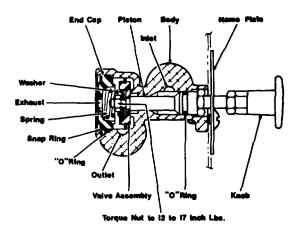


Fig. 2 Cross Section of Spring Brake Control Valve

MAINTENANCE

Once each year or every 160,000 km (100,000 miles) the valve should be removed, disassembled and a repair kit installed.

SERVICE CHECKS

Leakage Test

Use air pressure source equipped with in-line manual shut-off valve, air gauge known to be accurate and connection. Connect air source to

inlet port. Also connect a manifold with an air gauge and close manual shut-off valve to outlet. With air control valve in "out" position, open manual valve to build up 689-861 kPa (100-125 psi) to inlet port. Shut off manual valve. No air leakage is allowed around piston or through casting surfaces. Permissible leakage at exhaust port is a 25 mm (1") soap bubble in six seconds.

Push control valve in and build up 689-861 kPa (100-125 psi) pressure at both inlet and outlet. Shut off manual valve and repeat above leakage test.

Pull control valve out. Outlet port pressure should exhaust to zero through valve.

Operation Test

Begin with zero pressure at inlet and outlet. Hold control valve "in" and open manual valve to allow 48-241 kPa (7-35 psi) pressure to build up at both inlet and outlet. Control of valve should remain "in" at 48-241 kPa (7-35 psi) and above.

Second check is accomplished with 689-861 kPa (100-125 psi) in both inlet and outlet ports and both manual shut-off valves closed. Slowly open manual valve at outlet to bleed down pressure. The spring brake control should automatically move "out" when air pressure at inlet port reaches 48-241 kPa (7-35 psi).

If spring brake control valve does not perform as described it should be repaired or replaced.

DISASSEMBLY (Fig. 2)

Before moving spring brake control valve from vehicle, drain all air from all reservoirs.

- After valve is removed from vehicle, inspect it for damage. If casting is broken or shows fractures replace valve assembly.
- 2. Carefully remove end cap snap ring.
- 3. End cap, O-ring and spring can be removed now.
- 4. Remove nut, washer and valve assembly.
- 5. Pull piston with the knob out end of body and remove O-ring from piston.

CLEANING AND INSPECTION

Wash all metal parts in cleaning solvent. Inspect body and end cap seats. Face of seats must be flat and smooth with no cracks or nicks.

Use new parts supplied in repair kit.

REASSEMBLY (Fig. 2)

Lubricate O-rings, O-ring sealing surfaces and piston-to-body surfaces with Item 3 of LUBRICANT SPECIFICATIONS.

- 1. Install O-ring on piston and insert piston into body, aligning hex on piston to hex on body.
- Position valve assembly over end of piston, then position washer over piston stud end against metal face of valve.
- 3. Install nut and torque as specified on Fig.
- 2. Piston should move smoothly back and forth in body.
- 4. Install spring with small end against valve disc.
- Position O-ring over end cap. Align end cap over spring and push end cap into body. Hold end cap to prevent spring pushing end cap out.
- 6. Install snap ring in valve body groove.

Plunger should move in and out by applying force to move plunger in and releasing it.

Before releasing vehicle for service perform SERVICE CHECKS as outlined.

TWO WAY CONTROL VALVE

(WAGNER ELECTRIC TYPE PB) DESCRIPTION

The type PB control valve is a push-pull air valve, providing on-off manual control when an air system requires a simple non-metered application and exhaust of air pressure. It is used as the Trailer Emergency Brake Valve (control valve for the tractor protection valve) in a combination vehicle protection system to change the system for normal operation with trailer connected and to discharge the system in an emergency or bob-tailed tractor operation.

OPERATION

Applied Position

Valve knob will be pushed in to release trailer emergency. The reservoir port is open and exhaust port is sealed. The delivery port is always open and air flows from reservoir into system.

Released Position

Valve knob is pulled out to apply trailer emergency system or operate tractor without trailer. The reservoir port is sealed and exhaust port is open. Pressure in the emergency system at delivery now flows through exhaust port.



Fig. 3 Two-Way Control Valve (Push-Pull Type)

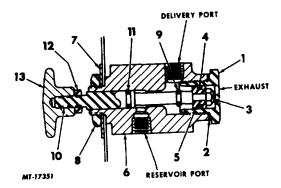


Fig. 4 Sectional View of Type PB, Two-Way Control Valve

Legend for Fig. 4

<u>Key</u> D	<u>escription</u>	<u>Key</u>	<u>Description</u>
2 GA 3 NU 4 O-F (1/2 5 PIS 6 BO		9 10 11 12	NUT, Mounting O-RING STEM, Center (5/16" OD) STEM, Valve O-RING STEM, Front (3/8" OD) NUT, Lock KNOB

MAINTENANCE

Once each year or every 160,000 km (100,000 miles) the valve should be removed, disassembled and repair kit installed.

SERVICE CHECKS

Normal usage tests will provide good checks for valve.

However, it should be checked periodically as follows.

Air leaks (disregarding normal exhaust) may appear at exhaust port. Nominal leakage of slow bubbling of soap will have little consequence in most systems. A leak at exhaust port when valve is applied indicates exhaust seal leaking. If leakage occurs at stem end (at control knob) of valve, stem seal is leaking.

If leakage is noted the valve must be removed and either replaced or repaired.

REMOVE

Refer to Fig. 4 for numbers in parenthesis.

- Loosen lock nut (12) and remove knob (13). Lock nut can now be removed.
- 2. Disconnect air lines at valve.
- 3. Loosen and remove valve mounting nut (8); then name plate (7); then remove valve.

REINSTALL

- 1. Position valve through instrument panel.
- 2. Install name plate and mounting nut.
- 3. Connect air lines; then install control knob lock nut and knob. Tighten lock nut against knob to secure it.

Prior to returning vehicle to service, perform SERVICE CHECKS as outlined.

DISASSEMBLY

Refer to Fig. 4 for numbers in parenthesis.

- 1. Remove end cap (1) and gasket (2).
- Remove valve stem nut (3). To remove nut install two nuts on opposite end of stem (10) locking stem. Use a wrench at each end of stem to loosen stem nut (3).
- 3. Pull stem (10) from body (6).
- 4. Remove piston (5) from body.

CLEANING AND INSPECTION

Wash all metal parts in good cleaning solvent. Inspect body for nicks or burrs in bore of valve. Replace complete valve assembly if body is not considered serviceable.

Use new parts supplied in repair kit.

REASSEMBLY

Lubricate O-rings, O-ring sealing surfaces and stem with Item 3 of LUBRICANT SPECIFICATIONS (refer to Fig. 4 for numbers in parenthesis).

- 1. Install new O-rings on stem (10) and piston (5).
- 2. Insert stem in valve body; then position piston (5) in valve body over stem.
- 3. Install stem nut (3).
- 4. Install valve end cap (1) and new gasket (2).

Before vehicle is returned to service, perform SERVICE CHECKS on valve as outlined.

TWO WAY CONTROL VALVE

(BENDIX TYPE TW-1)

DESCRIPTION

The TW-1 two-way control valve, which is an off-on valve, is mounted on the instrument panel and is primarily used in conjunction with various other air devices in vehicle air systems. The systems in which these valves may be used are: transmission air control valve, quick release valve, two-speed shift cylinders, manually operated tractor protection valve and power divider lock-out system.

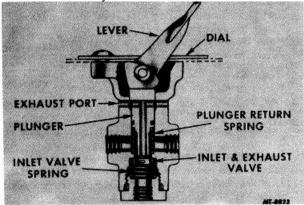


Fig. 5 Lever-Operated Two-Way Control Valve

OPERATION

Applying

When the lever is actuated in the delivery position, he hollow plunger of the valve is depressed and makes contact with the inlet valve and unseats it. In this position the exhaust passage through the hollow plunger is closed and air from the inlet port has free passage through the two-way valve and out the delivery port to

the device being operated.

Releasing

When the lever is released, the plunger is raised by the plunger spring and the inlet valve moves to its seat and is held closed by the inlet valve spring and inlet air pressure. Any air pressure in line or lines connecting the two-way valve with the device being operated will be exhausted through the hollow plunger and exhaust opening near the top of the valve.

MAINTENANCE

Once each year or every 160,000 km (100,000 miles) the two-way valve should be disassembled and thoroughly cleaned. Replace all grommets and inlet valves worn or damaged in any way.

SERVICE CHECKS

Operation Test

Plug one delivery port and install an air pressure test gauge in remaining port. Install second air pressure gauge in the air inlet line. With air connected to the inlet port, place the lever in applied position. The air gauge in the delivery port should read the same as the gauge installed in air inlet line.

Leakage Test

With air supplied to the inlet port of the two-way valve and the lever in released position, use Leak Detector Tester (SE-2326) at exhaust opening at top of the valve (where lever enters valve) to locate any leak.

Move lever or button to applied position and check exhaust opening with Leak Detector Tester (SE-2326) to locate leakage past exhaust plunger.

REMOVE

- 1. Disconnect air lines at two-way valve.
- 2. Remove machine screws securing control valve in place and remove valve.

REINSTALL

- Install valve using the machine screws. Position lever-operated or push button-operated two-way valve on instrument panel with body of valve behind instrument panel and dial or instrument panel plate showing on front of panel.
- 2. Connect all air lines and perform tests outlined in SERVICE CHECKS.



DISASSEMBLY

- 1. Press out lever or plunger roll pin.
- 2. If valve is of the push-pull type, loosen jam nut at control button, then remove button and jam nut.
- Remove plunger and plunger return spring from body.
- 4. Unscrew cap nut at inlet port and remove valve spring and valve from body.
- 5. Remove grommets from plunger and cap nut.

CLEANING AND INSPECTION

- 1. Wash all metal parts in cleaning solvent.
- 2. Check plungers for damage. Hollow hole plunger must be clean and free of all foreign material.
- 3. Inspect small end (exhaust seat) of plunger carefully; if chipped, worn or distorted, replace.
- Check plunger retainer spring and valve spring for damage.
- 5. Valve body must be replaced if seat is worn excessively or damaged.

REASSEMBLY

- 1. Install new grommet on plunger.
- Apply a small amount of the lubricant listed in LUBRICANT SPECIFICATIONS, <u>Item 1</u>, on the plunger and insert plunger return spring and plunger in the body. Plunger must move freely with only a slight drag due to grommet. Depress plunger and then release; plunger spring must return plunger.
- 3. Apply a lubricant comparable to that listed in LUBRICANT SPECIFICATIONS, <u>Item 1</u>, to cap nut grommet and position grommet on cap nut.
- 4. Position valve and valve spring in valve body.
- 5. Install cap nut in valve body.
- 6. Position lever on top of plunger and align hole in lever with hole in body.
- 7. Install lever pin and stake edge of hole.
- 8. Install jam nut and button on push-pull type valve. Install bracket on remote control (cable-operated) type valve.

MODULAR CONTROL VALVE

(BENDIX TYPE MV-2) DESCRIPTION

The modular control valve (Fig. 6) provides the functions of a standard three (3) valve combination plus a supply reservoir selection. The major features are:

- 1. Tractor protection control.
- 2. Trailer supply.
- 3. Complete system park.
- 4. Trailer park only.
- 5. Trailer charge with tractor spring brakes applied (tractor park only).
- 6. Supply reservoir selection (two way check valve).

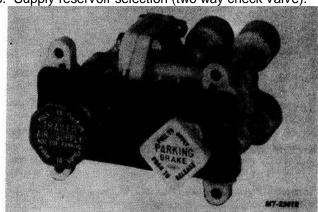


Fig. 6 Modular Control Valve

The bodies for the module, as well as "spool" inserts, are molded of a non-metallic, non-corrosive material. The assembly consists of two push-pull valves and a dual circuit supply valve which triggers at a pre-set pressure differential. The valve "spool" inserts, as well as the dual circuit supply valve spool and shuttle, may be removed from the valve bodies without disconnecting the air lines.

The MV-2 valve includes a spring loaded dual circuit supply (double check) valve which selects, as the air source for both control valves, the primary reservoir at all times unless the pressure in the primary reservoir falls not more than 207 kPa (30 psi) below that of the secondary reservoir, when the dual circuit supply valve will shuttle and establish the secondary reservoir as the supply. An auxiliary air delivery port is also available which receives its supply from the dual circuit supply valve. All air connections are at the bottom of the valve, as shown in Fig. 7, including the auxiliary air delivery port.

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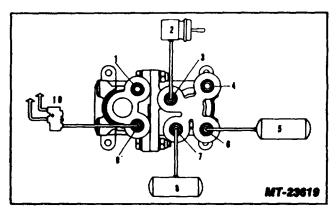


Fig. 7 Typical Air System Schematic with Modular Control Valve

- 1 Exhaust Port
- 2 Spring Brake Chamber
- 3 Delivery-Tractor Port
- 4 Auxiliary Air Delivery
- 5 Secondary Reservoir
- 6 Reservoir #Z Supply Port
- 7 Reservoir #1 Supply Port
- 8 Primary Reservoir
- 9 Delivery-Trailer Port
- 10 Tractor Protection Valve

The trailer air supply valve or tractor protection control (red knob) (see Fig. 6) delivers air to the trailer supply line and also will trip (pop out) automatically and shut off the trailer supply if pressure decreases to 276 t 27.6 kPa (40 t 5 psi).

IMPORTANT

Reservoir No. 1 must be the reservoir that supplies the primary brake system.

Reservoir No. 2 must be the reservoir that supplies the secondary brake system.

The parking brake valve (yellow knob) controls the spring brakes on the tractor and when exhausted, simultaneously causes the trailer supply valve to trip and exhaust, thus applying both tractor and trailer parking brakes as required by Federal Regulations. The trailer brakes may be independently released by pushing only the trailer air supply valve (red knob) in.

OPERATION

Initial Charge

With the system completely discharged, both knobs are out (Fig. 8). When system pressure reaches 448 kPa (65 psi),

the red knob (trailer supply) may be pushed in (Fig. 9) and should stay in, charging the trailer system and releasing the trailer brakes. The yellow knob (system park) may now be pushed in (Fig. 10) which will supply air to the tractor spring brakes, releasing them.

System Park (Fig. 8)

With both knobs in for normal tractor-trailer run modes, the parking brakes on both tractor and trailer may be actuated by pulling the yellow knob out, which exhausts the air from the tractor spring brakes and simultaneously causes the trailer supply valve to pop out, applying the trailer brakes. This complies with Federal Regulations that one control must apply all the parking brakes on the vehicle.

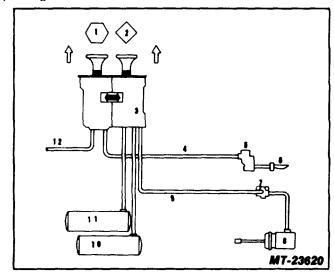


Fig. 8 Total Vehicle Parked

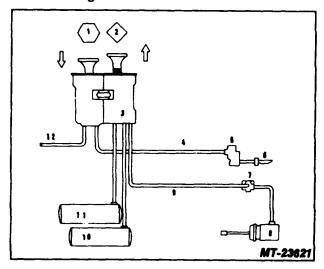


Fig. 9 Charge Trailer with Tractor Parked

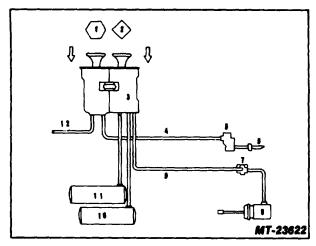


Fig. 10 Normal Operating Position

Legend for Figs. 8, 9, 10 & 11

- 1 Trailer Supply
- 2 Parking (Spring) Brake
- 3 Modular Control Valve
- 4 Trailer Emergency
- 5 Tractor Protection Valve
- 6 Trailer Emergency
- 7 Quick Release Valve
- 8 Spring Brake Chamber
- 9 Tractor Spring Brake Control
- 10 Secondary Reservoir
- 11 Primary Reservoir
- 12 Exhaust

Trailer Charge (Fig. 9)

If both valves are out, parking the combination vehicle, and it is desired to recharge the trailer leaving the tractor spring brakes applied, the red knob may be pushed in repressurizing the trailer supply line. This mode may also be used to park a combination vehicle with tractor spring brakes only.

Automatic Application

With both knobs in, as in the normal run position (Fig. 10), and supply pressure to the push-pull valves is reduced to 276 t 27.6 kPa (40 t 5 psi), the red knob (trailer supply valve) must pop out, applying the emergency or parking brakes on the trailer. If the red knob is held in manually and the pressure decreases to 207 t 27.6 kPa (30 + 5 psi), a tripper piston within the trailer control spool will move upward, exhausting the trailer air supply, thus applying the trailer brakes.

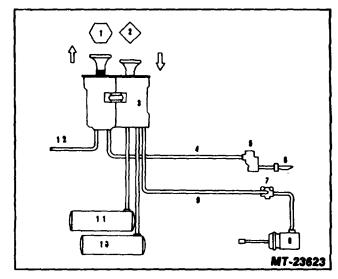


Fig. 11 Park Trailer with Tractor Released or Bobtail Tractor

Normal Run Position (Fig. 10)

With both knobs pushed in, air is now being supplied to the trailer and to the tractor spring brakes; all brakes are released.

Actuation of Trailer Park or Emergency Brakes (Fig. 11)

To actuate the trailer brakes only, the red knob is pulled out, exhausting the trailer supply line. The trailer brakes are now applied either by emergency air or spring brakes, depending on the type of trailer system. This mode would be used to uncouple from the trailer and during bob-tail operation.

MAINTENANCE

Once each year or every 160,000 km (100.000 miles) the modular control valve should be disassembled and thoroughly cleaned. Replace all components supplied with the repair kit.

Lubricate all components with lubricant lid in LUBRICANT SPECIFICATIONS, Item 3.

Perform the Service Checks after rebuilding valve assembly.

SERVICE CHECKS

When the service checks on the modular control valve are performed on the vehicle, both the Leakage and Operating checks will be accomplished simultaneously.



In some instances it will be necessary to remove the instrument panel bezel and the access panel on the instrument panel to gain access to the valve. Block or hold vehicle by means other than the parking brake while performing the Service Checks.

- With both control knobs out, charge the air brake system to 448 kPa (65 psi), and check for leakage. No leakage permitted.
- With supply pressure still at 448 kPa (65 psi), push the red knob in. The knob must stay in. Leakage at the exhaust port must not exceed a 25 mm (1") bubble in 5 seconds.
- 3. With the engine off, apply the foot valve several times to deplete the air supply. The red knob must pop out when the reservoir with the highest pressure reaches 276 + 27.6 kPa (40 + 5 psi). If air is depleted quickly, the red knob could pop immediately. Leakage at exhaust port must not exceed a 25 mm (1") bubble in 5 seconds.
- 4. With the engine off, apply the foot valve depleting the air lower. Air must start to escape from the exhaust port when the air pressure in the reservoir with the higher pressure reaches 207 kPa (30 + 5 psi). The yellow knob may pop out at this time.
- 5. With the engine off, deplete the air system further with the foot valve. At 172 kPa (25 + 5 psi) the yellow knob must pop out and maintain supply pressure. Leakage at exhaust port should not exceed 25 mm (1") bubble in 5 seconds.
- Rebuild the supply pressure to at least 276 kPa (40 psi). Push in the yellow knob; the yellow knob must remain in. Leakage at the exhaust port should not exceed a 25 mm (1") bubble in 5 seconds.
- 7. Charge the system to 817 kPa (120 psi) and push both knobs in. Pull the red knob out. The yellow knob must remain in.
- 8. Push the red knob in and pull the yellow knob out. The red knob must pop out almost instantaneously.
- 9. Install a gauge to monitor tractor spring brake delivery pressure. Apply 817 kPa (120 psi) to both primary and secondary reservoirs. Push in the Delivery pressure should equal the yellow knob. pressure in the primary reservoir. Reduce the pressure in the primary Delivery reservoir. pressure and primary reservoir pressure should descend together to 724-621 kPa (105-90 psi) at which point the dual circuit

- supply (double check) valve shuttle should switch to the secondary reservoir and delivery pressure should increase to the secondary reservoir pressure. After the primary reservoir pressure is reduced to zero, a leakage of a 12.7 mm (1/2") bubble in 5 seconds is permitted at the primary reservoir opening. Close the leak which had been created at the primary reservoir.
- 10. Leaving the yellow knob in, recharge the secondary reservoir to 817 kPa (120 psi). The delivery pressure should also read 817 kPa (120 psi). Recharge the primary reservoir to 689 kPa (100 psi). Slowly vent the secondary reservoir. As the secondary reservoir pressure and the delivery line pressure descend between 793-724 kPa (115-105 psi), the dual circuit supply (double check) valve shuttle should switch to the primary reservoir, causing the delivery line pressure to adjust to the primary reservoir pressure.
- 11. Close all vents or leakage points and charge both reservoirs to 817 kPa (120 psi). Position the red knob out and the yellow knob in. Develop a leak in the spring brake delivery line and hold the yellow knob in. The primary reservoir pressure must reduce to zero and the secondary reservoir pressure to 138-207 kPa (20-30 psi). The dual circuit supply valve shuttle should cycle several times during this leakdown period.

REMOVE

- 1. Block and hold vehicle by means other than the parking brakes.
- 2. Bleed air system completely.
- 3. Remove bezel panel and remove instrument panel access cover, to expose valve body cover plates, Item 1 of Fig. 12.
- 4. Mark or identify all air lines connected to valve. Then disconnect air lines.
- 5. Remove valve assembly from instrument panel.
- 6. Remove all fittings from the rear of the valve. Note the direction of all fittings.

REINSTALL

- Assemble fittings in rear of valve. Apply a nonhardening sealing compound to fittings. Do not assume that the fittings will seal themselves to the body. Maximum torque to apply to the fittings is 14 N-m (10 ft. lbs.).
- 2. Assemble valve to instrument panel.

- 3. Connect air lines to their respective fittings (refer to Fig. 7 for porting designation).
- Charge air system and perform Service Checks as outlined.
- 5. Remove the identification tags.
- 6. After checking the serviceability of valve, reinstall the bezel and instrument panel access cover.

DISASSEMBLY

It should be unnecessary to remove the valve assembly to accomplish the normal service in replacing the components. Be sure to block the wheels and drain all air reservoirs. Remove the trim bezel to expose the valve cover plates. It is recommended that the valve be serviced by replacing the complete spool assemblies and the four (4) O-rings and spring in the dual circuit supply (dual check) valve.

Refer to Fig. 12 for numbers in parentheses.

- 1. Remove the screws from the cover plates (1) (four screws in each plate).
- 2. Carefully pull on the knobs to remove their respective spools from valve body.

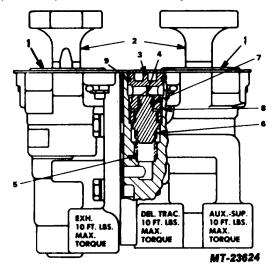


Fig. 12 Cross Section of Dual Circuit Supply

1	Plate Cover (2)	6 O-ring
2	Knob Control	7 O-ring
3	Valve Spool	8 O-ring
4	Valve Shuttle	9 O-ring

Spring Return

- Remove roll pins which retain the control knobs on spool stems. The cover plates (1) can then be removed.
- 4. The dual circuit supply (double check) valve, located in the tractor control (parking brake) body is disassembled by grasping the web in the top of the valve spool (3) with a narrow nose pliers, twist and pull the valve spool out.

The shuttle (4) should also come out with the spool.

5. Remove the shuttle return spring (5) and O-rings (6), (7), (8) and (9).

CLEANING AND INSPECTION

The acetal components which comprise most of the parts of the MV-2 valve should not be immersed in any solvent type cleaner. Old lubricant should be wiped off parts to be reused and the bores of the body wiped out with a clean dry cloth.

REASSEMBLY

Lubricate O-rings, bore and sliding surfaces with lubricant listed in LUBRICANT SPECIFICATIONS, <u>Item</u> 3.

- 1. Place the shuttle return spring (5) in the dual circuit supply valve bore in the body.
- Install O-rings (6) & (7) on the shuttle (4), and (8) and (9) on the valve spool (3).
- Insert the small end of the shuttle in the spool and insert the assembly into the valve bore, flush with top of body. The dual circuit supply valve spool is retained in the body by the same cover plate which also retains the tractor control (parking brake) spool.

New service replacement spools will be prelubricated.

- 4. Place cover plates over each plunger stem. The cover plates are identical and are installed convex side up.
- Place the red knob on the longer spool (for trailer air supply), matching the groove in the knob with the tongue in the cover plate (where applicable), and secure with the roll pin.



- Place the yellow knob on the shorter spool (for tractor air supply), matching knob and cover (where applicable) and secure with the roll pin as before. A new roll pin will be found in each spool package.
- 7. Insert the shorter spool assembly with yellow knob in the tractor supply bore (housing with the dual supply valve). If the entire valve assembly has been removed, position the assembly so that the tractor control body housing is at 3 o'clock. With the open bore (trailer supply) at 9 o'clock, rotate the button until wording on top-center is horizontally readable. The stepped side of the cover plate should be
- covering the dual supply valve. Secure the plate with the four flat head Phillips screws; torque to 2.83 N-m (25 in. lbs.).
- Insert the longer spool assembly with red knob in the remaining bore. The stepped sides of the cover plates should key with each other cover when the remaining four flat head screws are torqued to 2.83 N-m (25 in. lbs.).
- 9. Perform the SERVICE CHECKS as outlined.
- 10. Reinstall the bezel assembly.

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CHAPTER X

HAND CONTROL VALVE

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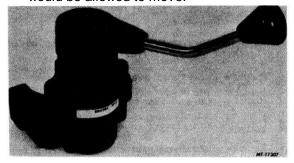
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DESCRIPTION

The hand control valve (Fig. 1) is used for controlling the brakes on a trailer independently of the brakes on the towing vehicle. The valve is usually mounted on the steering column or on the dash and provides the operator with a finely graduated and easy means of applying and releasing the brakes. The distance the brake handle is moved in a clockwise direction toward applied position determines the severity of the brake application.

CAUTION

The hand control valve should never be used to hold the brakes applied when the chassis is parked and unattended as air could leak from system and vehicle would be allowed to move.



BENDIX TC-2 TYPE

Two types of the TC-2 hand control valves are used--the handle control type and the remote control type.

OPERATION

<u>Apply</u>

When the handle is moved in a clockwise direction from the released position, force is exerted on top of the pressure regulating spring through the action of the cam and cam follower. The force on top of the spring causes the piston to move down. The exhaust seat is in the center of the piston, contacts the exhaust valve and closes the exhaust passage in the piston. At the same time the exhaust closes, the continued downward movement of piston moves the inlet valve off its seat. Air pressure from the reservoir then flows by the open inlet and out the delivery port, through the service line and applies the brakes.

The air pressure that flows by the open inlet valve also becomes effective on the bottom area of the piston. As the force of the air pressure beneath the piston balances the force of the depressed graduating spring above, the piston lifts slightly and the inlet valve returns to its seat. The exhaust valve remains seated so the flow of air through the valve is stopped and air pressure in the service line is held.

Release

When the handle or operating lever is moved in a counterclockwise direction, the force above the piston is decreased. The air pressure beneath will then lift the piston, moving it away from the exhaust valve. With the exhaust passage open, air pressure in the service line will exhaust out the exhaust port of the valve.

MAINTENANCE

Every three months or 40,000 km (25,000 miles) the hand control valve should be checked for graduation and proper operation. The linkage or lever connections to the remote operated type valve should be checked and lubricated if required.

Once each year or 160,000 km (100,000 miles) disassemble the hand control valve. Clean and inspect all parts. Inlet and exhaust valves should be replaced if the valve insert is completely disassembled.

SERVICE CHECKS

Operation Test

Check the delivered pressure of the valve with a test gauge known to be accurate.

Move the control handle to the fully applied position; it should deliver full reservoir pressure. Some special hand control valves are preset to deliver higher or lower pressures, but the standard valve used on tractor-trailer combinations is set to deliver full reservoir pressure.

Move the handle between the released and fully applied positions and note that the air pressure registered on the test gauge varies accordingly.

Leakage Test

With the valve handle in the released position, check the exhaust port for inlet valve leakage.



With the handle in the fully applied position, check the exhaust port for exhaust valve or piston grommet leakage.

In neither of the above checks is excessive leakage permitted.

If the brake valve does not function as described or leakage is excessive, it is recommended that it be repaired or replaced.

REMOVE

- 1. Apply parking brake or block wheels to prevent vehicle from moving.
- 2. Drain air brake system.
- 3. If valve is remote-operated type, disconnect the operating mechanism.
- 4. Disconnect air lines at bottom of the valve -- including exhaust carry-off line if used.
- 5. Remove mounting clamp bolts, clamp and then valve.

REINSTALL

- 1. Check and clean air lines to valve.
- 2. Operating mechanism for remote type should be checked functionally and for proper adjustment.
- 3. Mount valve with clamp and mounting bolts.
- Tighten mounting bolts evenly to avoid bending or breakage of the valve body, clamp or steering column.
- 5. Connect operating mechanism to remote-mount type valve.
- 6. Perform tests on the valve as outlined in SERVICE CHECKS.

DISASSEMBLY

- If valve is handle operated, drive out the roll pin and remove the handle, head and head seal grommet.
- 2. Remove handle grommet.
- On the remote type valve remove the set screw; then the head and head seal grommet.
 From this point the disassembly of both the handle and remote types is the same.

4. Remove adjusting ring lockwasher.

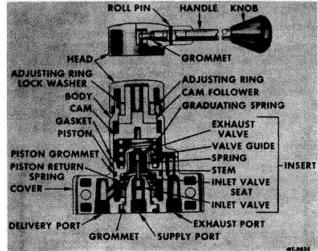


Fig. 2. Sectional View of TC-2 Hand Control Valve

- 5. Remove capscrews that hold body and cover together; separate cover from body.
- 6. Remove gasket and graduating spring.
- 7. Remove cam and cam follower from cover.
- 8. Unscrew and remove adjusting ring.
- 9. Remove piston and piston return spring from body.
- 10. Remove piston grommet.
- Remove inlet and exhaust insert screws and lockwashers, then insert and grommet seal. The inlet and exhaust valve insert assembly can be disassembled now.
- 12. Insert some object such as a capscrew in the supply port to hold the inlet valve on its seat.
- 13. Next, depress the exhaust valve guide and spring and remove the exhaust valve.
- 14. Remove stem with inlet valve from inlet seat and remove inlet valve from stem.

CLEANING AND INSPECTION

- 1. Wash all metal parts in good cleaning solvent and dry.
- 2. Replace all rubber parts.
- Inspect all parts for excessive wear or deterioration.

- 4. Check springs for cracks, corrosion or distortion.
- Inspect valve seats and piston bore for nicks and burrs.
- 6. Replace all parts not considered serviceable during these inspections.

REASSEMBLY

Before starting to reassemble the TC-2 valve assembly, lubricate the body and cover bores, cam and cam follower, piston grommet and cover top with a lubricant comparable to that listed in LUBRICANT SPECIFICATIONS, Item 1.

- 1. Press the inlet valve on stem. A little water in the boot valve or some soap on the stem will make it easier to press on the inlet valve.
- Place stem with inlet valve installed in the inlet seat. Insert some object such as a capscrew to hold the inlet valve up against its seat.
- 3. Position spring and exhaust valve guide.
- 4. Depress guide and spring, then press exhaust valve on stem.
- Place seal grommet over insert seat and with capscrews and lockwashers, install inlet and exhaust insert in body. Recommended torque on insert capscrews is 60-80 inch-pounds.
- 6. Install piston return spring.
- 7. Install piston grommet on piston and install piston in body.
- 8. Install adjusting ring in cover and screw it down until it is flush with top of cover.
- 9. Place cam follower and cam in cover.
- 10. Position graduating spring and gasket in body.
- 11. Connect body to cover; tighten capscrews evenly. Torque recommended is 8.4-10.6 Nm 75-95 inch-pounds.
- 12. Install adjusting ring lockwasher, head seal grommet and head.
- 13. Install set screw in head of remote-operated type valves.

Before installing handle and roll pin of handleoperated type, the rebuilt valve should be tested and adjusted on a suitable test rack. If facilities are not available, the valve can be tested on the vehicle.

14. Test the hand control valve as outlined in SERVICE CHECKS.

ADJUSTING

The standard brake valve should deliver full reservoir pressure. There are a few exceptions in special valves.

If the delivered pressure is below 862 kPa (125 psi), it can be adjusted by removing the head and adjusting ring lockwasher and rotating the adjusting ring clockwise to raise the delivered pressure. If the delivered pressure is above 862 kPa (125 psi), it can be lowered by rotating the adjusting ring counterclockwise.

A spanner wrench can be used to rotate the adjusting ring, but if such a wrench is not available, the adjusting ring can be turned with a small screwdriver inserted in one of the inner notches of the ring. Turning the adjusting ring one notch will raise the delivered pressure about 35 kPa (5 psi).

MIDLAND-ROSS

Refer to Fig. 3 for numbers in parenthesis throughout this text which applies to the Midland-Ross Hand Control Valve.

OPERATION

VlqqA

When the handle (23) is moved in a clockwise direction from the released position, a rotary force is applied to a spiral cam (8 and 13) which in turn converts rotary motion to axial thrust which forces the compensator spring (14) into compression. The spring (14) acting on the piston (15), moves the piston (15) along the centerline of the valve to close the gap between the piston (15) and the discharge valve assembly (16) which closes off air passage between (A) and (B). Further piston movement opens inlet valve (4) by moving it away from valve seat of body (18). Reservoir air pressure at the supply inlet port enters cavity (A) and passes thru to the delivery port and out to the trailer service brake line. The delivery port is common to cavity (A). Air is blocked from exhausting thru (B).

Hold

Air pressure in (A), acts against piston (15) to move it axially against spring (14). When the

resultant forces above and below piston (15) approach a balance, piston (15) moves to allow the inlet valve to seat against body (18). Providing that spring forces and air pressure forces maintain equilibrium by virtue of holding the cam position and air pressures at the resultant condition, the valve attains a "lap" position. It is instantly responsive to any change in lever movement to increase or decrease the delivery pressure. This controlled modulating characteristic occurs from 0 to about 552 kPa (80 psi). When the handle is traveled fully clockwise, the valve will deliver full inlet supply pressure.

Release

Returning the handle (23) towards the "off" position reduces the forces of the spring (14) acting against piston (15). The "lap" position whereby both exhaust valve and inlet valve are seated simultaneously is instantaneously traversed. Force from air pressure in cavity (A) continues to move piston (15) away from exhaust valve (16). Air pressure feeding back from the delivery port enters cavity (B) and exhausts to atmosphere thru the exhaust port.

MAINTENANCE

The hand control valve is designed for maintenance free operation for the life of the vehicle. Should disassembly be necessary, follow disassembly instructions.

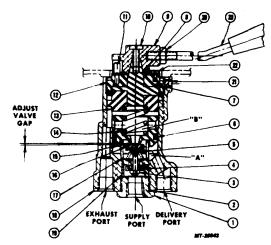


Fig. 3. Sectional View of Midland Ross Hand Control Valve

	Leg	end for Fig	ure 3
<u>Key</u>	<u>Description</u>	<u>Ke</u> y	<u>Description</u>
1	End Cap	13	Cam

2	O-Ring	14	Spring
3	Lock Nut	15	Piston
4	Valve Disc Assem.	16	Discharge Valve Assem.
5	Spring	17	Spring
6	O-Ring	18	Body
7	O-Ring	19	Valve
8	Cam Shaft	20	Nut
9	Cover	21	Set Screw
10	Screw	22	Screw
11	Lock Assembly	23	Handle Assembly
12	Bearing		

TEST AND ADJUSTMENT

- 1. Connect 690 to 862 kPa (100 to 125 psi) air supply (full reservoir pressure) to the inlet port and a gauge to the delivery port.
- 2. Check for exhaust port leakage. A 25.4 mm (1 in.) bubble in 6 seconds is permissible.
- 3. Apply the valve by moving the handle c.w. Delivery pressure should start to build up after 10 to 15 degrees of handle motion and full supply pressure should be delivered after 60 degrees of handle rotation. 70 degrees of handle travel is available between full application and full release.

If handle travel is excessive before delivery begins, or if full supply pressure is not delivered, bearing (12) must be threaded further into the valve body.

If air is delivered with the handle in the fully released position, bearing (12) should be turned counter clockwise to back it further out of the valve body.

Proper adjustment will result by screwing bearing (12) into the body (without air pressure connected) until valve disc assembly (4) is held open and then connecting the air supply and backing bearing (12) out of the valve body to the point where delivery pressure is zero and then continuing 1/2 turn. Bearing (12) can be rotated slightly in either direction as required to allow lock assembly (11) to be installed in its proper position.

- 4. Check valve exhaust port for leakage with low pressure delivery of 103 kPa (15 psi) and with full pressure delivery. A 25.4 mm (1 in.) diameter bubble in 6 seconds is allowable.
- 5. Rotate the valve handle to a position giving 483 kPa (70 psi) delivery pressure. The valve



should retain 414 kPa (60 psi) delivery pressure minimum when the handle is released.

REMOVE AND REINSTALL

Refer to the Remove and Reinstall procedures outlined in the BENDIX Hand Control Valve portion of this chapter.

DISASSEMBLY

Rotate handle to the release position. Mark location of cover (9) and lock assembly (11) in relation to body (18).

- 1. Loosen nut (20) and unscrew handle (23) from cover (9).
- 2. Remove screw (10) and remove cover (9).
- 3. Remove screw (22) and remove lock assembly (11).
- 4. Loosen set screw (21), remove bearing (12), Oring (7), cam shaft (8), cam (13) and spring (14).
- Carefully remove piston (15), O-ring (6) and spring (17). Turn valve upside down for further disassembly:
- 6. Carefully remove end cap (1), O-ring (2) and valve guide (19).
- Reach down thru large bores and grip discharge valve assembly carefully, so as to prevent damage, to stop it's rotating while removing lock nut (3). Remove discharge valve assembly (16) and valve disc assembly (4) and spring (5).

CLEANING AND INSPECTION

- 1. Wash all metal parts in mineral spirits and dry.
- 2. Wipe clean all plastic parts <u>DO NOT USE SOLVENTS.</u>
- 3. Replace all rubber parts and springs as provided in repair kit.
- 4. Lubricate all seals except O-ring (7) with lubricant comparable to that listed in LUBRICANT SPECIFICATIONS Item 3. <u>Do Not lubricate cam (13) or cam shaft (8).</u>
- Inspect all metal and plastic parts for nicks, scratches, or excessive wear. Replace if necessary.
- 6. Reassemble valve.

REASSEMBLY

Hold valve in horizontal position.

- Slip spring (5) on discharge valve assembly (16) with small diameter end against discharge valve and place stem first thru seat from large bore end of valve.
- Holding discharge valve assembly (16) with spring (5) securely and from opposite end, assemble valve disc assembly (4) over stem of discharge valve assembly and assemble lock nut (3). Torque lock nut to .6 - .8 Nm (5-7 inchpounds) torque.
- 3. Install valve guide (19).
- Slip O-ring (2) on end cap (1) and install end cap (1) in body (18). Securely position valve with large bore up and complete assembly 5. Install spring (17) in proper groove in body (18' 6. Slip O-ring (6) on piston (15) making sure that the O-ring and piston are well lubricated.
- 7. Install piston (15) in body (18) making sure spring (17) is not cocked.
- 8. Install spring (14) on top of piston (15) and place cam (13) in grooves provided in body (18).
- 9. Install cam shaft (8) in cam (13).
- Place O-ring (7) in bearing (12) and slip bearing (12) over cam shaft (8) and tighten until a gap of .896/.672 mm (. 040/.030 in.) is registered between piston (15) seat and discharge valve assembly (16) face (approx. 8 turns). Refer to Adjust Valve Gap; Fig. 3.
- 11. Place lock assembly (11) in bearing (12) so as to line up previously scribed lines marked on lock assembly (11) and body (18). Retain, using screw (22) in first hole clockwise of lock pin. Tighten set screw (21) until contact is made with bearing (12) and then go one additional turn to lock the bearing in place.
- 12. Assemble nut (20) on handle assembly (23). Screw handle assembly (23) into cover (9). Rotate handle assembly (23) to desired position and lock in place with nut (20).
- 13. Install cover and handle assembly (9 and 23) making sure previously scribed locating marks line up.
- 14. Secure cover and handle assembly (9 and 23) with screw (10) torqued to 1.4-1.6 Nm (1214 inch-pounds).



CHAPTER XI

TRACTOR PROTECTION VALVE AND MANIFOLDED TRACTOR PROTECTION VALVE

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MIDLAND-ROSS TRACTOR PROTECTION VALVE DESCRIPTION

The tractor protection valve (Fig. 1) is normally mounted at the rear of cab where tractor air system is connected to the service and emergency air hoses used for coupling tractor and trailer brake systems. Valve has a piston arrangement that is pressure sensitive to tractor air brake system, which provides automatic closing of both lines when system pressure approaches low energy levels. Manual actuation of the valve is performed by the operator through use of a two-way air control valve. When the control valve is opened (knob pushed in), air pressure is supplied to control port to open the tractor protection valve. Pulling air control "out" exhausts the air, allowing the tractor protection valve to close.

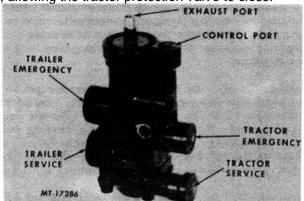


Fig. 1. Tractor Protection Valve.

A quick release feature is also incorporated in the valve and serves to improve normal service brake release time of trailer brakes. During brake release, control air delivered to actuate trailer brakes will exhaust at tractor protection valve as compared to exhausting through foot or hand control valves.

If either an automatic or manual operation closes the tractor protection valve, air in the trailer emergency line is exhausted through the tractor protection valve.

During normal tractor operation without trailer, the air control valve is "out" and tractor protection valve is closed. Air passages leading from tractor system to trailer couplings are blocked.

After coupling a trailer to the tractor, the twoway air control is pushed "in." Air flows through tractor protection valve emergency line to charge trailer brake system reservoirs. Trailer brakes are released simultaneously if trailer brakes are holding prior to coupling.

During normal tractor-trailer operation, the tractor protection valve remains open. It allows air to flow in either direction between trailer air brake system and tractor air brake system. Trailer service brakes are applied and released by driver's operation of either the foot brake control or hand control valve. Service brake control air flows through the service passage of the tractor protection valve. Trailer air reservoirs and brake system are replenished by air flow through the emergency passage.

Driver can make an emergency trailer brake application by moving air control valve "out." Tractor-to-trailer service and emergency passages close and exhaust passages open. Trailer brakes apply when air exhausts from the trailer emergency line through tractor protection valve exhaust passage.

The air control valve is moved "out" to close tractor protection valve prior to disconnecting trailer from tractor.

OPERATION

Fig. 2 illustrates the tractor protection valve in the closed position for operating a tractor without a trailer (bob-tailed). Refer to Fig. 2 for numbers in parenthesis.

Closed Position (Air Control Valve "Out")

Rubber valve (13) is seated against spool (7) closing off passage of air through valve from tractor service to trailer service port. Exhaust valve assembly (5) is seated against valve body (20) closing off passage of air through valve from tractor emergency to trailer emergency port. The control port and cavity "A" are vented to exhaust through the two-way air control valve on instrument panel. Both trailer emergency and service ports are open to atmosphere through exhaust passages "B" and "C."

Open Position (Air Control Valve "In")

When trailer hoses are connected to trailer, air pressure is supplied from tractor air system to control port and enters cavity "A." Air pressure above 345 kPa (50 psi) acts against piston (17) to move it towards spring (19). Piston seats a-

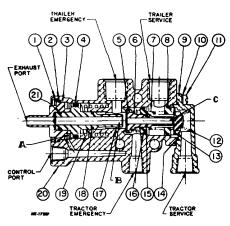


Fig. 2. Tractor Protection Valve

Legend for Fig. 2

Key	<u>Description</u>	Key	<u>Description</u>
1	RING, Snap	11	SCREW
2	SEAL, O-Ring	12	SPRING
3	CAP, End	13	VALVE, Rubber
4	SEAL, O-Ring	14	SEAL, O-Ring
5	VALVE, Exhaust	15	SEAL, O-Ring
	Assembly	16	SEAL, O-Ring
6	SPRING	17	PISTON
7	SPOOL	18	SEAL, O-Ring
8	SEAL, O-Ring	19	SPRING
9	COVER, End	20	BODY
10	LOCKWASHER	21	SEAL, O-Ring

gainst valve face of assembly (5). Further movement pushes exhaust valve assembly (5) away from body seat (20), seats assembly (5) against rubber valve (13) and pushes it away from spool seat (7). Service and emergency air passages from tractor to trailer ports are open. Exhaust seats are closed, blocking air from passing through cavities "B" and "C" to atmosphere.

During normal service brake release, brake control air supplied through the downstream of the tractor protection valve acts to unseat valve (13) from exhaust valve (5). Air enters cavity "C," goes through "B" and out exhaust port. Air upstream from tractor protection valve is exhausted through foot valve or hand control valve.

If tractor brake system pressure drops to 172-276 kPa (25-40 psi), spring force (19) moves piston (17) towards exhaust port. Simultaneously, springs (6) and (12) push assembly (5) and valve (13) to follow. Tractor-to-trailer passages are closed and trailer emergency air is exhausted through "B." Trailer brakes apply automatically.

If the two-way air control valve is pulled "out" for emergency braking or uncoupling trailer, the pilot air exhausts from cavity "A." Tractor protection valve attains closed position and trailer brakes apply.

MAINTENANCE

Once each year or every 160,000 km (100,000 miles) remove, disassemble and clean all parts. All rubber parts must be replaced.

SERVICE CHECKS

Leakage Test

Use air pressure source equipped with in-line manual shut-off air gauge and connection.

Install pipe plugs in any threaded ports not shown or labeled by Fig. 2.

Connect air line to tractor service port. Open manual valve slowly to build up 681-861 kPa (100-125 psi) and shut off manual valve. No air leakage is permissible through end cover and body casting surfaces, around screws and jointing flanges. No air leakage permissible that is passing through valve and evident at tractor emergency, trailer service and emergency or exhaust ports.

Disconnect air line from tractor service port and connect to tractor emergency port. Build up 681-861 kPa (100-125 psi) pressure. No air leakage permissible through surrounding casting surfaces. No leakage permissible through valve and evident at tractor service, trailer service and emergency or exhaust ports. Disconnect air line.

Connect air line to control port. Build up 681861 kPa (100-125 psi) air pressure. No air leakage permissible through casting surfaces or evidence of air leakage out any of the other five open ports or around end cap snap ring. Disconnect air line.

Operation Tests

Performance Checks: An additional manifold fixture with two connections, air gauge and manual shut-off valve will be required for performance checks. Preferably, the manifold should be supplied with air by a separate line to the air source.

Install separate air gauges in trailer service and emergency ports. Connect manifolded fixture to control port and tractor emergency port.

Open manual valve to allow 345-379 kPa (50-55 psi) air pressure buildup to both ports. Shut off manual valve. Pressure buildup at trailer emergency port should have occurred. Gauge at

trailer service port must not show pressure. Permissible leakage at exhaust port is a 25 mm (1") diameter bubble in six seconds.

During next check, 379-414 kPa (55-60 psi) air pressure needs to be maintained at control port and tractor emergency port.

Connect air line with gauge and shut-off valve to tractor service port. Open valve to build 345 kPa (50 psi) pressure and shut off valve. Trailer service gauge must show build-up pressure. While maintaining steady pressure of 379-414 kPa (55-60 psi) at pressurized ports, permissible leakage at exhaust port is 25 mm (1") diameter bubble in three seconds. Disconnect air pressure to tractor service port. Trailer service port pressure must exhaust to zero.

Begin with manifold pressure supplying both control and tractor emergency ports at 681-861 kPa (100-125 psi). Shut off manual valve and disconnect air source. Open manual valve slowly and allow manifold pressure to bleed down to 272 kPa (40 psi) and close manual valve. Air pressure at trailer emergency port should have exhausted to zero. While maintaining steady pressure of 138-172 kPa (20-25 psi) at control port and tractor emergency port, connect air to tractor service. Open manual valve to build up 345 kPa (50 psi) pressure. Gauge at trailer service must not show pressure. Disconnect all air lines and gauges and remove pipe plugs where used.

DISASSEMBLY

Refer to Fig. 2 for numbers in parenthesis.

After valve is disconnected and removed from tractor, inspect it visually for damage. If casting is broken or shows fractures, replace valve.

To disassemble valve, place hand force against end cap (3) while carefully removing snap ring (1) by prying it out of the groove. (Pulling exposed end of snap ring straight out will distort it.) Spring (19) will push end cap (3) and piston (17) out of body (20). Remove spring (19) and O-ring (2) from body. End cap (3) and piston (17) can be separated easily.

Maintain finger force against end cover (9) while removing four screws (11) and four washers (10). Carefully allow spring (12) to free height. Remove end cover, spring and valve (13). Be alert for spring (6) to push out spool (7). Remove spool, spring and exhaust valve assembly (5) from body. Remove O-rings (4), (8), (14), (15), (16), (18) and (21) from pistons, spool and cover. (Remove metal retainer and rubber seal from assembly (5).

CLEANING AND INSPECTION

Wash all parts in clean mineral spirits or equivalent cleaning solvent and then dry.

Examine rubber valve seals and O-rings. Rubber parts must be free of cuts, nicks or tears.

Examine end cap, pistons and spool. All contacting surfaces for O-ring seals must be smooth and round and free of deep scratches, dents or gouges. Valve seats at end of piston tubes and spool must be flat and smooth showing no dents or distortion. Spool must not be fractured or have pieces broken out. Flange on piston for valve assembly (5) must not be dented or bent.

Examine valve body and end cover. Castings should be free of cracks and voids. All surfaces for Oring seals must be smooth and round and free of deep scratches, dents or gouges. Small hole passage from control port into main bore must not be plugged. Mating surfaces of valve body and end cover flange must not be dented or bent. Snap ring groove in valve body must not be distorted and must be free of corrosion. Valve body seat must be flat and smooth, free or dents and deep scratches.

Examine springs, valve retainer, snap ring, screws and washers. Parts should be free of distortion and corrosion.

Replace parts that show any of the above defects.

It is recommended that all rubber parts be replaced with new parts supplied in the repair kit.

REASSEMBLY

Lubricate O-rings and valve seal and all O-ring sealing surfaces and bearing surfaces on pistons, end cap, cover, spool and body. Apply a thin film of Item 3 of LUBRICANT SPECIFICATIONS. Install O-ring (15), valve seal and retainer washer to make exhaust valve assembly (5). Install assembly (5) into valve body (20). Install spring (6) with large end against exhaust valve retainer. Install O-rings (8) and (16) on spool (7) and O-ring (14) on end cover (9). Place spool on spring (6) with spool seat facing out. Place spring (12) and rubber valve (13) on top of spool (refer to Fig. 2 to see position of valve to spring). Align end cover (9) to valve (13) and body (20). Push gently and firmly to compress spring (6) until cover contacts spool. Continue pressing spool into body. Hold end cap and install four washers (10) and screws (11). Tighten screws to 6-7 N.m (50-60 in lbs) torque.

Install spring (19) into valve body (20). Install O-rings (4), (18) and (21) on piston (17). Install O-ring (2) on end cap (3) and mate piston to end cap. Install piston and end cap on spring. Align and push end cap firmly into body and hold to prevent spring from pushing end cap out. Install snap ring (1) into valve body groove properly.

MIDLAND MIDLAND-ROSS MANIFOLDED TRACTOR PROTECTION VALVE

DESCRIPTION

The manifolded tractor protection valve (Fig. 3) can be referred to as a modular tractor protection valve, since it is one valve that incorporates several different functions.

The valve incorporates a manifold built into it to accommodate two (2) brake valve or foot valve ports and a hand control port through two built in two way check valves for service brake application. It also incorporates a quick release feature, automatic shut off on loss of emergency trailer air and an automatic bleed back of any trapped service air.

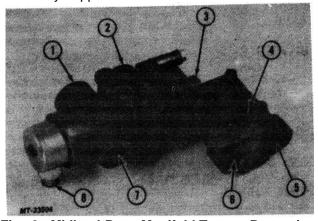


Fig. 3. Midland-Ross Manifold Tractor Protection Valve

Location of Ports of Valve Shown in Fig. 3

- 1 Trailer Emergency
- 2 Trailer Service
- 3 Stop Light Switch
- 4 Brake Valve Secondary
- 5 Hand Control Valve
- 6 Brake Valve Primary
- 7 Tractor Emergency
- 8 Exhaust

The manifolded valve establishes whether the service air brake line connecting tractor and trailer brake

systems is opened or closed. The emergency passage through the valve is always open. The opening and closing of the service air brake lines is established by shuttling a spring loaded tapered piston working against piston forces developed by air pressure levels in the emergency passage. Manual activation of the valve is performed by the operator through the use of the air control valve at the instrument panel.

When the Trailer Emergency Control is opened (knob pushed in), air pressure is supplied to the emergency port to open the tractor protection valve. Pulling the Trailer Emergency Control knob "out" exhausts the emergency line at the air control valve allowing the tractor protection valve to close.

A quick release feature incorporated in the service passage serves to improve brake release time response. During service brake release, the service line air pressure in the trailer system is exhausted to atmosphere at the tractor protection valve as compared to exhausting at the foot valve or hand control valve.

The automatic shut-off bleed back feature allows the valve to automatically shut off under a full service brake application. When the Trailer Emergency Control is pulled out while the service brakes are applied, the bleed back feature allows the trapped air in the trailer service line to bleed to "O" kPa or psi pressure.

During normal tractor operation without trailer, the Trailer Emergency Control knob is "out" and the "service" passage at the tractor protection valve is closed. The Trailer Emergency Control valve blocks the air pressure to the emergency passage to the tractor protection valve. Air passages leading from tractor system to trailer couplings are blocked.

When coupling the tractor to the trailer, the Trailer Emergency Control (dash valve) knob is pushed "in". Air flows through the tractor protection valve emergency line to charge trailer brake system reservoirs. Trailer brakes are released simultaneously if trailer brakes are holding prior to coupling. When the air pressure in the emergency line reaches approximately 276-345 kPa (40 to 50 psi), the tractor protection valve service passage will open.

During normal tractor-trailer operation, the tractor protection valve remains open, allowing air to flow in either direction between tractor and trailer air brake system. Trailer service brakes are applied and released by operation of either the foot brake valve or hand control valve, when air flows through the service passage of the tractor protection valve. Trailer air reservoirs and brake system are replenished by air flow through the emergency passage.

OPERATION

Refer to Fig. 4 for numbers in parenthesis throughout this text which applies to the Midland-Ross manifolded tractor protection valve.

Figure 4 illustrates the tractor protection valve in normally closed position for operating the tractor "bobtail" (without trailer).

Rubber valve (8) is seated against check valve body (6) by piston (10) closing off passage of air through valve from tractor service ports to trailer service port. Cavity "B" is vented to exhaust through the Trailer Emergency Control (not shown) located in cab dash panel. The trailer service port and cavity "A" are vented to atmosphere.

After connecting the trailer and pushing the Trailer Emergency Control valve knob "in", air pressure is supplied from tractor system through cavity "B" (from tractor emergency port to trailer emergency port). Air pressure above 276-345 kPa (40 to 50 psi) against piston (10) causes it to move towards spring (12). Piston bottoms out on exhaust disc (13) which is held securely in place by snap ring (16). Service air passage from tractor to trailer is open.

During normal service brake application, the controlled air supplied by the foot valve enters the service ports marked foot valve no. 1 (primary) and foot valve no. 2 (secondary). The air pressure moves valve disc (3) against cover (2) closing off hand control port. Air is allowed to enter cavity "A". The air pressure moves valve (8) down to seat on piston (10) blocking off cavity "C". Air then flows around the diaphragm effect

of seal (8) and out the trailer service port to trailer brakes. The air supplied by the hand control valve enters the service port marked "hand control". The air pressure moves valve disc (3) (under cover (2)) against the seat on check valve body (6) blocking the air passage to the foot valve port no. 1. The air flows around valve disc (3) and enters cavity "D". The air pressure pushes valve disc (3) (under cover (4)) against cover (4) blocking the air passage to foot valve port no. 2. The air pressure enters cavity "A" and continues the same function as previously stated in service brake application.

When the service brakes are released, the controlled air supplied through and downstream of the tractor protection valve acts to unseat valve (8) from exhaust seat on piston (10). The exhaust air enters cavity "C" and out exhaust port. Air upstream from tractor protection valve is exhausted through foot valve or hand control valve.

If service brake system pressure on the tractor drops to 30 to 40 psi, spring force (12) moves piston (10) towards inlet seat on check valve body (6) and closes the tractor to trailer service port.

The automatic shut-off and bleed back feature functions when the service brakes or hand control valve are applied. When the Trailer Emergency dash control valve is pulled out, pressure in cavity "B" will be reduced to "O" psi, trapping applied service brake pressure in trailer service port. At this time, the trapped air will bleed by one-way check disc (21) into cavity "B" which is exhausted to atmosphere through trailer emergency valve at instrument panel.

(Text continued on Page 9)

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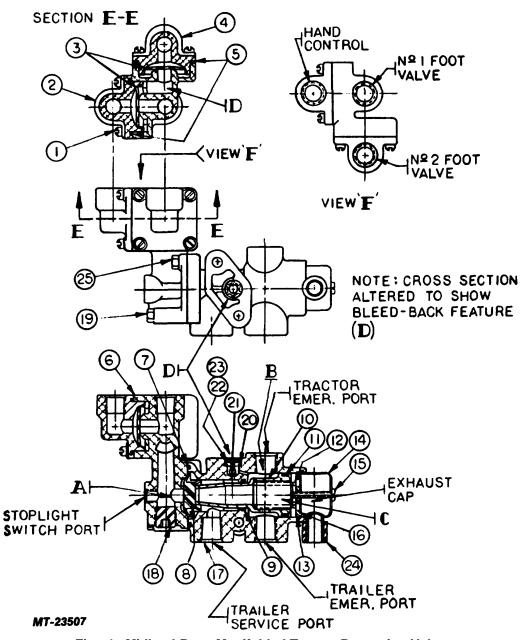


Fig. 4. Midland-Ross Manifolded Tractor Protection Valve

Key	<u>Description</u>	<u>Key</u>	<u>Description</u>	<u>Key</u>	Description	Key	Description
1	Screw	7	"O" Ring	13	Exhaust Disc	19	Screw
2	Cover (hand control)	8	Valve Seal	14	Cap Assembly	20	"O" Ring
3	Valve Disc	9	"O" Ring	15	Screw	21	Valve Disc
4	Cover (foot valve no.2)	10	Piston	16	Snap Ring	22	Plug
5	"O" Ring	11	"O" Ring	17	Body	23	Star Washer
6	Check Valve Body	12	Spring	18	Pipe Plug	24	Foam Seal
	-		-			25	Screw

SERVICE CHECKS

When the service checks of the tractor protection valve are made on the vehicle, both the Leakage and Performance checks will be accomplished simultaneously.

To obtain access to the manifolded tractor protection valve on some vehicles, removal of the floor panel directly ahead of the driver's seat will be required.

Unless otherwise instructed, all disconnect points in the following instructions will be made at the tractor protection valve.

Leakage Checks on Vehicle

- 1. Disconnect hand control and trailer service air lines, Trailer Emergency Control valve pulled out (no air to Trailer Emergency).
- With 689-861 kPa (100-125 psi) in both primary and secondary air systems, apply the brake (foot) valve. Total leakage measured at hand control port, trailer service port and exhaust port should not exceed 82 cm3 (5 cu. in.) per minute or total of a 25 mm (1") soap bubble in 12 seconds.
- 3. Connect hand control valve line to tractor protection valve and disconnect brake (foot) valve lines (1 and 2).
- 4. Apply hand control valve. Total leakage measured at foot valve ports (1 and 2), trailer service port and exhaust port must not exceed 82 cm3 (5 cu. in.) per minute or a total of a 25 mm (1") soap bubble in 12 seconds.
- 5. Disconnect lines at hand control port and trailer emergency port.
- 6. Install a pipe plug in trailer emergency port.
- 7. With 689-861 kPa (100-125 psi) in both primary and secondary air systems, push trailer emergency control "in". Leakage through valve and at trailer service and exhaust ports should not exceed 82 cm3 (5 cu. in.) per minute or a total of 25 mm (1") soap bubble in 12 seconds.
- 8. Pull Trailer Emergency Control out and remove pipe plug from trailer emergency port. If valve passes leakage check, the performance check should be made.

Performance Checks on Vehicle

1. Install a duplex gauge or two single air gauges at trailer service and emergency ports.

- 2. With 379 kPa (55 psi) in both primary and secondary air systems, push the Trailer Emergency Control "in". Air pressure at instrument panel gauge and trailer emergency port should read approximately the same. The air gauge connected at trailer service port must not show pressure. Permissible leakage at exhaust port is a 25 mm (1") soap bubble in three (3) seconds.
- 3. Replenish air to 689-861 kPa (100-125 psi) in both primary and secondary systems.
- 4. Bleed off secondary air reservoir.
- 5. With Trailer Emergency Control at instrument panel pushed in, apply the hand control valve. There should be a minimum of 586 kPa (85 psi) at trailer service port.
- Release hand control valve and apply brake (foot) valve. Pressure at trailer service port should be within 35 kPa (5 psi) of air gauge at instrument panel.
- 7. Replenish air systems to 689-861 kPa (100-125 psi) and bleed off the primary air reservoir.
- 8. With the Trailer Emergency Control at instrument panel pushed in and hand control valve released, apply brake (foot) valve. Pressure at trailer service should be within 35 kPa (5 psi) of air gauge at instrument panel.
- 9. Replenish complete air system to 689-861 kPa (100-125 psi).
- Apply brake (foot) valve, pull Trailer Emergency (red) knob out. The duplex gauge connected to trailer service port should record the same valve (689-861 kPa or 100-125 psi) as gauge at instrument panel. Gauge connected at trailer emergency should be "O".

If valve passes the aforementioned leakage tests and performance tests, it is considered a serviceable valve. Remove duplex air gauge and reassemble trailer service and emergency air lines.

REMOVE

- Pull park brake control on instrument panel out, to set parking brake. Be sure trailer emergency control is pulled out.
- Bleeding air system is not required since there will be no air supplied the manifolded tractor protection valve with the brake (foot) valve and hand control valve released.
- 3. Mark all air lines in relation to valve to assist in reconnecting lines.

- 4. Disconnect air lines at valve. Disconnect stop light switch wires.
- 5. Remove mounting bolts.
- 6. If tractor protection valve is being replaced remove stop light switch.

REINSTALL

Installation of the manifolded tractor protection valve is basically the reverse of the removal.

Be sure to perform the service checks before returning the vehicle to service.

DISASSEMBLY

Refer to Fig. 4 for numbers in parenthesis.

- Inspect the valve for visual damage. If casting is broken or shows fractures, replace the complete valve assembly. Remove stop light switch assembly if it was not removed during the removal of valve assembly.
- 2. Remove exhaust end cap (14) by removing screw (15).
- 3. Press exhause disc (13) in and remove snap ring (16). Take precaution as exhaust disc is spring loaded. Then remove exhaust disc.
- 4. Remove piston (10) from body (17).
- 5. Remove O-ring (11) from piston and O-ring (9) from body.
- 6. Remove star washer (23) from body by prying it out from bore. Then remove plug (22), O-ring (20) and valve disc (21) from body.
- 7. Remove the eight cover screws (1) so that hand control cover (2) and foot valve no. 2 can be separated from check valve body (6).
- 8. Remove both check valve discs (3).
- Scribe alignment marks on check valve body (6) and body (17) for reassembly purposes.
 Remove the four cap screws (19 & 25) so that check valve body (6) can be separated from body (17).
- 10. Remove O-ring (7) and valve seal (8) from body (17).

CLEANING AND INSPECTION

Wash all metal parts in cleaning solvent, then dry. Discard all rubber parts which are supplied with service kit.

Examine covers, check valve body, piston and body. All contacting surfaces for O-rings must be smooth, round and free of deep scratches, dents or gouges. Valve seat at end of piston and in the check valve body must be smooth showing no dents or distortion. The sealing surfaces in the cover must be smooth and free of dents and gouges. Snap ring groove in valve body must not be distorted and must be free of corrosion.

Replace parts that show any of the above defects.

REASSEMBLY

Lubricate all seals and sliding surfaces using Item 1 in LUBRICANT SPECIFICATIONS. Refer to Fig. 4 for numbers in parenthesis.

- 1. Position valve (8) in body (17) so that the valve lays flat on flutes of body.
- Position O-ring (7) in groove of the flange of valve body.
- 3. Position check valve body (6) on body (17) aligning scribed alignment marks. Install cap screws (19 & 25). Tighten cap screws to 13.56-15.82 Nm (120-140 in. lbs.).
- 4. Position O-rings (5) in grooves in both covers (2 and 4).
- 5. Position check valve discs (3) on valve seats in the check valve body.
- Position hand control cover (2) on check valve body adjacent to foot valve no. 1 port, then install foot valve no. 2 cover (4). Tighten screws to 1.356-1.808 Nm (12-16 in. lbs.) torque.
- 7. Position O-ring (9) in valve body and O-ring on piston (10). Insert piston assembly with tapered end toward check valve body.
- 8. Position spring (12) in piston and place exhaust disc (13) on spring. Align and push exhaust disc firmly into valve body. While holding spring in valve body, install snap ring (16), making sure it seats properly in valve body.
- 9. Position valve disc (21), O-ring (20) and plug (22) in bleed back opening (D). Then install star washer (23).

When reinstalling manifolded tractor protection valve on vehicle, be sure to perform the service checks before releasing the vehicle for service.



CHAPTER XII FLEXIBLE HOSE, NYLON TUBING, RIGID PIPING AND FITTINGS TRAILER BRAKE HOSE AND COUPLINGS

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DESCRIPTION

Rigid (copper) tubing and fittings of different sizes have been used to connect different air devices in the air system. However, flexible hoses and nylon tubing is gaining increasingly wide usage in place of copper piping on IH vehicles.

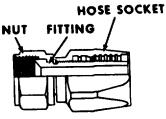
FLEXIBLE HOSE

Any size or length of hose can now be made locally for service requirements.

The hose is constructed of a seamless synthetic rubber lining or tube reinforced with one fabric braid of high tensile steel wire which is covered with a synthetic rubber-impregnated oil-resistant fabric braid.

These hoses can be used for air systems and air brake systems, except air line from air compressor to air reservoir, where the temperature will exceed 167 degrees C (300 degrees F).

The fittings used at the ends of the flexible hose are of the swivel type, such as that shown in Fig. 1. The swivel end permits one end of the hose to be disconnected and not disturb the complete hose.



SWIVEL HOSE FITTING

Fig. 1 Flexible Hose Fitting

CAUTION

Do not try to mix different type hoses and hose fittings. In some cases the hose and hose fittings may seem to fit, but the ends may not hold up under pressure which could result in loss of air while vehicle is being operated. If in doubt as to the identification of the hose and/or fittings which are being repaired, use new IH components to make up a new hose assembly.

Hose Assembly Instructions

When the assembly procedure in making up a

hose is being performed, each step should be finished carefully to assure proper connections at the hose ends.

- Remove the hose fitting and nut from socket and hose. Fig. 1 illustrates the swivel hose fitting. So that the swivel nut and fitting can be removed from the hose and socket assembly, install a pipe adapter in the swivel nut and tighten it, locking the swivel joint assembly (nut and fitting). The swivel nut and fitting can now be turned out of the hose using a wrench.
- 2. Separate the hose from the socket.
- Repeat steps 1 and 2 for the removal of second end.
- 4. Use a fine-tooth hack saw to cut hose to desired length (Fig. 2). Use care in supporting the hose so as not to crush or damage the hose during the cutting operation.

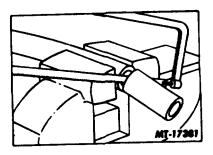


Fig. 2

- 5. Lightly clamp the hose socket in a vise.
- 6. Screw end of new hose into socket until hose bottoms in fitting (turn hose counterclockwise). Then back off hose 1/4 turn (Fig. 3).

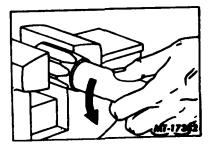


Fig. 3

 Reposition hose and socket in the vise as shown in Fig. 4. Lubricate hose socket and fitting threads.

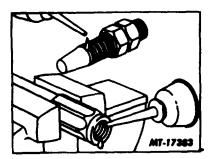


Fig. 4

8. Position hose socket in swivel nut and reassemble pipe adapter (if removed) to lock swivel nut on the fitting. Thread the fitting and swivel nut (with pipe adapter) assembly into the hose as shown in Fig. 5 leaving .793-1.59 mm (1/32 inch to 1/16 inch) clearance between nut and socket so that the nut can swivel freely.

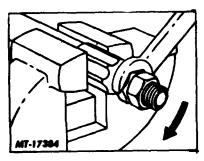


Fig. 5

- 9. Repeat steps 5, 6, 7 and 8 on opposite end of hose to install the remaining nut and fitting.
- 10. Lubricate the threads of the hose assembly when connecting the lines (use light engine oil sparingly).
- 11. When installing the new hose assembly on the vehicle be sure to check for possible leakage and correct any leaks if leaks are present.

Hose Assembly Special Instructions

Installation and routing of these hoses is just as important as special attention given to the installation of the ends. Common problems encountered with installation and routing which will result in short service life of these hoses are:

1. High external temperatutes will shorten the life of a hose. Route hoses away from hot manifolds and exhaust systems.

- 2. Abrasion of hoses will cause outer surfaces to wear and weaken the hose. When installing these flexible hoses avoid contact or crisscrossing, sharp surfaces and contact of moving parts (shift levers and pedals). Clip hoses in place to prevent vibration, abrasion; route hoses together and parallel. If the hose cannot be clipped adequately, the hose must be equipped with a protective conduit (cover). If the hose being replaced has a protective conduit, be sure to use a cover on new hose.
- 3. Flexing of short hoses should not be allowed, since this will tend to wear the hoses at the fittings. If the hose must move, do not permit the hose to twist; keep the bend in the hose in the same plane as the movement where the hose is connected. Provide enough hose to permit any movement which may be required. Avoid sharp bends or turns in the hoses.

NYLON TUBING

In past years nylon tubing of varying construction has been used in such diverse applications as rear axle shift control lines, windshield wiper motor supply lines, transmission shift control lines and engine governor control lines.

With production of nylon tubing as a replacement for certain copper tubing in chassis <u>air brake system</u> applications, a superior nylon tubing which is suitable for all of the above applications as well as air brake system applications is now being provided for field service use.

Nylon Tubing Assembly Instructions

For the most part nylon tubing in air brake systems is assembled much like copper tubing. The same fittings, sleeves and nuts used with copper tubing can be used with nylon tubing. Long or short tube nuts may be found on chassis in service with nylon tubing (Figs. 6 and 7). Either nut may be satisfactorily used on the nylon lines.

If copper tubing is being substituted for nylon tubing, the short tube nut shown in Fig. 7 must not be used. Either the short tube nut or the long tube nut may be used satisfactorily with nylon tubing.

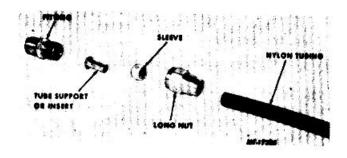
A tube support or insert will be used in all applications of the nylon tubing in air brake systems. The insert provides a stiff or rigid area for the sleeve to be crimped or compressed on the tubing and prevents

collapsing the tubing when the nut is tightened. The parts listing notes that there are some sizes of tubing that are used only in accessory piping systems. In repairing accessory piping systems tube supports are needed with all sizes of tubing except 1/8" O.D. if compression-type fittings are used.

Once the tubing has been connected and tightened the sleeve has been crimped on the tubing and insert. Since the sleeve has been compressed and distortion of the insert may have resulted, the sleeve and inserts should never be used the second time.

To assemble tubing ends for use with compression-type fittings, the following steps should be followed carefully.

- 1. Loosen and remove nut from fitting.
- 2. Pull tubing from fitting.
- Repeat the same operations at other end of tubing. If only one end of line needs repairing, second end need not be disconnected if line is long enough to permit repairing.
- 4. Cut the selected size of tubing to length. Be sure to make smooth, square cuts. Either a sharp knife or hack saw may be used.
- 5. Position nut on tube.
- 6. Position compression sleeve on tube.
- *7. Insert tube support into tube.
- *8. Position the tube, support and sleeve in the fitting. Push tube in fitting <u>until it bottoms</u>.
- 9. Then install and tighten tube nut to secure sleeve on tubing.
- 10. Inspect tubing connections for air leakage. With the tubing and associated fittings charged to full system air pressure coat tubing lines and fittings with soap suds to check for leakage. No leakage is permissible. Leakage at a tubing fitting is sometimes corrected by tightening the tubing fitting nut. If this fails to correct the leakage, replace the tubing fitting, tubing, or both.
- No tube support is used with 1/8" O.D. tubing. Certain fittings used in accessory piping systems have the tube support as an integral part of the fitting body. These fittings may be reused if no distortion of the tube support has occurred.



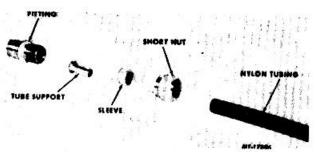


Fig. 7 Nylon Tubing Assembly with Short Nut

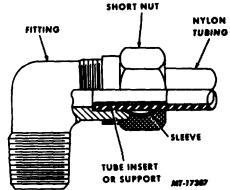


Fig. 8 Nylon Tubing Assembly Cross Section Nylon Tubing Special Instructions

For the present this nylon tubing should not be substituted in the field for any metallic tubing. In addition, the following precautions must be taken in the use of nylon tubing.

- Do not use nylon tubing for any application which would cause it to be exposed to temperatures below <u>-40 degrees C or +111</u> <u>degrees C (-40 degrees F or above +200</u> degrees F).
- 2. Do not subject nylon tubing to working pressure in excess of 1034 kpa (150 psi).
- 3. Do not use nylon tubing for frame-to-axle, tractor-to-trailer or any similar line where a high degree of flexibility is required.

- Observe extreme care when welding near nylon tubing. Hot slag or spark will damage the tubing.
- 5. Protect nylon tubing from battery acid. The service nylon tubing will be marked at regular intervals with name, number, type, size and manufacturing code designations. This marking is intended to positively identify the tubing and prevent substitution of inferior quality tubing.

TRAILER BRAKE HOSE COUPLING AND DUMMY COUPLING

Hose couplings provide a convenient means for connecting and disconnecting air lines between tractors and trailers. When two couplings are joined, their packing rings are forced together under pressure to form an air tight seal.

Dummy coupling is the term given to those couplings which are used to keep dirt or foreign matter out of the air lines when they are not being used. Dummy couplines are either rigidly mounted to the truck or fastened by a chain.

Test

- 1. With hose couplings connected and brakes applied, coat the hose couplings with soapsuds to check for leaks. No leaks allowed.
- 2. Leakage results from worn, damaged, or improperly installed packing rings.

Replacement

- At least once a year or if leaking, the hose coupling should be disassembled, cleaned and serviced
- Remove old packing ring by prying out with a screwdriver, Be sure packing ring groove is thoroughly cleaned.
- Install new packing ring by partially collapsing it with the fingers, (Fig. 9) and entering one side of flange in groove in coupling.
- Work the remaining part of the packing ring into place with a blunt nosed screwdriver or similar tool (Fig. 10). Exposed fact of packing ring will be flat and free of any bulges when properly installed.

TRAILER BRAKE HOSE ASSEMBLIES AND CONNECTORS

Trailer brake hose assembles are used for making flexible connections between components on the truck which change positions in relation to each other or for making flexible connections between the

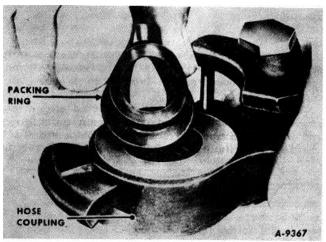


Fig. 9 Installing Packing Ring in Hose Coupling

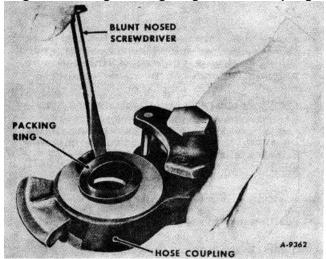


Fig. 10 Using Screwdriver to Complete Packing Ring Installation

tractor and trailer. Hose lines or couplings at the rear of tractor are marked by tags identifying them as "SERVICE" or "EMERGENCY".

<u>Test</u>

- If a line is suspected of being restricted, remove and blow air through it in both directions.
 Air passage through hose must not be obstructed in any way.
- To check for leaks, apply the brakes and coat hose and connections with soap suds. No leaks are permitted. Leakage at hose connectors is sometimes corrected by tightening the connector nut, but if this fails, replace the connectors or hose, or both.

MAINTENANCE

Every six months all air connections should be checked and tightened if leaking (refer to SERVICE CHECKS). Once each year all tubing and hoses should be inspected for dents, kinks, swelling, chafing or crimping. Replace tubing if these conditions are found.

Be sure to inspect trailer brake hoses and hose coupling packing rings and replace if necessary.

SERVICE CHECKS

Operating Tests

If any evidence is found that an air line is restricted, remove and blow out through it in both directions to be sure the passage through the tubing is not obstructed in any way. Inspect piping for partial restrictions such as may be caused by dents or kinks. Damaged pipes must be replaced.

Leakage Tests

With the air system fully charged, the governor cut out and brakes applied, use SE-2326 Leak Detector Tester at air lines, hoses and fittings to check for leakage. No leakage is permissible. Leakage at a tubing fitting is sometimes corrected by tightening the fitting nut. If this fails to correct the leakage, replace the tubing, sleeve or fitting, the tubing or hose.

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CHAPTER XIII ALCOHOL EVAPORATOR

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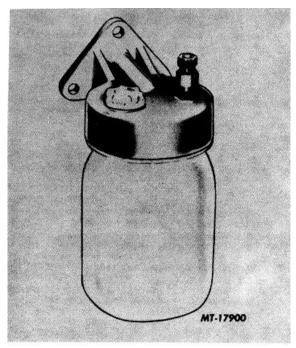


Fig. 1 AE-1 Alcohol Evaporator

BENDIX AE1 & AE2 TYPES

DESCRIPTION

The alcohol evaporator is designed to permit vaporized alcohol to be drawn into the air brake system to overcome possible freezing of any moisture in the air brake system.

IMPORTANT

Installation of an alcohol evaporator does not mean that daily draining of all air reservoirs is not required. In a moisture laden atmospheric air system, a properly installed and maintained alcohol evaporator and daily draining of all reservoirs will be very effective in preventing air system freeze-ups.

The AE-1 alcohol evaporator (Fig. 1) is the older style evaporator. It has a die cast body which houses the filter, filter cap and evaporator tube. The die cast body also serves as a mounting bracket. The container can either be glass, plastic or metal and may also either be a pint, quart or two-quart size.

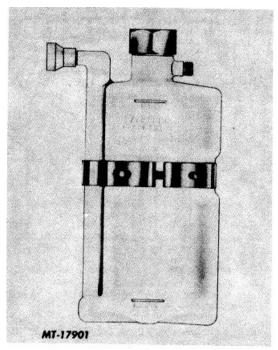


Fig. 2 AE-2 Alcohol Evaporator

The newer alcohol evaporator is known as the AE-2 (Fig. 2). The body and evaporator tube are molded translucent plastic and is available in the quart size only. The new style evaporator is not available with a steel container; therefore, it cannot be used with turbocharged compressor induction.

Some installations require the use of a check valve to prevent alcohol entering the engine induction system.

OPERATION

When the air compressor is in the compressing cycle, a partial vacuum is present at the compressor intake. A line from the evaporator is connected to the compressor intake, therefore a vacuum is created above the alcohol in the alcohol reservoir. Air at atmospheric pressure or greater, depending upon the type of installation, enters the evaporator and passes through the tube which is immersed in the alcohol. This air passing through the alcohol causes the alcohol to bubble and the vapor formed by the bubbling is induced into the compressor intake and on into the air system.

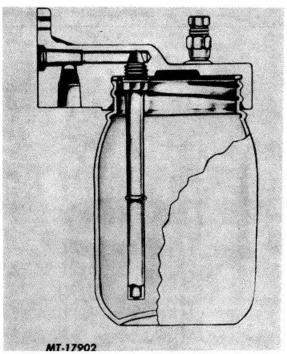


Fig. 3 Cutaway View of AE-1 Alcohol Evaporator CONSUMPTION OF ALCOHOL

Complaints of inoperative alcohol evaporator or excessive use of alcohol can be traced to either a wrong kit being installed or an incorrect installation of a kit. For that reason the correct selection of a kit is very important.

The consumption of alcohol will vary on different vehicles. The main determining factor on properly installed and maintained units is the percentage of time the air compressor is in its loaded (compressing) cycle. Since the alcohol is only used when the compressor is compressing air, good maintenance practice should be followed by keeping air leakage in the system to a minimum and keeping the brakes adjusted.

It is difficult to estimate the amount of alcohol a vehicle will use. A guide to determine if the alcohol evaporator is working properly is:

Alcohol Usage = 30 cc to 70 cc (1 oz to 2 ozs) per hour if compressor is continuously pumping.



Fig. 4 Cutaway View of AE-2 Alcohol Evaporator

Example: If a compressor on a tractor-trailer will be loaded (compressing air) 20% of the total operating time of 12 hours (or roughly 2-1/2 hours), consumption of alcohol can be calculated by multiplying 70 cc of alcohol (maximum usage) by 2.5 hours, or approximately 175 cc of alcohol (1/3 to 1/2 pint) in 12 hours. Additional calculations reveal that if a compressor operates a greater percentage of time, more alcohol will be used.

TYPE OF ALCOHOL TO BE USED

It is recommended that only pure methanol alcohol be used in the air brake system. Certain types of alcohol and antifreeze solutions contain ingredients which leave residue or deteriorate parts in the air system.

Bendix Heavy Vehicle System Group markets alcohol under the name "Air Guard."

1 Qt. Can - Part No. 242100

1 Gal. Can - Part No. 246972

MAINTENANCE

40,000 km or 25,000 Miles

Make sure all fittings are tight and bubbles are present in alcohol when compressor is compressing air. Refer to Trouble Shooting Guide if evaporator assembly is not operating properly.

80,000 km or 50,000 Miles

If strainer is present, check to be sure it is clear. Clean or replace if necessary.

160,000 km or 100,000 Miles

Disassemble evaporator and check valve (if equipped); clean all parts, replacing all gaskets and rubber parts.

FILLING

- Always use the filler plug on AE-1 evaporator. Frequent removal of alcohol reservoir will cause possible deterioration of gasket which will allow leakage and affect performance.
- Fill reservoir 2/3 full. Be certain proper alcohol is used.

DISASSEMBLY, CLEANING AND INSPECTION, REASSEMBLY

- 1. Carefully disassemble, noting order of removal of parts.
- 2. Wash all metal parts in solvent; wipe all rubber parts clean.
- 3. Inspect all parts and replace all parts not considered serviceable.
- 4. Assemble parts, making sure new gaskets and rubber parts are properly installed.

TESTING FOR SERVICEABILITY

With compressor in compressing cycle, bubbles should be evident in alcohol.

If air bubbles are not present, check Trouble Shooting Guide.

INSTALLATION OF ALCOHOL EVAPORATOR KITS

Installation of alcohol evaporator on vehicles in the field is a common practice and is easily accomplished. However, complaints of inoperative alcohol evaporators or excessive use of alcohol can usually be traced to either the wrong kit being installed or an incorrect installation of the proper kit. Therefore, the selection and installation of the correct kit is important. All field installation kits have installation instructions; however, the following information may be helpful.

There are four different types of alcohol evaporator kits and it is very important the correct kit is installed. Before selecting the alcohol evaporator kit, you must <u>first</u> determine the type compressor and the method of air induction to the compressor. After this determination has been made, the alcohol evaporator kit can be selected from one of the following four types:

The Tu-Flo 501 air compressor will use the same installation in all cases as the Tu-Flo 500 air compressor.

1. Standard Kit (Fig. 5)

This kit is used where the compressor utilizes its own strainer and piping consists of a single 4.76 mm (3/16") O.D. copper tubing line run from the top of the alcohol evaporator to the adapter mounted between the strainer and compressor inlet.

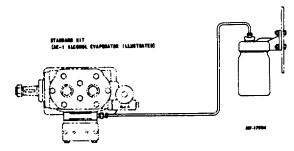


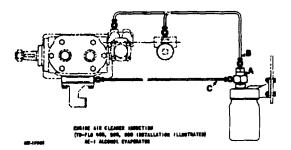
Fig. 5

2. Engine Air Cleaner Induction

(Fig. 6 and Fig. 7)

This kit is used when the compressor inlet is connected to the engine air cleaner on the engine intake manifold and the engine is naturally aspirate(not supercharged or turbocharged)A single check valve "A" is employed in this installation and depending on evaporator used may be connected directly to

the evaporator (as shown) or connected to the governor (refer to installation instructions). Note line "B" is connected to the unloader port of the governor. When the compressor is unloaded (not compressing air), the air pressure in line "B" holds the check valve "A" closed and prohibits alcohol from being drawn into line "C" thus stopping any possible flow of alcohol from the jar into the engine intake.



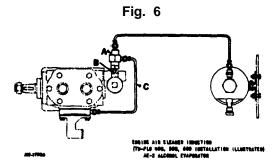


Fig. 7

3. <u>Supercharged Compressor Induction</u>

(Fig. 8 and Fig. 9)

This kit is used when the compressor inlet receives its air supply from the engine supercharger.

This kit employs two adapters "A" with a gasket "B" between them. This gasket has an orifice (see the following NOTE) and when the compressor is loaded (compressing air) a differential is created across the gasket. (The pressure on the compressor side of the

gasket "B" is less than the pressure on the inlet fitting side of gasket "B.") The alcohol will be induced through line "C" into the compressor inlet and thus into the air brake system. The choke fitting "D" prohibits a quick change of pressure in the alcohol jar when a momentary vacuum is created in the compressor air induction line by the engine and prohibits evacuation of alcohol from the jar. Maximum safe operating pressure is 34.47 kPa (5 psi).

Orifice size depends on compressor used.

Tu-Flo 400 compressor uses a gasket with 7.9 mm (5/16") orifice.

Tu-Flo 500, 501, 600, 1000 compressors use a gasket with 9.5 mm (3/8") orifice.

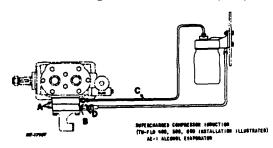


Fig. 8

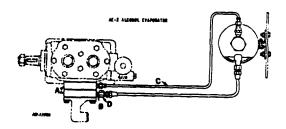


Fig. 9

4. Turbocharged Compressor Induction (Fig. 10)
This kit is used when the compressor inlet receives its air supply from the blower propelled by the turbocharger and operates identically the same as the supercharged compressor

induction kit described, except the maximum safe-operating pressure is 136 kPa (20 psi) which necessitates the use of a metal can.

Orifice size in gasket "B" depends on compressor used.

Tu-Flo compressor uses a gasket with 7.9 mm (5/16") orifice.

Tu-Flo 500, 501, 600, 1000 compressors use a gasket with 9.5 mm (3/8") orifice.

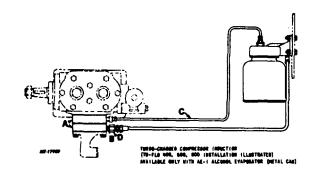


Fig. 10

TROUBLE SHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	REMEDY
Alcohol Evaporator Does Not Operate	Wrong kit installed.	Install proper kit.
	Kit is piped incorrectly.	Check diagram for correct piping.
(*)	Lines restricted (foreign material, kinked, etc.)	Clean or replace lines.
	Alcohol evaporator filter (Standard Engine Air Cleaner Induction Kit).	Clean or replace filter clogged material.
	Leaky fittings, lines, jar over gasket or filler cap gasket.	Tighten or replace necessary parts.
	3/16" line from compressor to alcohol evaporator longer than five (5) feet. (Standard Kit and Engine Air Cleaner Induction Kit only.)	Line from compressor to alcohol evaporator should not be longer than 1.52 m (5'). (Standard Kit and Engine Air Cleaner Induction Kit only.)
	Compressor not in loaded (compressing air) cycle.	By observing dash gauge, make certain compressor is in loaded (compressing air) cycle.
(*) Proof that evaporate	Check valve stuck in closed position.(Engine Air Cleaner Induction Kit only.) or is functioning can be determined by:	Replace necessary parts or complete check valve.

- 1. If a glass jar is being used, alcohol should bubble when engine is revved (compressor loaded).
- 2. If a plastic jar or metal can is used, check exhaust of devices or reservoir drain for odor of alcohol.



PROBLEM	POSSIBLE CAUSE	REMEDY
Excessive Use of Alcohol	Wrong kit installed; i.e., if a compressor receives its air through the engine air cleaner and a standard kit is installed without check valve, it is possible for alcohol to be drawn into the engine.	Install proper kit.
	Leaky compressor unloaders (supercharge and turbocharge induction kits only). Leaky unloaders can cause alcohol to be "blown" into the engine intake.	Replace compressor unloaders.
	Evaporator is subjected to excessive temperature (greater than 49° C, 120° F).	Relocate alcohol evapora tor.
	Check valve leaking or inoperative (Engine Air Cleaner Induction Kit only).	Replace necessary parts or complete check valve.
	Excessive system leakage (causing compressor to be in loaded compressing air cycle in excess of normal).	Check system leakage. Leakage should not be greater than 2 psi in one minute for single vehicles or 3 psi in one minute for tractor-trailer com- binations (with brakes re- leased).
	Choke fitting not used (super- charged and turbocharged induction kits 'only).	Install choke fitting at compressor inlet.
	Clogged air strainer (will cause excessive intake vacuum). (Standard Kit only.)	Clean or replace air strainer element.
Deposit of Residue in Valves from Alcohol	Wrong alcohol being used.	Use only pure methanol alcohol, Bendix-Westinghouse "Air Guard" or equivalent.



CHAPTER XIV

AIR DRYER

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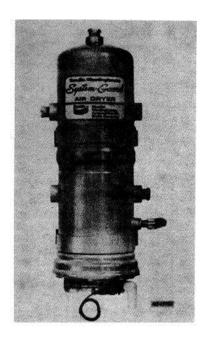


Fig. 1 AD-1 Air Dryer
BENDIX ADI & AD2 TYPES

DESCRIPTION

The air dryer function is to collect and remove moisture and contaminants before air reaches the first reservoir, thus providing "super dry" air for the air brake system. Daily draining of the air system reservoirs is no longer necessary with an air dryer and air brake system maintenance is considerably reduced when compared to an air brake system without an air dryer.

The air dryer is installed in the discharge line between the air compressor and supply reservoir. The unit is mounted vertically, usually on the frame of the vehicle.

The housing assembly consists of two cylindrical steel stampings welded together. The housing on the AD-2 Air Dryer incorporates two inlet ports, one reservoir port and one purge volume port. The side outlet port of the AD-2 has an integral single check valve with the top

port used for the addition of purge volume.

The AD-1 Air Dryer has two inlet and three outlet ports, but is not equipped with a single check valve in any of the three outlet ports.



Fig. 2 AD-2 Air Dryer

The safety valve protects against excessive pressure buildup within the housing.

The desiccant sealing plate is located midway in the housing assembly and houses a replaceable single type check ball and a purge orifice. The desiccant cartridge and paper pleated oil filter are removable and comprise a complete serviceable unit.

The desiccant beads, referred to as the "drying bed," are a drying substance which has the unique property of exposing a tremendous surface area in proportion to its bulk. Desiccant beads weighing .454 km (1 lb.) have about 186,000 m² (two million square feet) of absorptive area made up of a large number of submicroscopic cavities in each bead. Each bead absorbs or extracts moisture from the compressed air.

The desiccant beads are held in place in the cartridge with steel perforated plates and filter cloths. The top plate is held in place by a spring, while the bottom plate rests on a shoulder about 3 mm (1/8") from the bottom of cartridge housing.

The end cover assembly is retained by

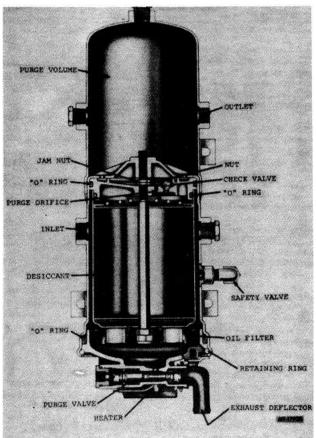


Fig. 3 Sectional View of AD-1 Air Dryer

a lock (retaining) ring, capscrews and retainers, and houses the purge valve and heater assembly if so equipped.

The heater and thermostat assembly prevent freeze-up in the purge drain valve when the dryer is used in severe winter conditions. The heater and thermostat assembly is standard in the AD-2 and was optional equipment for the AD-1.

The 60 watt, 12 or 24 volt DC heater and thermostat assembly has an operating range between 10° C and 32° C (50° F and 85° F).

OPERATION

The operation of the air dryer can best be described by separating the operation into two cycles; the charge cycle and the purge cycle.

Charge Cycle (Fig. 5)

With the compressor in its "loaded" or compressing cycle, air from the compressor enters the air dryer through the

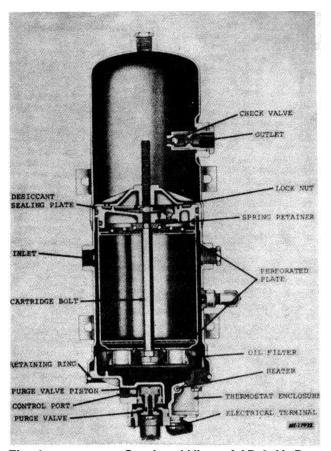


Fig. 4 Sectional View of AD-2 Air Dryer

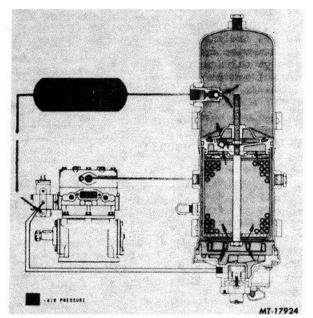


Fig. 5 AD-2 Operational Charge Cycle

discharge line. When the air along with the water and contaminants enter the air dryer, the velocity or speed of the air reduces substantially and much of the entrained liquid drops to the bottom or sump of the air dryer. The initial air flow is toward the bottom of the dryer, but air flow direction changes 180 degrees at the bottom of the air dryer dropping some water and oil.

The air now passes through the oil filter which removes some oil and foreign material but does not remove water vapor. At this point, the air remains saturated with water.

The filtered air and vapors penetrate the desiccant drying bed and the adsorption process begins. Water vapor is removed from the air by the desiccant.

The unsaturated "dry air" passes through the ball check valve and purge orifice into the purge volume. From the purge volume air flows through a check valve and into the first reservoir.

The AD-1 Air Dryer does not incorporate an integral check valve. The single check valve in an AD-1 installation would be located in the line between the AD-I outlet port and the, first reservoir.

Purge Cycle (Fig. 6)

When desired system pressure is reached the governor cuts out, pressurizing the unloader cavity of the compressor which unloads the compressor (non-compressing cycle). The line connecting the governor unloader port to the end cover purge valve port (bottom of the air dryer) is also pressurized, opening the exhaust of the purge valve open, contaminants in the discharge line and dryer sump are purged or forced past the open exhaust out to atmosphere.

The reverse air flows across the desiccant and starts the removal process of moisture from the desiccant surface. Dry air flowing from the purge volume through the purge orifice and across the drying bed further dries the desiccant.

The combination of these reverse flows strips the water vapor from the desiccant (drying bed). This normally takes between 12-15 seconds.

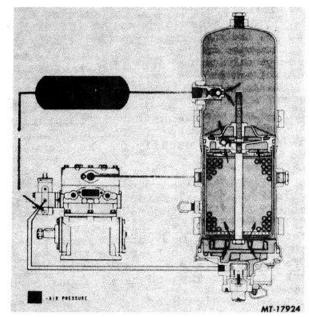


Fig. 6

Operational Purge Cycle

The desiccant becomes activated from this cycle and is now ready for another charge cycle, which occurs when the compressor returns to the compressing cycle. It is for this reason the air dryer must be purged for 20 seconds after receiving moisture saturated air for a maximum of 60 seconds from a 1.2 m^2 (12 CFM) compressor.

MAINTENANCE & CHECKING SERVICEABILITY

Every 37,000 km (23,000 miles) or every three months:

1. Inspect for moisture in the air system by opening reservoirs, drain cocks or valves and checking for presence of water. In areas where more than approximately a 17° C (30° F) range of temperature is common, small amounts of water can accumulate in the air brake system due to condensation. The presence of small amounts of water due to condensation is normal and should not be considered as an indication that the dryer is not performing properly.

The desiccant cartridge should be replaced or rebuilt when it has been determined that the desiccant is contaminated and does not have adequate water adsorption capacity. However, the following checks should be made before replacing the desiccant cart-

ridge to ascertain that the water accumulation is not related to the following listed items:

- a. An outside air source has been used to charge the system. This air did not pass through the drying bed.
- b. Air usage exceptionally high and not normal for a highway vehicle. This may be due to accessory air demands or some unusual air requirement that does not allow the compressor to load and unload (compressing and non-compressing cycle) in a normal fashion. Check for high air system leakage.
- c. The air dryer has been installed in a system that has been previously used without an air dryer. This type system will be saturated with moisture and several weeks of operation may be required to dry it out.
- d. Location of the air dryer is too close to the air compressor. Refer to "Installation" section.
- 2. Check mounting bolts for tightness. Check all air and electrical connections.
- 3. Check the operation of the integral single check valve in the AD-2 or the "in-line" check valve used with AD-1. Build the air system to governor cutout and observe the test air gauge installed in the supply reservoir. A rapid loss of pressure could indicate a failed check valve. This can be confirmed by checking at the purge valve exhaust.

Purge valve will be open when governor cut-out pressure is reached. Allow two minutes for purge cycle before testing the check valve.

- 4. Check for excessive leakage at the purge valve by coating the exhaust with a soap solution while the compressor is loaded (compressing air).
- 5. Check the operation of the safety valve by pulling the exposed stem while the compressor is loaded (compressing air). There must be an exhaust of air while the stem is held and the valve should reseat when the stem is released.

- 6. Check all lines and fittings leading to and from the air dryer for leakage and integrity.
- 7. Check the operation of the heater and thermostat during cold weather operation. This can be done by allowing the end cover assembly to cool below 10° C (50° F) and feeling the end cover when the ignition is turned on. The end cover should be warm to the touch within a few moments. Warming should cease at about 30° C (85° F).

The desiccant change interval may vary; however, it is generally recommended that the desiccant be replaced every 12 months (yearly). If experience has shown that extended or shortened life has resulted for a particular installation, then the yearly interval can be increased or reduced accordingly.

REMOVAL OF DESICCANT CARTRIDGE AD-1 & AD-2

- 1. Make certain the vehicle is safely parked. Block the wheels if necessary.
- 2. Drain the air system completely being sure that the lines leading into and out of the air dryer are at atmospheric pressure.
- 3. Disconnect the air line from the end cover and mark location of this port on the dryer.
- 4. Disconnect the heater wire.
- 5. Loosen the three capscrews on the end cover and turn the retaining clamps aside (capscrews may be left finger tight).
- 6. Locate the notch in the dryer shell. While pushing the end cover up into the dryer, insert the blade of a screwdriver in the notch and slowly pry out the retainer ring. Remove the end cover assembly and set it aside temporarily.
- 7. Using a 3/4" socket wrench, remove the cartridge and desiccant sealing plate assembly.

Be certain the desiccant sealing plate assembly comes out with the cartridge.

REMOVING AND REBUILDING DESICCANT SEALING PLATE

Before the desiccant cartridge can be replaced or rebuilt the desiccant sealing plate must be removed. It is recommended that all non-metallic parts be replaced when the plate is removed. In the past, three methods have been employed to secure the desiccant sealing plate to the desiccant cartridge; a Tru Arc retaining ring, two special thin nuts and the latest method a single hex lock nut. Removing the securing device will permit the desiccant plate to be separated from the desiccant cartridge. After removing the desiccant cartridge:

- 1. Remove the two o-rings from the desiccant plate and discard them.
- 2. Remove the ball check valve retaining clip and remove and discard the rubber ball valve.
- 3. Clean the desiccant plate thoroughly using a quality commercial solvent making sure the purge orifice and check valve seat are clean.
- 4. Install new ball check valve and replace the retaining clip and screw (Fig. 7).



Fig. 7

Installing Check Valve

- 5. Thoroughly lubricate the two new o-rings and install them in their respective grooves in the purge plate (Fig. 8).
- 6. Set the desiccant sealing plate aside for reinstallation on the desiccant cartridge.

REPLACING DESICCANT CARTRIDGE

If the desiccant cartridge is to be replaced as an assembly rather than rebuilt (see desiccant cartridge rebuilding instructions), the cartridge removed from the

air dryer may be discarded after the desiccant sealing plate is removed.

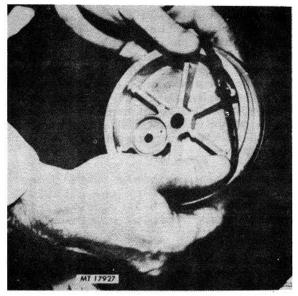


Fig. 8

Installing O-Rings

The current revision replacement desiccant cartridge is shown in Fig. 9. All prior revisions of the cartridge will interchange with no modifications to either air dryer.



Fig. 9 Replacement Desiccant Cartridge

Prior to installing the new replacement cartridge in the air dryer, the following steps must be follows:

- 1. Carefully remove the lock nut from the cartridge bolt using an 11/16" open end or box wrench. Care <u>must</u> be taken not to allow the cartridge bolt to slip out of the cartridge when the lock nut is removed. Loss of desiccant material will occur should this happen.
- 2. Install the previously rebuilt desiccant sealing plate on the cartridge bolt so that the ball check retaining clip remains visible (see Fig. 7).
- 3. While holding the cartridge bolt, reinstall the lock nut on the cartridge bolt.

IMPORTANT: Before tightening the lock nut down make certain that the shoulder (unthreaded portion) of the cartridge bolt extends slightly above the perforated desiccant plate (see Fig. 14).

4. By tightening the lock nut, draw the desiccant sealing plate down into the desiccant cartridge until the shoulder of the desiccant sealing plate is against the cartridge shell.

REBUILDING DESICCANT CARTRIDGE

Only the current revision desiccant cartridges (Fig. 9) can be rebuilt. Currently revised desiccant cartridges are identified positively by the Bendix trademark BW stamped in the hex head of the cartridge bolt and by the letters and number AD-2 displayed on the bottom face of the oil filter. If an old revision desiccant cartridge is removed from the air dryer, it should be replaced with a complete currently revised desiccant cartridge.

Disassembly of Desiccant Cartridge

- 1. Carefully remove the lock nut on top of the desiccant sealing plate. (The plate is spring loaded; however, the spring load is completely relieved when the nut is removed.)
- 2. Remove the desiccant sealing plate and rebuild it as outlined in "Removing & Rebuilding the Desiccant Sealing Plate."

3. Remove and retain the spring, spring seat, bolt and cartridge shell. Discard the oil separator filter, the two perforated plates and desiccant material.

Reassembly of Desiccant Cartridge

1. Insert one of the perforated plates into the cartridge, <u>felt cloth up</u>, and tap it firmly to the bottom. Felt always faces desiccant material (see Fig. 10).

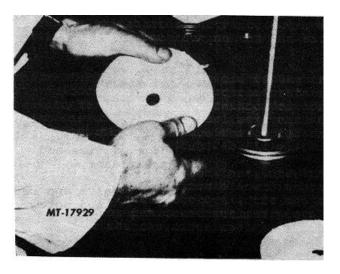


Fig. 10 Installing Felt Cloth in Cartridge

2. Slide oil filter separator over the cartridge bolt with the gasket surface next to the shell (Fig. 11).

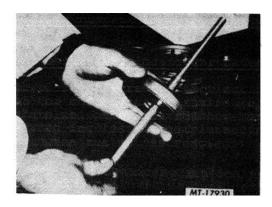


Fig. 11 Installing Oil Filter Separator

3. Install the bolt with the oil separator into the bottom of the shell and through center hole of the perforated plate in the bottom of the shell (Fig. 12).



Fig. 12

Installing Cartridge Bolt

4. Pour the <u>entire package</u> of desiccant material into the shell making <u>sure none is lost</u>. Handle shell carefully so that the bolt does not fall out (Fig. 13).

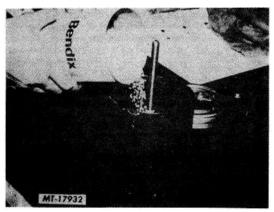


Fig. 13

Installing Desiccant

5. Level the desiccant material and install second perforated plate, <u>felt cloth down</u>. Make sure the shoulder of the bolt is centered and extends slightly above the top of the perforated plate (Fig. 14).

NOTE: If the shoulder of the bolt does not extend above the perforated plate, tap the side of the desiccant container.



Fig. 14 Installing Second Perforated Plate

- 6. Set the conical spring on top of the perforated plate (large diameter down; small diameter up).
- 7. Place the spring retainer on top of the spring (Fig. 15).

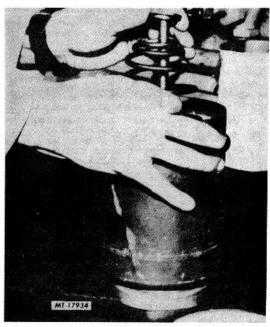


Fig. 15 Positioning Spring Retainer On Spring

- 8. Install the previously rebuilt desiccant sealing plate on the cartridge bolt so that the ball check retaining clip can be seen.
- 9. Using the lock nut draw the assembly together to approximately half of the spring's free height. While slowly turning the cartridge, tap the side of the shell with a plastic mallet (Fig. 16). This allows the desiccant material to settle properly into place. Continue to tighten the nut making sure all items are properly aligned. Tighten nut firmly using an 11/16" socket or box wrench.



Fig. 16

REBUILDING AD-1 END COVER ASSEMBLY

To remove the end cover assembly from the air dryer follow Steps 1 through 6 under "Removal of Desiccant Cartridge AD-1 & AD-2." Before rebuilding the end cover, clean the exterior thoroughly using a quality commercial solvent.

Disassembly

- 1. Remove and discard the large O-rings around the end cover.
- 2. Remove the exhaust elbow and clamp.
- 3. Remove the cap nut and discard the cap nut O-ring.
- 4. Place the handle of a large screwdriver in a vise and secure it.

- 5. Place the slot in the plunger (cap nut end) over the blade of the screwdriver, hold it securely and remove the nut from the plunger using a 1/2" socket wrench.
- 6. Remove the plunger, spring and valve; discard the valve.
- 7. Clean and inspect the plunger bore and the valve seat.
- 8. Remove and discard the three O-rings from the plunger; clean the plunger.

If during the serviceability checks it was determined that the heater and thermostat were defective, replace end cover as an assembly.

Reassembly

- 1. Using Item 1 of LUBRICATION SPECIFICATIONS, lubricate and install O-rings on the plunger and cap nut.
- 2. Lubricate the plunger bore and install the spring and plunger (through the cap nut end).
- 3. Install the valve on the plunger making certain the chamfered end of the valve is in contact with the metal seat of the body.
- 4. Using the screwdriver held in the vise, as described in Steps 4 and 5, compress the plunger into the bore while installing and tightening the nut.
- 5. Install the cap nut and tighten it.
- 6. Lubricate and install the large diameter O-ring around the end cover assembly with Item 1 of LUBRICANT SPECIFICATIONS.

REBUILDING AD-2 END COVER ASSEMBLY

To remove the end cover assembly from the air dryer, follow Steps 1 through 6 under "Removal of Desiccant Cartridge AD-1 & AD-2." Before rebuilding the end cover, clean the exterior thoroughly using a quality commercial solvent.

Disassembly

1. Remove and discard the large O-ring around the end cover assembly.

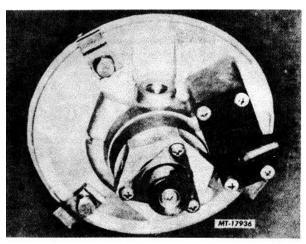


Fig. 17

AD-2 End Cover Assembly

- 2. Remove the single 6-32 screw securing the exhaust diaphragm and separate the diaphragm, washer and screw.
- Discard the diaphragm.
- 3. Remove the three No. 6-32 screws securing the exhaust cover and remove the exhaust cover.
- 4. Remove the purge valve assembly, the large hex cap nut from the end cover and discard both O-rings around the cap nut.
- 5. Using a 7/16" socket wrench and a large screwdriver, remove the 1/4"20 hex head cap screw which holds the assembly together.
- 6. Separate capscrew, purge valve, purge valve piston and the piston return spring.

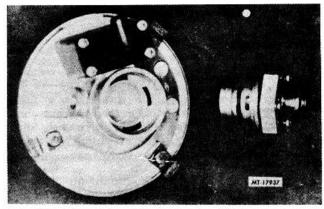


Fig. 18 AD-2 End Cover Assembly with Purge Valve Assembly Removed

- 7. Discard the piston O-ring, the purge valve and the piston return spring.
- 8. Wash all remaining parts in a commercial solvent making sure all surfaces, bores, ports and passages are clean and dry before reassembly.

The heater and thermostat assembly in the AD-2 end cover are non-serviceable. <u>Do not remove the thermostat cover.</u> Should this assembly become defective, the end cover must be replaced.

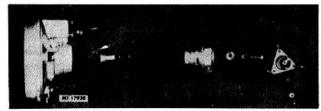


Fig. 19 Purge Valve Assembly Disassembled

Reassembly

- 1. Lubricate the piston O-ring and install it on the piston.
- 2. Lubricate the piston bore and install the piston.
- 3. Install the purge piston return spring and piston.
- 4. Install the purge valve in the large cap nut so that the rubber portion rests on the metal seat of the cap nut.
- 5. Secure the valve to the piston using the 1/4"-20 capscrew and lockwasher and torque to 5.5 N.m (50 in. lbs.).
- 6. Lubricate and install the two cap nut O-rings.
- 7. Lubricate the cap nut threads and the cap nut bore of the end cover and install the cap nut; torque it to 19.8 27.5 N.m (180 250 in. lbs.).
- 8. Secure the exhaust diaphragm to the exhaust cover using the No. 6-32 phillips head screw and diaphragm washer.
- 9. Secure the exhaust cover to the purge valve hex head cap nut using the

No. 6-32 phillips head screws.

10. Lubricate and install the large diameter O-ring around the end cover assembly.

OUTLET PORT CHECK VALVE ON AD-2

The one-way check valve located in the outlet port of the AD-2 dryer assembly is replaced as a complete assembly. The removal and installation procedure is as follows (Refer to Fig. 20).

- 1. Set parking brake by applying the control valve.
- 2. Bleed air from main air reservoir.
- 3. Locate outlet port on air dryer assembly which is the air supply to main air reservoir. Then disconnect the air supply line or hose.
- 4. After hose is disconnected, the elbow and check valve assembly can then be removed separately.
- 5. Install new check valve assembly and seal.
- 6. Reinstall elbow and connect hose.
- 7. After air supply is restored, check connection for air leaks.

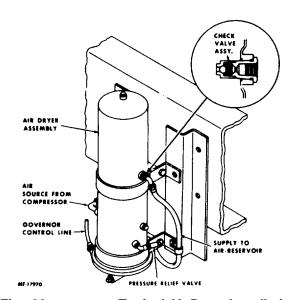


Fig. 20 Typical Air Dryer Installation

CR BRAKEMASTER 62 & 68 MODELS

DESCRIPTION

The CR Brakemaster units (Figs. 21 & 22) are actually heat exchangers since the compressed air from the air compressor is cooled.

When the compressed air leaves the air compressor, it is about 149° C (300° F) and by the time it reaches the Brakemaster unit, the temperature will drop to about 60° C (140° F).

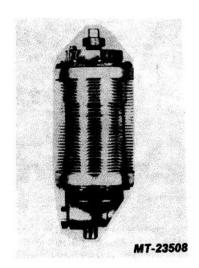


Fig. 21 CR Brakemaster Model 62

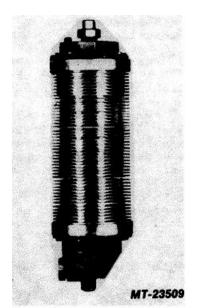


Fig. 22 CR Brakemaster Model 68

The hot compressed air enters the expansion chamber where the sudden drop in pressure cools it off. The heat is carried away through the external fins which are an integral part of the one piece aluminum body.

As the air cools in the expansion chamber, both water and oil vapors are condensed out. This condensation collects on the walls of the expansion chamber and runs down into the collection area where it is automatically discharged by a specially designed unloader valve.

The heat exchanger has a permanent air filter element which traps carbon particles that can harm other components in the air system. Every time the unloader operates (each time the compressor completes a cycle) there is a back rush of air through the filter, so that any carbon trapped in the filter element is flushed out and ejected through the unloader valve.

In an air system where the compressor is in good condition, the filter will require little or no maintenance. If the filter should require servicing, it should only need a bath in cleaning solvent. Replacement should be unnecessary.

MAINTENANCE

Periodic or scheduled maintenance is not required. However, for trouble free operation, the following items should be checked.

- 1. Steam clean cooling fins to remove accumulated road grime.
- 2. Check to be sure cooling fins have not been painted.
- 3. Check air lines to be sure they have not become kinked, cracked, broken or chafed.
- 4. Perform the Service Checks.

SERVICE CHECKS

- 1. Build up pressure in air system using the air compressor. Bleed off air to cause the compressor to cycle several times,
- 2. Check and compare the temperature at the inlet and outlet ports. This check can be accomplished by holding your hand on each of the port areas.

CAUTION

The inlet port may be very warm and a burn could result.

The inlet port should be warmer than the outlet port; the outlet port should be at or slightly above ambient temperature. Since the vehicle is stationary, the unit will become warmer than normally experienced during over the road operation. If both inlet and outlet temperatures are high or at the same temperature (about 66° C or 150° F) the deflector will need servicing.

3. Hold a clean shop towel under the unloader (exhaust) port and make the air compressor go through several "unload" cycles. Catch water from the unloader port. If water is oily, the compressor should be checked. If

water is "brownish" or if brown particles are expelled, the deflector requires servicing.

- 4. After the heat exchanger has "exhausted" and while the air compressor is in "stand-by" mode, hold your hand under the unloader port. If air flows out the port, the check valve at the top (outlet port) of the heat exchanger is stuck open and requires service, or the compressor inlet is connected to the outlet side of the turbocharger.
- 5. If air leaks past the exhaust port while the compressor is building up pressure, the unloader valve is stuck open and requires attention.
- 6. While the air compressor is building up pressure, it is normal for the check valve to produce a rattling sound through rapid opening and closing.
- 7. When the air compressor is rebuilt or replaced or if the heat exchanger is moved from one vehicle to another it is recommended that the heat exchanger unit be completely disassembled and cleaned.

If the unloader valve should stick in the open position while the vehicle is on the road, the air system can be restored by threading a i" pipe plug into the exhaust port. By doing this, the air system pressure can be restored but moisture, etc. cannot be exhausted from the air dryer. The unit should be serviced as soon as possible by repairing the unloader valve.

DISASSEMBLY AND REASSEMBLY

General Instructions

Before any work is accomplished, it is important for your safety and the cleanliness of your system to adhere to the following:

- 1. The area surrounding the unit, and the unit itself, should be thoroughly cleaned to remove dirt, oil and other road grime.
- 2. Set parking brake.
- 3. Relieve ALL AIR from vehicle's air system.
- 4. Relieve pressure in line from "UNL" port of compressor governor to unloader port in the center of the large nut on the bottom of the unit.

Each part of the heat exchanger can be serviced by means of using the various service and replacement kits available.

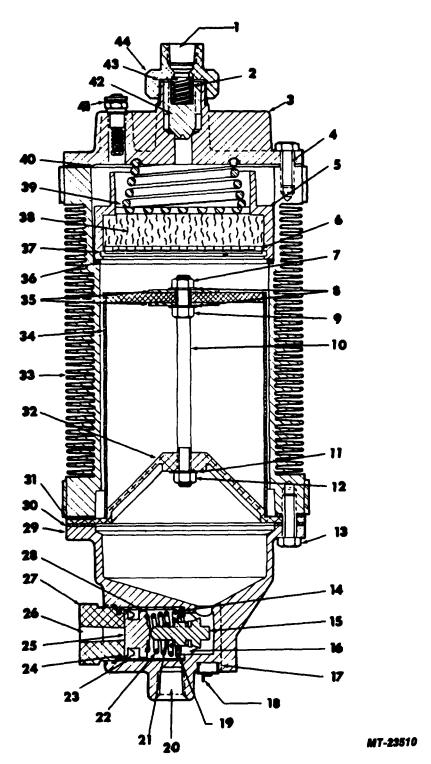


Fig. 23 Cross Section of CR Brakemaster Heat Exchanger

Legend for Fig. 23

- 1. Outlet Port
- 2. Spring
- 3. Cap, Top
- 4. Screw, Cap 3/8"-16x1"
- 5. Cup, Filter
- 6. Strainer
- 7. Nut. 3/8"-16
- 8. Washer, Lock 3/8"-ext. tooth
- 9. Nut. 3/8"-16
- 10. Rod, Support
- 11. Washer, Lock 3/8"-ext. tooth
- 12. Nut, 3/8"-16
- 13. Screw, Cap Socket hd. 3/8"-16x1 1/4"
- 14. Gasket
- 15. Spindle
- 16. Seat, Ring
- 17. Heater
- 18. Thermostat
- 19. Spring
- 20. Port, Exhaust
- 21. Ring, Retaining
- 22. Spring
- 23. Cup, U
- 24. Ring, O
- 25. Piston
- 26. Port (UNL) Unloader
- 27. Nut, Unloader
- 28. Sleeve
- 29. Cap, Bottom
- 30. Gasket
- 31. Gasket
- 32. Plate, Support
- 33. Body
- 34. Deflector
- 35. Washer
- 36. Ring, Packing
- 37. Spring, V
- 38. Filter
- 39. Spring
- 40. Gasket
- 41. Valve, Safety
- 42. Spindle
- 43. Gasket
- 44. Nut

Servicing Unloader Valve

There are several indications which may mean that the unloader valve of your heat exchanger unit needs servicing:

The compressor goes into "stand-by" mode but cycles rapidly.

Air flows from the exhaust port when compressor is attempting to build up pressure in the air system.

The unit does not "unload" when compressor goes into stand-by mode.

These situations can be caused by several conditions. Check the TROUBLE SHOOTING GUIDE to make sure that the probable cause is a malfunctioning unloader valve on the CR BRAKEMASTER unit. If the probable cause is the unloader valve, it could mean that a piece of debris is clogging this valve, and it only needs to be cleaned, or that the valve assembly itself has been worn and needs to be replaced. In either case, the following steps should be taken.

Refer to Fig. 24 for numbers in parenthesis.

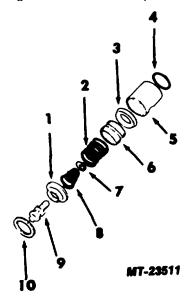


Fig. 24 Contents of Unloader Valve Kit

- Ring Seat 6 Piston
- 2 Spring, Large 7 Ring, Retaining
- 3 Cup, U 8 Spring, Small
- 4 Ring, 0 9 Spindle, Unloader
- Sleeve 10 Gasket (2 reg'd)
- 1. Disconnect electrical wire to heater.
- 2. Disconnect inlet air line from bottom cap.
- 3. Remove governor control line from UNL port.
- 4. Remove large unloader nut from UNL port.

CAUTION Use care in removing the nut to prevent bodily injury since nut is spring loaded.

5. Remove complete unloader valve assembly including copper gaskets (10).

Excessive accumulation of oil in the unloader assembly indicates that the air compressor requires attention.

- Examine unloader valve assembly. If the unloader sleeve (5) is nicked, wrinkled or has axial scratches, the unloader valve assembly should be replaced. The unloader valve assembly if clogged should be cleaned with a good cleansing solvent.
- 7. Do not remove retaining ring (7) from unloader spindle (9) since they are serviced as an assembly with spring (8) and seat ring (1).
- 8. Install new "U" cup (3) in groove of unloader piston. Lips of "U" cup should face away from spring seat. Do not use sharp tools that may mar or score parts.
- 9. Apply a light film of Item 1 in LUBRICANT SPECIFICATIONS to O-ring (4) and position on unloader nut.
- 10. Position the two copper gaskets (10) together and lightly coat exposed surfaces with <u>Item 1</u> of LUBRICANT SPECIFICATIONS. Then position lubricated gaskets on shoulder of ring seat (1). Gaskets should be on face opposite the spring (8).
- 11. Place gaskets (10) followed by seat ring assembly into bottom cap (Item 29 of Fig. 23).
- 12. Install unloader sleeve (5) in unloader port against the seat ring. Be sure the 12.7 mm (i") diameter cross hole is next to the seat ring.
- 13. Position large spring (2) in the sleeve (5) with large diameter coil against seat ring.
- 14. Insert unloader piston (6) into unloader sleeve. Lips of U-cup (3) must face out with spring seat toward spring. The unloader spindle (9) and seat ring (1) is a mated assembly and should not be disassembled. If either the ring seat or spindle is nicked, the entire mated assembly must be replaced as an assembly.
- 15. Insert a 12.7 mm (i") diameter rod or equivalent through the exhaust port in the bottom cap (Item 29 of Fig. 23) and into the cross hole of sleeve (5) to maintain alignment. If the cross holes are not aligned, the unit will not operate.
- 16. Apply a non-hardening sealing compound to thread of the unloader valve nut (Item 27 of Fig. 23) and install the nut. Tighten nut to 81 Nm (60 ft. lbs.) maintaining the alignment of the cross holes of sleeve (5). Overtightening of the unloader nut will result in damage to the unloader assembly.

- 17. Remove the alignment rod inserted in step 15.
- 18. Reinstall the governor control line to UNL port in center of unloader nut.
- 19. Reinstall in air input line from the air compressor.
- 20. Connect electrical lead for the heater.
- Test unit using the instructions listed in SERVICE CHECKS.

Servicing Deflector Assembly

There are several indications which may mean that the deflector assembly needs servicing:

Compressed air was cooled by the unit but no longer is cooled properly.

Water exhausted by the CR BRAKEMASTER is brownish or brown particles are exhausted.

A piece of the deflector is caught in the unloader valve assembly causing it not to operate properly.

These situations can be caused by several conditions. Check the TROUBLE SHOOTING GUIDE to make sure that the probable cause is a malfunctioning deflector assembly. If it is a malfunctioning deflector assembly, the following are the instructions for replacing this deflector assembly.

Refer to Fig. 25 for numbers in parenthesis.

- 1. Refer to General Instructions.
- 2. Disconnect air compressor service line at inlet port.
- 3. Disconnect governor control line from unloader nut (Item 27 of Fig. 23).
- 4. Disconnect wire from heater assembly.
- 5. Remove the eight cap screws (Item 13 of Fig. 23) retaining bottom cap to body (2).
- 6. Remove bottom cap and deflector assembly.

On older units the deflector is secured to the bottom cap. If this is the case, the deflector should be removed from the bottom cap by means of removing the four screws holding the deflector to the bottom cap. The feet of the bottom cap (to which the deflector was attached) must be removed.

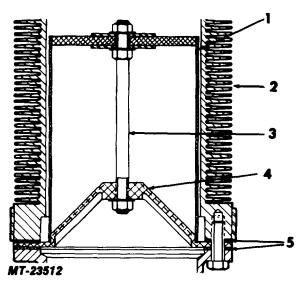


Fig. 25 Contents of Deflector Kit

- 1 Deflector
- 2 Body Tube
- 3 Rod, Support Assy. (Refer to Fig. 3 for detail)
- 4 Plate, Mounting
- 5 Gaskets
- Remove all traces of old gasket(s) material from gasket surfaces of bottom cap and body. Discard old gaskets. Be careful not to scratch or mar gasket surfaces.
- 8. Wash bottom cap and inside of unit with cleaning solvent.
- 9. Position new gasket (5) on top of surface of deflector mounting plate (4).
- 10. Position second new gasket (5) on gasket surface of bottom cap.
- 11. Align bolt holes and position assembly against bottom gasket surface of body tube (2). Use of gasket sealant is NOT recommended.
- 12. Insert eight cap screws to attach bottom cap to body tube and deflector assembly. Tighten alternately and evenly to 20.3 Nm (15 ft. lbs.). If unit previously had old style deflector attached to bottom cap, use the eight longer cap screws contained in the deflector replacement kit.
- 13. Reconnect the air line to the inlet port (this line leads from the compressor service port).

- 14. Reconnect the governor control line to the unloader port in unloader nut (Item 27 of Fig. 23).
- 15. Reconnect the wire to the heater.
- 16. Test the unit following the instructions listed in SERVICE CHECKS.

Servicing Check Valve Assembly

There are several indications which may mean that the check valve needs servicing:

Air is exhausted from exhaust port when compressor is in stand-by mode.

System air pressure bleeds off rapidly when air using equipment is not being operated.

Compressor goes into stand by mode but cycles rapidly.

Compressor attempts to build pressure but system pressure will not build up.

Safety valve opens.

These situations can be caused by several conditions. Check the TROUBLE SHOOTING GUIDE to make sure that the probable cause is a defective assembly. The following is the procedure for servicing and replacing the check valve assembly.

Refer to Fig. 26 for numbers in parenthesis.

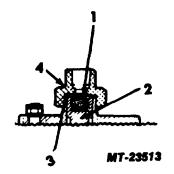


Fig. 26 Check Valve Assembly

- 1 Spring 3 Gaskets
- 2 Spindle 4 Nut
- 1. Refer to the General Instructions.
- 2. Disconnect air line at outlet port at top of unit.

- 3. Remove top nut (4). This nut is spring loaded.
- 4. Remove copper gaskets (3), spring (1), and check valve spindle (2).
- Clean and dry entire check valve area and top nut
 (4).
- 6. Position new check valve spindle (2) in top cap with tapered end down.
- 7. Install spring (1) in check valve spindle.
- 8. Position new copper gaskets (3) in nut (4) and rub a small quantity of grease on the gaskets to help them keep their position in the top nut.
- Thread nut on to top cap and torque to 81 Nm (60 ft. lbs.). Top nut (4) is not included in check valve replacement kit.
- 10. Reconnect the air line to the outlet port. The safety valve (Item 41 of Fig. 23) cannot be serviced and it is recommended that it not be removed from the top cap. If the safety valve was removed, apply nonhardening sealant to threads of top cap.
- 11. Test the unit following the instructions listed in SERVICE CHECKS.

Servicing Filter Assembly

Although the filter assembly of the unit is designed to require little or no servicing, it is a good practice to service the filter assembly when performing service on the other filters located on the vehicle. This servicing can be accomplished in one of two ways, either replacing the entire filter assembly, or by servicing the filter assembly. In most cases, simply servicing will only be necessary. The following are the steps for servicing the filter assembly. If the entire filter assembly is being replaced, those steps preceded by an asterisk (*) can be eliminated.

Refer to Fig. 27 for numbers in parenthesis.

- 1. Refer to the General Instructions.
- 2. Remove air line at outlet port.
- 3. Remove eight cap screws holding top cap (2) to body (8).

CAUTION

Use care in removing top cap bolts to prevent bodily injury because the cap is spring loaded with approximately 178 Nm (40 ft. lbs.).

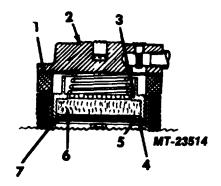


Fig. 27 Servicing Filter Assembly

- 1 Gasket
- 6 Filter
- 2 Top Cap3 Filter Cup
- 7 Packing Ring

5 Strainer

- 4 V Spring
- 4. Remove spring (Item 39 in Fig. 23).
- Remove all traces of gasket material from top cap and body gasket surfaces (2 & 7). Discard gasket.
 Be careful not to scratch or score gasket surfaces and wash top cap in cleaning solvent.
- Remove complete filter assembly.
- 7. Remove rubber packing ring (7) and discard.
- 8. Discard old stainless steel filter. If you are replacing entire filter assembly, the entire filter assembly including filter cup (3), strainer (5) and V-spring (4) may also be discarded.
- Wash strainer (5) and filter cup (3) in cleaning solvent.
- Assemble stainless steel filter (6) in filter cup (3).
 Filter should be stretched slightly to fill the space in filter cup.
- 11. Reinstall strainer (5) with flat face of strainer towards stainless steel filter.
- 12. Install V-spring (4) holding filter assembly together.
- 13. Install new packing ring (7) on ledge of body.
- 14. Position filter assembly into body with large end down. The filter must set on packing ring.
- 15. Install heavy spring (39, Fig. 23) with larger diameter coil against top of filter assembly.

- 16. Position new gasket (1) on body. Do not use gasket cement.
- 17. Position top cap and spring so that the small diameter coil on spring fits groove in top cap.
- 18. Compress spring and install four 3/8 cap screws (4, Fig. 23) into body. Each of these four (4) screws should be engaged at least three full turns before load on cap is remove Cap screws should be equally spaced. Then thread remaining screws into place.
- 19. Tighten all top cap bolts alternately and evenly to 20.4 Nm (15 ft. lbs.).
- 20. Reconnect air line to outlet port.
- 21. Test unit operation following instructions outlined in SERVICE CHECKS.

<u>Servicing Thermostatically Controlled Cartridge Type</u> Heater

The current heat exchanger units contain a 12 volt 50 watt heater as standard equipment. This heater requires a newly designed bottom cap which is completely interchangeable with those in use previously. Use of this new cap may, however, necessitate a change of the deflector assembly if your present bottom cap has the deflector attached to it by screws. Wrap around strap type heaters, which are NOT thermostatically controlled are available for this old style bottom cap. Refer to Servicing Wrap-Around Strap Type Heater.

There are two kits used in servicing the thermostatically controlled cartridge type heater assembly. Both heaters are 50 watt, however, one is 12 volt and the other is a 24 volt.

Instructions for installing either of the kits are as follows.

- Refer to the General Instructions.
- Disconnect the electrical line from the CR BRAKEMASTER heater.

- 3. Remove old cartridge type heater by loosening set screw for heater on bottom cap.
- Remove old thermostat from bottom cap by removing the two small screws which retain the thermostat on the bottom cap. Discard entire heater/thermostat assembly.
- 5. Install new heater by inserting it into hole from which old heater was removed and retighten set screw.
- 6. Install new thermostat by inserting it into the hole from which old thermostat was removed and attach by means of the two screws provided.
- 7. Attach the lead from the thermostat to the electrical system. Even though the heater is thermostatically controlled, it is recommended that the heater be hooked up through a control switch.
- 8. Be sure the unit is grounded to the chassis.

Servicing The Wrap-Around Strap Type Heater

This heater is designed for use with the older style (prior to January 1, 1979) bottom caps which do not contain a standard cartridge type heater. The following are the instructions for installing or replacing this strap type heater.

- 1. Clean the semi-circular boss farthest from the unloader nut.
- 2. Position heater on boss with mounting flange against fin on bottom cap.
- 3. Mark hole location on fin.
- 4. Drill a 3/32 diameter hole at hole location.
- Reinstall heater and install by means of the screw 6-32 supplied.
- 6. Connect heater lead wire to electrical system of vehicle. The wrap-around strap type heater is not thermostatically controlled, therefore it will be necessary to either be connected to the vehicle's heater switch or to a toggle switch at the instrument panel to be controlled by the operator.

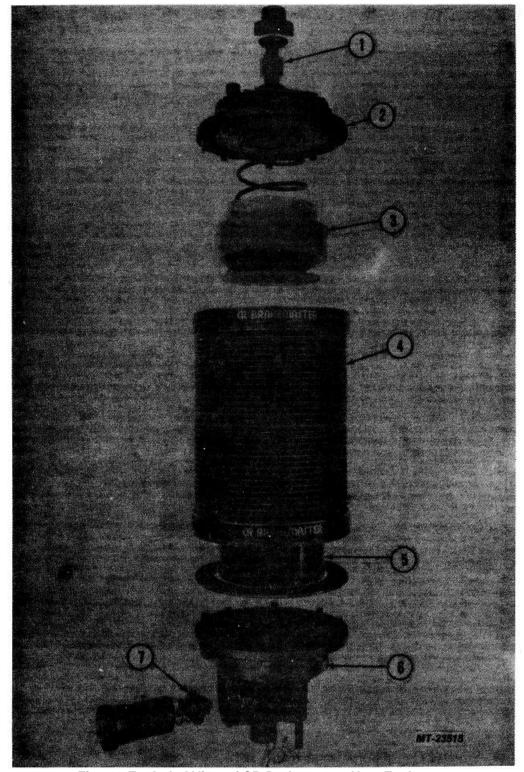


Fig. 28 Exploded View of CR Brakemaster Heat Exchanger

- 1 Check Valve Assembly
- 2 Top Cap3 Filter Assembly
- 4 Body

- 5 Deflector Assembly
- 6 Bottom Cap
- 7 Unloader Valve Assembly

TROUBLE SHOOTING THE CR BRAKEMASTER UNIT

SYMPTOM		PROBABLE CAUSE	REMEDY
Air is exhausted from exhaust port when compressor is in the stand-by mode.		Inlet side of compressor connected to outlet side of turbocharger. Check valve at outlet port	Consider changing compressor inlet connection. Consult vehide manufacturer. Clean or replace check valve
System air pressure bleeds off rapidly when air using	1.	stuck open. Leak in air line connection(s).	assembly. Tighten or replace fittings.
equipment is not being operated.	2. 3.	Leak in air line or reservoir. Check valve at outlet port stuck open.	Repair or replace faulty item(s). Clean or replace check valve assembly.
Compressor runs continuously (will not go into stand-by mode).	1. 2.	•	Tighten or replace fittings. Repair or replace faulty item(s).
easy.	4.	Compressor defective. Unloader valve stuck open. assembly.	Rebuild or replace compressor. Clean or replace unloader valve
	5.	Compressor capacity too low for vehicle.	Install larger compressor.
Compressor goes into "stand- by" mode but cycles rapidly.		Leak in air system. Check valve in CR Brakemaster outlet port stuck open. Defective seal in unloader. Unloader sleeve defective.	Correct leak. Clean or replace check valve assembly. Repair unloader valve. Replace sleeve.
Air flows from exhaust port when compressor is attempting to build up pressure in air system.		Unloader valve stuck open.	Rebuild unloader valve. Replace seat assembly.
	3.	Piece of dirt or foreign material stuck in unloader valve.	Replace seat assembly.
Compressor attempts to build pressure but system pressure will not build up.	1.	Refer to "Compressor runs continuously" of Trouble Shooting Guide.	
will not build up.	2.	Line between compressor and exchanger blocked.	Replace line or remove blockage.
		Check valve in outlet port stuck closed.	Clean outlet and replace check valve.
	4. 5.	Pressure sensing device defective. Blockage in air line between compressor and sensing device (Note: If safety valve of exchanger opens, blockage is after unit).	Replace Remove blockage.



TROUBLE SHOOTING THE CR BRAKEMASTER UNIT (Cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
Does not cool air (initial installation).	 Mounted in location where it Cannot be cooled by ambient air. 	Relocate unit.
	Mounted too near heat produc- ing equipment or too near other heat dissipating equip- ment.	Relocate unit.
	Copper tubing from compressor to inlet too short.	Increase length of copper tubing.
Does not "unload" when compressor goes into stand-by mode.	UNL port of governor not con- nected to unloader port or line broken.	Connect or repair line.
	Components of unloader valve worn.	Rebuild unloader valve.
	Ice formed in area of unloader valve.	Shorten line (24" min. allowable length) and/or install heater.
	Heater inoperative.	Replace heater or check electrical connections.
Safety valve opens.	Check valve in outlet stuck closed.	Clean outlet and replace check valve assembly.
	Obstruction in air line beyond heat exchanger.	Remove obstruction.
	Compressor governor valve defective.	Replace.
	4. Safety valve defective.	Replace.
Water exhausted by unit contains excessive oil and/or soot.	Compressor rings defective.	Rebuild or replace compressor.
No water exhausted during unloading cycle.	Insufficient water in ambient (inlet) air.	
	Not cooling air sufficiently to condense water.	Lengthen copper line from compressor to heat exchanger (36" max. length allowable). Relocate heat exchanger to area of greater ambient air flow.
Compressed air was cooled by unit but no longer is cooled properly.	 Covered with dirt or paint. Deflector damaged or broken. 	Steam clean and/or remove paint. Replace deflector assembly.
Water exhausted is brownish or brown particles are exhausted.	Broken or damaged deflector.	Replace deflector assembly.

FMVSS 121 AIR SYSTEM

GENERAL INFORMATION

Application of IH Brake Code Combinations which apply to FMVSS 121 are as follows (all codes listed include split air system):

ORIGINAL RELEASE OF FMVSS 121 (Date: March 1, 1975)

IH CODES 04061 04062 04061 + 04070 04062 + 04070	APPLICATION Truck with Antilock Front and Rear Axles Tractor with Antilock Front and Rear Axles Truck - Omit Antilock (Export or Exempt Vehicles) Tractor - Omit Antilock (Export or Exempt Vehicles)
FMVSS 121	- DOCKET 75-16 - NOTICE 07 (Date: March 1, 1976)
IH CODES 04061 + 04067 04062 + 04069 04061 + 04070 04062 + 04070 04081 04082 04091 04092 04081 + 04076 04082 + 04076	APPLICATION Truck with Antilock Rear Axles Only Tractor with Antilock Rear Axles Only Truck - Omit Rear Antilock (Export and Exempt Vehicles) Tractor - Omit Rear Antilock (Export and Exempt Vehicles) Truck, with Antilock Rear Axles Only Tractor with Antilock Rear Axles Only Truck Less Antilock (Export or Exempt Vehicles) Tractor Less Antilock (Export or Exempt Vehicles) Truck - Add Front Axle Antilock (Special Equipment) Tractor - Add Front Axle Antilock (Special Equipment)
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BRAKE AIR PRESSURE DISTRIBUTION VALVE	
COMPLETE OPERATIONAL CHECK FMVSS121 SPLIT AIR SYSTEM	18
TORQUE CHART	
TROUBLE SHOOTING BRAKE SYSTEM	
GLOSSARY OF BRAKE TERMINOLOG	

SPECIAL EOUIPMENT

Special tools required to perform air brake maintenance and service on chassis with split air system and antilock system are:

Tool Number	<u>Description</u>
SE-2575 *	Antilock Brake Tester
SE-2579 *	Volt Ohmmeter
SE-2326	Leak Detector Tester
SE-2325	Duplex Gauge Set
SE-2581	Antilock - Exciter Ring Runout Fixture. Use attachment extensions and swivel sleeves from Dial Indicator Set SE-1848
SE-2582	Sensor Adjusting Tool
SE-2227 or SE-2414	Wheel Dolly

^{*} Jumper wire, one foot long with small alligator clips or test probes. Small nails may be used for test probes.

GENERAL INFORMATION

Air brake equipment on trucks and truck tractors provides a means of controlling brakes through a medium of compressed air. The air system consists of various components required to maintain a supply of air, direct the flow of air and convert energy of compressed air into mechanical force to apply the brakes. Different types and sizes of devices are used on different types of vehicles to meet operating requirements.

The National Highway Traffic Safety Administration (NHTSA), branch of the Department of Transportation (DOT), has issued a special Federal Motor Vehicle Safety Standard 121 (FMVSS 121) which specifies that all chassis equipped with air brakes must meet very demanding brake performance requirements.

Some factors that govern braking effort and effectiveness are brake lining area, brake dimensions such as diameter and width, contact pressure, type of lining material (functional characteristics).

In general, these requirements in FMVSS 121 for chassis with air brakes are as follows:

Very stringent stopping requirements from 96.6 km/h (60 mph) in a 3.7 m (12 foot) wide lane on dry pavement and on wet pavement.

The law also has special requirements for emergency stopping which means if air loss occurs on any one of a vehicle's axles, the chassis must still have a means of stopping.

There are also special performance requirements for emergency and parking brake systems. A vehicle must remain stationary on a smooth, dry concrete roadway with a 20% grade, facing uphill or downhill, loaded to its gross vehicle weight and rating. Basically, this means all vehicles with air brakes will have a spring brake system as standard equipment and 6x4 vehicles may have spring brakes on both rear axles.

All chassis with air brakes will have dual or split air control circuits, consisting of a primary and secondary system.

Improvements for air brake activation time, compressor build-up times and minimum reservoir volumes have been required by FMVSS 121. Other devices which are specifically required by FMVSS 121 standard include dual low pressure warning devices, tractor protection valve, warning lights, dual air gauges and others, many of which have been in use prior to FMVSS 121.

An antilock or wheel lock control is used in order to meet the stopping distance requirements and maintain the degree of vehicle control required to keep the vehicle within the 3.7 m (12 foot) lane during a stop.

The term "antilock" could be misleading due to the fact that a momentary brake or wheel lockup does occur. Also wheel lockup can occur at the end of a panic stop; this will be somewhere below 16 km/h (10 mph), depending upon road surface and tire condition.

As of March 1, 1975 (original effective date), all vehicles had to comply with the stopping distance requirement of 75 m (245 ft) +5% from 96.6 km/h (60 mph) empty and 84 m (277 ft) from 96.6 km/h (60 mph) loaded. These requirements were in effect from March 1, 1975 through March 1, 1976.

As of March 1, 1976, the law states that a vehicle must comply to a stopping distance of 89 m (293 ft) from 96.6 km/h (60 mph) loaded or empty.

With this relax of stopping requirements, less powerful front brakes are being used and no antilock is required at front axle applications.

School buses manufactured between June 1, 1976 and September 1, 1977 are not required to have antilock.

Vehicles with an axle having a GAWR of 10,886 kg (24,000 lbs) or more do not have to have antilock system until September 1, 1977.

With a Court decision, the requirements of FMVSS have allowed the omit-antilock option on all domestic vehicle applications effective November 1, 1978.

AIR SYSTEM

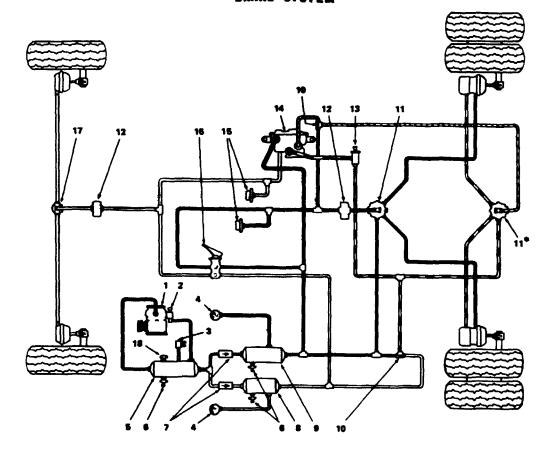
Refer to Figures 1 through 8 for various chassis applications to the split air system.

The air system is a split system consisting of a primary service system (rear axle brakes) and secondary service system (front axle brakes).

This split system begins where the main air supply reservoir branches off into two separate (primary and secondary) systems. This takes place through a series of check valves, separate air reservoirs and brake valve which has two supply and delivery systems for service and emergency braking. The purpose of this split system is to provide a means of making a controlled stop if a failure occurs in either the primary or secondary air systems. A tractor has the advantage of utilizing trailer air brake system during emergency stopping. The primary service system on all chassis is located on the rear axle brakes and secondary service system is located on the front axle. On tandem rear axles, both rear brakes are the primary service system.



4 x 2 TRUCK BRAKE SYSTEM



ITEM DESCRIPTION

- 1 COMPRESSOR, AIR
- 2 GOVERNÖR, AIR COMPRESSOR
- 3 SWITCH, LOW PRESSURE
- 4 GAGE, AIR
- 5 RESERVOIR, SUPPLY
- 6 COCK, DRAIN
- 7 VALVE, CHECK
- 8 RESERVOIR, SECONDARY
- 9 RESERVOIR, PRIMARY
- 10 VALVE, TWO-WAY CHECK
- 11 "VALVE, RELAY
- 12 VALVE, MODULATOR
- 13 VALVE, SPRING BRAKE CONTROL
- 14 VALVE, INVERSION
- 15 SWITCH, STOPLIGHT
- 16 VALVE, BRAKE
- 17 VALVE, QUICK RELEASE
- 18 VALVE, SAFETY

*Same vehicles may have a quick release valve in parking broke system.



MT-170188

FIG.1 (All Trucks To Date)

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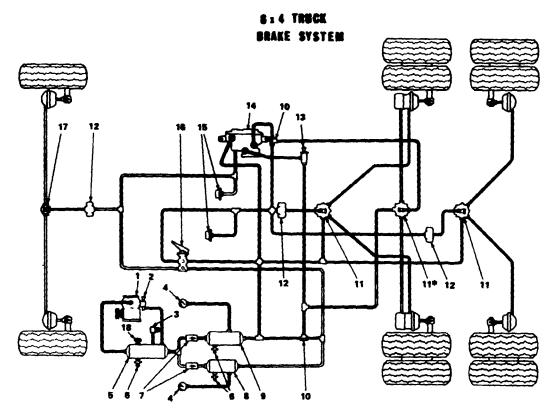


FIG. 2 (ALL Trucks To Date)

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ITEM DESCRIPTION

- COMPRESSOR, AIR
- GOVERNOR, AIR COMPRESSOR
- SWITCH, LOW PRESSURE
- 4 GAGE, AIR
- B RESERVOIR, SUPPLY
- 6 COCK, DRAIN
- 7 VALVE, CHECK
- RESERVOIR, SECONDARY
- 9 RESERVOIR, PRIMARY
- 10 VALVE, TWO-WAY CHECK
- 11 *VALVE, RELAY
- 2 VALVE, MODULATOR
- 13 VALVE, SPRING BRAKE CONTROL
- 4 VALVE, INVERSION
- 15 SWITCH, STOPLIGHT
- 16 VALVE, BRAKE
- 17 VALVE, QUICK RELEASE
- 18 VALVE, SAFETY

PRIMARY SERVICE SYSTEM

SECONDARY SERVICE SYSTEM

PARKING BRAKE SYSTEM

SECONDARY & PARKING SYSTEM

MT-17019B

^{*}Some vehicles may have a quick release velve in parking brake system.

4 x 2 TRACTOR BRAKE SYSTEM

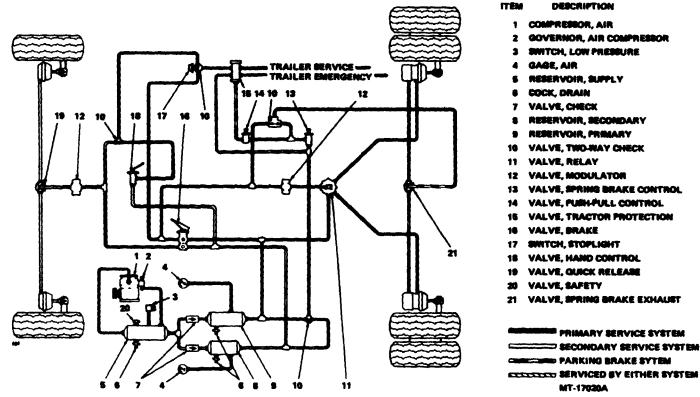


FIG.3 (Except CO Transtar Models Built After March 30,1979)

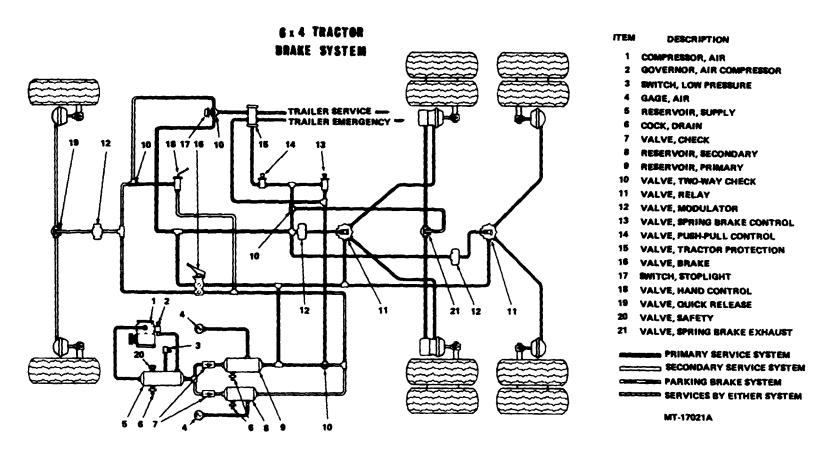


FIG.4 (Except CO Transtar Models Built After March 30,1979)

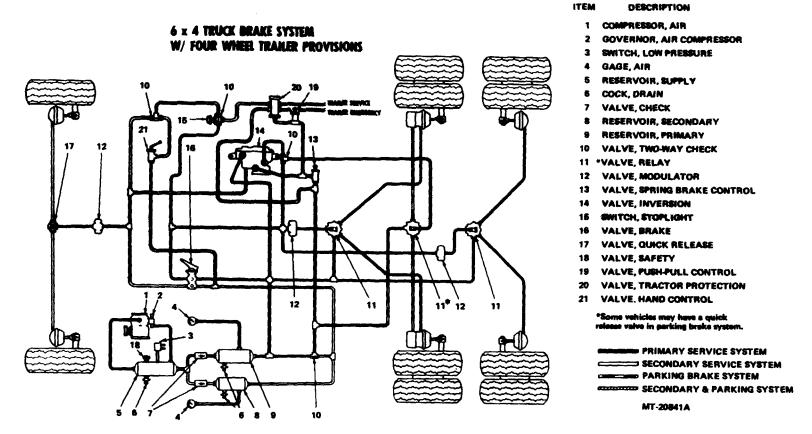


FIG.5 (Except Transtar CO Models Built After March 30,1979)



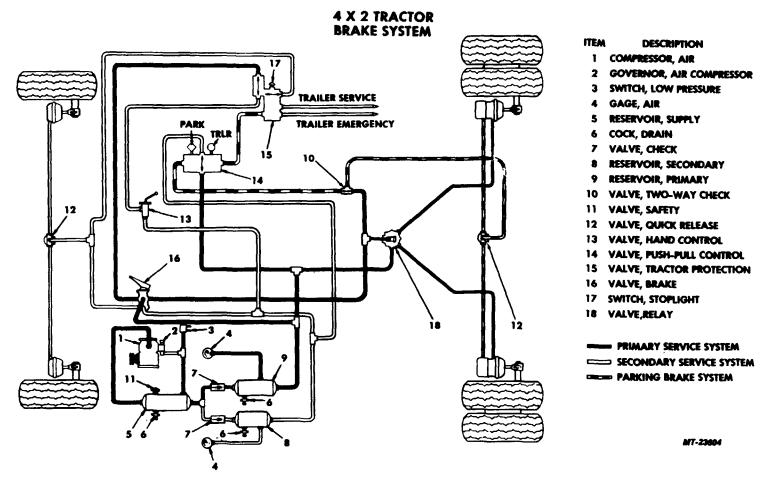


FIG. 6 (CO Transtar Models Built After March 29, 1979)



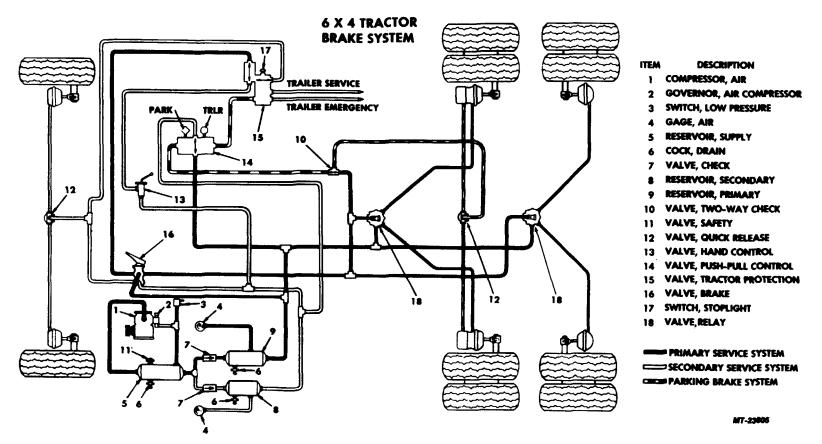


FIG. 7 (CO Transtar Models Built After March 29,1979)



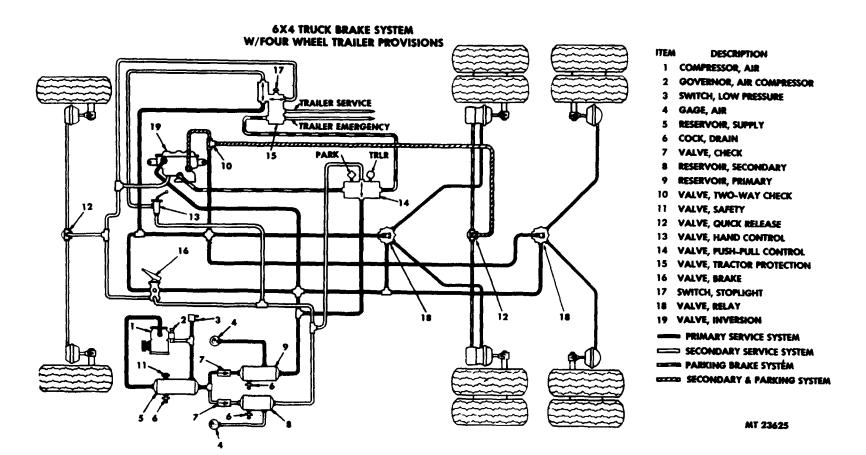


FIG. 8 (CO Transtar Models Built After March 29,1979)

On a straight truck (Figs. 1 and 2) there is an additional valve installed in the air brake system to apply the spring brake on the rear axle along with the front axle service brakes if air loss occurs in the primary system (rear axle brakes). This valve is called the inversion valve (FIG. 9) and its purpose is to sense air loss in the primary system and apply spring brakes through the use of service brake valve.

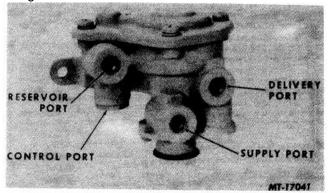


FIG. 9 Inversion Valve

The split air brake system on a tractor (Figs. 3 and 4) functions in a similar manner as a straight truck except there is no need for an inversion valve to apply the spring brakes. The trailer brakes which operate off the primary or secondary tractor air system provide braking effort to assist the tractor brake in an emergency situation (air loss on one of the systems).

On a straight truck which is equipped with trailer towing provisions (FIG. 5), the vehicle will have a split air system which combines both straight truck and tractor air systems as previously described.

IMPORTANT

A low pressure warning buzzer will sound warning the operator of a failure in either system. Under no circumstances should the vehicle continue to be operated when a failure is indicated, since air pressure cannot be built up in system until air leak is corrected, even though air for emergency stopping is retained in that portion of split air system not having a failure.

Figs. 6, 7 and 8 are equipped with two valves which simplify the plumbing on the vehicles.

The push pull control valve assembly (modular control valve) includes both the spring brake control and

the tractor protection valve control as well as a shuttle type double check valve.

The manifolded tractor protection valve includes two double check valve assemblies along with the stop light switch.

Vehicles with these valves also have the feature of Trailer Park Only and Trailer Charge with Tractor Spring Brakes Applied (tractor park only).

Complete detailed information pertaining to each of the air brake components may be found in AIR BRAKE COMPONENTS, CTS-2673.

ANTILOCK

During a brake stop, the maximum point of deceleration occurs before wheel lockup. When wheel lockup does occur, stopping distances increase and loss of directional control is the usual result. To overcome wheel lockup, a means of determining wheel speed was needed. This was done by installing an exciter ring in the rotating part of the brake system (wheel assembly) and a sensor installed on the stationary part of the brake system (backing plate). Refer to FIG. 10.

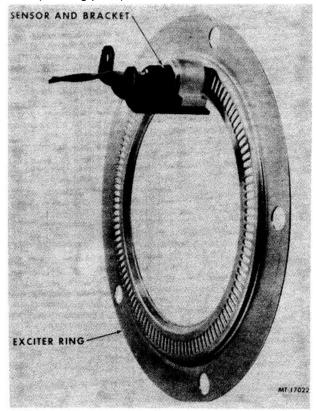


FIG. 10 Exciter Ring and Sensor Assembly

As the wheel rotates, an electronic signal proportional to wheel speed is generated and fed to a computer module (FIG. 11) which records the rate of impulses. (There is one computer for each axle.)

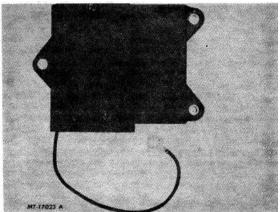


FIG. 11 Computer Module

During a brake application when the brake is about to lock up, the computer sends an electrical signal to the air control valve (FIG. 12). Within a fraction of a second the valve responds by exhausting air from the brake chambers to allow wheels to speed up and then automatically reapplies air. The computer brake control works only when a locked wheel is about to occur. Under normal braking, the antilock system will not be called upon.

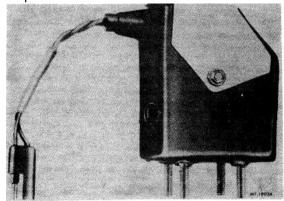


FIG. 12 Air Control Valve

A warning (monitor) light (FIG. 13) installed in the truck cab indicates system is working. The monitor light is mounted on the instrument panel of the vehicle. When the ignition switch is turned on, a one-half second illumination of the light followed by the light going out and remaining off indicates a satisfactory system. If the light should remain "on" a problem is indicated in antilock system. The service brakes will function; however, chassis will not have the advantage of the antilock.

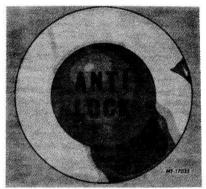


FIG. 13 Warning (Monitor) Light

Vehicles without antilock or vehicles without front axle antilock will not have an air control (modulator) valve in the air system (Item 12, Figs. 1 through 5). These vehicles will not have exciter rings or sensors at wheels, nor will the vehicle have modules for axles which do not have antilock.

Refer to ANTILOCK, CTS-2669 for complete information pertaining to antilock system.

SERVICE INSTRUCTIONS

It is important that the following service instructions be adhered to when brake maintenance or service is being performed on chassis with split air and antilock systems.

WHEEL BEARING ADJUSTMENT PROCEDURE

Hubs, bearing cups, nuts, locks, hub caps, shaft and spindles are to be free from any foreign matter and bearing cones are to be properly lubricated. Refer to LUBRICATION, CTS-2412 for proper lubricant for wheel bearings.

After hub and bearings are assembled in place on spindle, tighten wheel bearing adjusting nut to 68 N.m (50 ft lb) while rotating the drum. Then back off nut 1/4 turn. If lock or cotter pin can be installed at this position, do so. If not, tighten to nearest locking position and insert pin or lock. Bent type lock washer is to have one tab bent over adjusting nut.

For axles having double nut type lock, tighten jam nut to 136 203 N.m (100 150 ft lb). After tightening, bend one tab over jam nut.

This procedure is intended to result in zero to .254 mm (.010") end play with no preload.

INSPECTION

Check hub and drum end play with respect to spindle. A maximum end play of .254 mm (.010") is allowable. If no end play exists, check for rotation of

adjusting nut with fingers or small hand tool. With double nut type lock, it will be necessary to remove jam nut and lock. If adjusting nut can be loosened with less than 34 N.m (25 in lb) torque, the assembly is acceptable.

REMOVE WHEEL AND DRUM ASSEMBLY

1. Position vehicle on floor stands (FIG. 14).

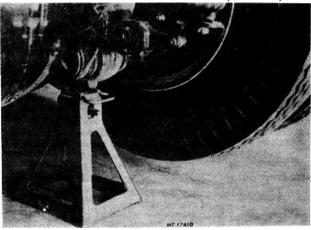


FIG. 14

Loosen or back off brake adjustment at slack adjusters so that drum will move freely without drag (FIG. 15).

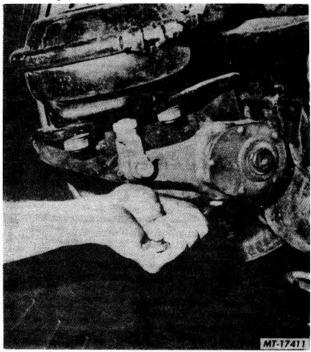


FIG. 15

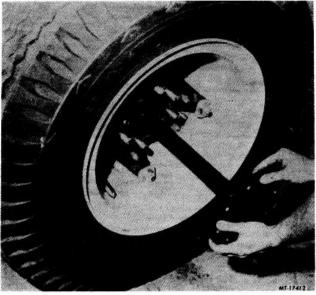


FIG. 16

- Remove outer bearing grease cap and gasket on front axles. Remove axle shaft from rear axles (FIG. 16).
- 4. Different combinations of wheel bearing adjustment nut locks will be found.
 - a. Some front wheels will require removing cotter key; then bearing nut can be removed.
 - b. Rear wheels and some front wheels will require bending locking ring tab, relieving outer bearing adjustment lock nut. Then outer bearing lock nut locking ring, bearing adjustment nut and retaining washer can be removed.
- 5. Use a wheel dolly to remove wheel and drum assembly (FIG. 17). Be sure to catch outer bearing assembly as wheel and hub is removed.
- Repeat same procedure for opposite wheel on same axle.

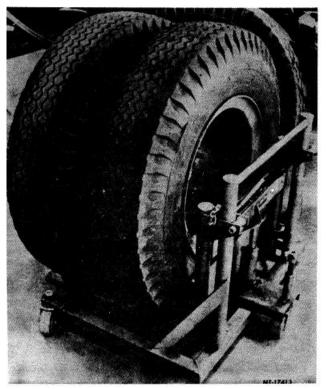


FIG. 17

REINSTALL WHEEL AND DRUM ASSEMBLY

- Pull sensor to its maximum outward travel (away from center of vehicle). Sensor Adjusting Tool SE-2582 is available to assist in pulling sensor out (FIG. 18). Inspect sensor for wear. Refer to ANTILOCK, CTS-2669 under "Maintenance."
- 2. Check continuity of sensor. It should be 4000 to 6000 ohms. This check is only required if

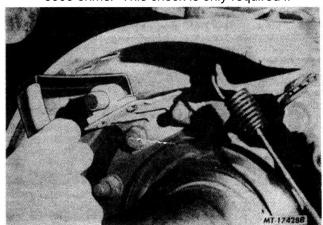


FIG. 18

- condition is questionable. Visually check condition of exciter ring prior to wheel installation to assure that it is not bent.
- 3. Use a wheel dolly to position wheel and hub assembly on spindle, only far enough to install outer bearing and bearing adjustment nut. When nut is tightened, hub and drum assembly with exciter ring will push sensor into bracket. When bearings are adjusted properly, the sensor will be set correctly.

Do not rock hub and drum when installing as the sensor may be pushed in too far and correct sensor output will not be obtained.

Sensor output must always be checked after any maintenance to be sure of sensor adjustment.

- 4. Adjust wheel bearings as outlined in Wheel Bearing Adjustment;
- 5. Check sensor for voltage output. Refer to ANTILOCK, CTS-2669 for detailed instructions. If correct output is not obtained wheel sensor is not adjusted properly. Remove wheel and drum, pull sensor out and then reinstall wheel and drum assembly, repeating Steps 1, 3, 4 and 5. Cocking brake drum during installation could push sensor in too far and a low voltage reading would be obtained.
- 6. Install outer bearing grease cap and gasket on front axles and install axle shaft on rear axles.
- 7. Repeat this same procedure for opposite wheel.
- 8. Adjust both brakes on axle where maintenance is being performed.
- 9. Remove floor stands.

REPLACE EXCITER RING (Hub and Drum Removed)

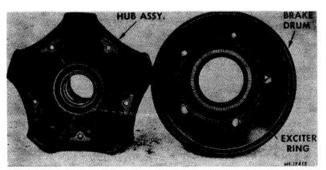


FIG. 19

2. Inspect exciter ring (FIG. 20) for possible wear at slots which is not probable since sensor does not contact exciter ring in normal operation. Only excessive wheel bearing looseness could cause wear; however, wear on sensor will be noted rather than exciter ring. Dirt or dust in slits of exciter ring will not affect its operation.

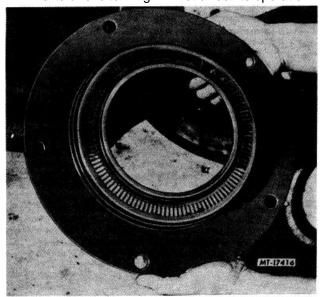


FIG. 20

- 3. Visually check condition of new exciter ring prior to installation to be sure it is not bent.
- 4. Assemble hub, drum and exciter ring and tighten bolts to specified torque and sequence (refer to TORQUE CHART). Be sure bolt heads are aligned properly in drum (FIG. 21).

When exciter ring is not located between hub and drum, flat washers must be used under bolt heads.

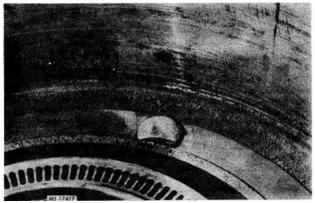


FIG. 21



FIG. 22

- Check exciter ring runout using Antilock Exciter Ring Runout Fixture SE-2581 and attachment extensions and swivel sleeves from Dial Indicator Set SE-1848 (FIG. 22). Exciter ring runout should not exceed .635 mm (.025") maximum.
 - If runout exceeds .635 mm (.025") maximum the drum and hub assembly may be separated and exciter ring relocated on different bolts to a more desirable location.
- Complete installation of wheel and drum as outlined in <u>Reinstall Wheel and Drum Assembly</u>.
 Be sure to check voltage output of sensor.

AIR SHIFT DIFFERENTIAL POWER DIVIDER LOCK

With the introduction of FMVSS 121 brake system, air shift power divider lock is disengaged (released) by air pressure and spring controlled for engagement (lock position). This arrangement eliminates the need for a spring brake unit at all four rear axle brake groups.

FIG. 20 illustrates typical air supply connections of the various air control valves at the instrument panel.

Prior to FMVSS 121, air operated power divider lock had air supply for engagement (lock position) and spring controlled for disengagement (release).

Operation (FIG. 23)

The air source of power divider lock system commences in the control line to spring brake chambers. Therefore, as long as spring brake control is in the parking brake "release" position, air will pass through the spring brake control and on to spring brakes holding brakes in released mode. At the same time air will pass

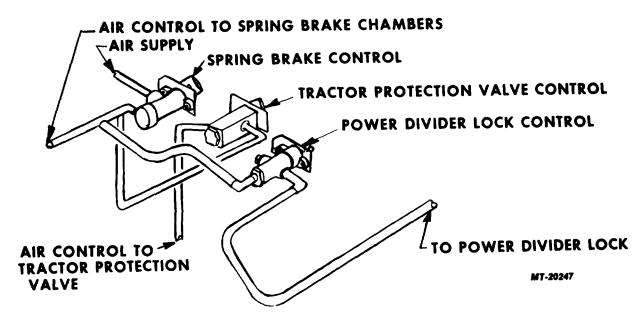


FIG. 23 Power Divider Lock Air Shift Control

on to the power divider lock (PDL) control. With the PDL in "unlock" or "released" position, air will pass through the PDL control and air pressure will hold the PDL in the disengaged mode.

When the PDL control is placed on the "lock" position, air is exhausted and PDL will shift into "lock" mode.

With the PDL in "unlock" or "released" position and the spring brake control is pulled out to "apply" position, air will be exhausted for both the spring brake system and PDL system. Thus, spring brakes will apply and PDL will automatically shift into lock mode due to loss of air in the system.

BRAKE AIR PRESSURE DISTRIBUTION VALVE

Prior to the introduction of FMVSS 121 (March 1975), front wheel limiting valves could be used on trucks and buses with air brakes which would permit full brake valve delivery pressure to front wheel brakes when operating on dry roads, or at the option of the operator reduce the pressure delivered to the front wheel brakes by 50% when operating on wet or slippery roads.

Since March 1, 1975, Federal Highway Administration, Department of Transportation, Subchapter B, Federal Motor Carrier Safety Regulation states that, "Manually operated devices to reduce or remove the front wheel braking effort must not be installed in a bus, truck or truck-tractor manufactured after February 28, 1975."

The regulation, however, does permit an automatic type device to reduce front wheel braking up to 50% of normal braking with certain specific limitations.

There has been a valve made available (code 04567) for special requests. It, however, is not a true front wheel limiting valve but a <u>brake air pressure distribution valve</u>. This valve only limits full front wheel braking during light brake applications regardless of road conditions. However, in a hard to panic brake applications, the driver obtains full front wheel braking (full braking potential).

There are other problems which one should be aware of with the installation of the air pressure distribution valve. They are:

1. Increased Rear Axle Brake Wear

The vehicle's brake wear <u>balance</u>, as designed, is equal on front and rear brakes. During normal brake stops with the installation of air pressure distribution valve, air pressure to front axle brakes is half of that applied to rear brakes, resulting in abnormal wear of rear axle(s) brake lining.

2. Glazing and Noise

During easy type brake applications, since front axle brakes with air pressure distribution valve will be doing about half the normally designed work, the possibility of glazing, poor burnish and noise problems could increase.



COMPLETE OPERATIONAL CHECK OF FMVSS121 SPLIT AIR BRAKE SYSTEM

Remember that there are three reservoirs in the split air system.

Main Air Reservoir ("let Tank) will have air source from air compressor. Some air reservoirs will be a two or three compartment type.

<u>Primary Air Reservoir</u> Air supply for all rear axle service brakes.

<u>Secondary Air Reservoir</u> Air supply for front axle service brakes.

- 1. Block wheels to prevent vehicle from moving.
- Open all drain cocks on all air reservoirs to completely drain reservoirs. The spring brake control should automatically apply between 48-241 kPa (7-35 psi).
- 3. Close all reservoir drain cocks.
- 4. Build up air supply in chassis system to approximately 758 kPa (110 psi).
- Position spring brake control in released position (pushed in) and Trailer Emergency pulled out (apply).
- Check air pressure for leakage by observing air gauges on instrument panel. Leakage should not be greater than 13.8 kPa (2 psi) in one minute.
- Open drain cock in secondary air reservoir.
 Drain cock must be opened all the way for quick loss of air.
 - You will note loss of air by observing air gauges or double indicator type gauge. One system will show a loss of air. With ignition switch on, low pressure indicator should come on at approximately 483 kPa (70 psi).
- 8. Apply service brakes and observe the slack adjusters and service brake chamber push rods. If you bled the secondary system, movement of the brake chamber push rods should occur on all rear brakes. If movement is noted at front axle brake chambers, you bled the primary reservoir (refer to Step 12). If brake chamber push rod travel movement is as described, the primary section is good.
- 9. Close drain cock in secondary air reservoir.
- 10. Build up air supply in air system again.

- Open drain cock in primary air reservoir.
 Be sure to open drain cock all the way.
 Again you should note loss of air by observing the opposite air pressure indicator (gauge).
- 12. Apply service brakes and observe the slack adjusters and service brake chamber push rods. If you bled the primary air reservoir, you should notice brake chamber push rod travel on front axle.
 - On straight trucks you should also notice movement of push rods on the rear axle with spring brakes. This application and release of spring brakes should be apparent until air pressure drops to 48-241 kPa (7-35 psi); then full spring brake application will be apparent.
- 13. Check operational performance of Trailer Emergency and Service Systems as follows:
 - a. Using two air gauges (0-160 psi) or Duplex gauge (SE-2325) with hoses and two additional trailer couplings (service and emergency), attach the air gauges to the service and emergency couplings on vehicle.
 - b. Build up air pressure in chassis air system.
 - c. With hand control valve, parking brake control, and tractor protection control (TRAILER EMERGENCY) in released position, the air gauge at emergency coupling should have air pressure corresponding to that of air gauges in cab. The air pressure at service coupling will remain at zero.
 - d. Apply service brakes (foot valve); the air gauge at service coupling should raise to approximately the same pressure of the gauges in cab, +41 kPa (+6 psi). Release service brakes. Air pressure at service coupling should drop to zero, while the air pressure at emergency coupling should correspond approximately to that of air gauges in cab.
 - e. Pull tractor protection control valve (TRAILER EMERGENCY) out. Air pressure should drop to zero at air gauge on emergency coupling. Then push valve "in" and air pressure should raise to that of air system of vehicle. No air pressure should be recorded at service coupling.

- f. Check hand control valve operation by moving handle from released position to applied position. As the handle is moved toward "applied" position air pressure at service brakes should gradually increase. At full applied position the air pressure should be the same as chassis secondary system. Then move control handle to released position and air pressure at service brake connection should drop to zero. The air pressure at emergency coupling should correspond to that of air gauges in cab.
- g. Pull parking brake control out. Air pressure at emergency connection should drop to zero. Push control knob in. Air pressure at emergency coupling should raise to that of main air system, while air pressure at service coupling should not raise.

If the foregoing checks perform as described, the chassis is ready for service. If the checks do not function properly, a more detailed check of components will be required. Refer to Components Section (CTS-2673) for detailed information regarding service check on various components.

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TORQUE CHART

TORQUE CHART			
HUB TO DRUM			
Nominal <u>Size</u>		TORC <u>N.m</u>	QUE <u>Ft</u> <u>Lbs</u>
1/2"		95 - 115	70 - 85
9/16"		144 - 170	105 - 125
5/8"		194 - 237	145 - 175
3/4"		346 - 407	250 - 300
Tigh	ten hub-to-drum bolts alternately, across from each other.		
RIM AND WHEEL	MOUNTINGS		
	Cast Wheels (Rim Clamp)		
	<u> Cast Wheels (Mill Clamp)</u>		
5/8"		217 -237	160 - 157
3/4"		237 -271	175 - 200
	<u>Disc Wheels - Light Truck</u>		
5/8"	In-Out Coined Mounting	237 -304	175 - 225
5/8"	Flanged Nut Mounting	373 -439	275 - 325
	Disc Wheels - Standard Mounting		
11/16"	Flanged Nut Mounting	475 - 542	350 - 400
3/4"	Standard Square Cap Nut Mounting (13/16" Across Flats)	610 - 678	450 - 500
3/4"	Standard Hex Cap Nut Mounting (1-1/2" Across Flats)	610 - 678	450 - 500
1-1/8"	Standard Hex Cap Nut Mounting (1-1/2" Across Flats)	610 - 678	450 - 500
	Disc Wheels - Heavy Duty Mounting		
1-1/8"	HD Hex Cap Nut Mounting (1-3/4" Across Flats)	882 - 949	650 - 700
15/16"	HD Square Cap Nut Mounting (15/16" Across Flats)	1017 - 1220	750 - 900
1-5/16"	HD Hex Cap Nut Mounting (1-3/4" Across Flats)	1017 - 1220	750 - 900

TROUBLE SHOOTING BRAKE SYSTEM

1. Insufficient Brakes

Brakes need adjusting or relining.

Low air pressure in brake system.

Brake valve delivery pressure low.

Wrong size actuators and/or slack adjusters.

Failure of part of a split air system.

2. Brakes Apply Too Slowly

Brakes need adjusting or lubricating.

Low air pressure in brake system.

Insufficient brake valve delivery pressure.

Excessive leakage with brakes applied.

Restricted tubing or hose.

Treadle travel restricted.

3. Brakes Release Too Slowly

Brakes need adjusting or lubricating.

Brake valve not returning to fully released position.

Restricted tubing or hose.

Exhaust port of components restricted or plugged.

Faulty components. (*)

4. Brakes Do Not Apply

No air pressure in brake system.

Restricted or broken tubing or hose.

Faulty brake valve.

5. Brakes Do Not Release

Sticking shoe guide pins.

Sticking anchor pins.

Broken or weak return springs.

Brake valve not fully released.

Faulty brake valve or relay valve.

Restricted or collapsed tubing or hose.

6. Brakes Grab or Erratic Braking

Grease on brake lining reline brakes.

Faulty brake valve or relay valve.

Sticking shoe guide pins.

Sticking anchor pins.

Broken or weak return springs.

No vehicle load high brake pressure.

7. Uneven Brakes

Brakes need adjusting or relining.

Improper axle mounting.

Grease on brake lining reline brakes.

Brake shoe return spring broken.

Brake drum out of round.

Brake chamber diaphragm failure.

Wrong brake lining.

Broken foundation brake parts.

8. Air Pressure Will Not Rise to Normal

Faulty air gauge (registering incorrectly).

Excessive valve or fitting leakage.

Governor out of adjustment.

Slipping compressor drive belt.

Faulty compressor.

Broken supply line.

Brake Valve, Quick Release Valve, Relay Valve

9. <u>Air Pressure Rises to Normal Too Slowly Excessive valve or fitting leakage</u>.

Clogged compressor air strainer.

Engine speed too slow.

Compressor discharge valve or inlet valves

leaking.

Compressor drive belt slipping or faulty drive coupling.

Worn compressor.

Excessive carbon in compressor cylinder head

or discharge line.

10. Air Pressure Rises Above Normal

Faulty air gauge (registering incorrectly).

Governor out of adjustment.

Faulty governor and safety valve.

Restriction in line between governor and compressor or restricted unloading valve.

Too much clearance at compressor unloader

valves or compressor unloading mechanism stuck in closed position.

11. Air Pressure Drops Quickly with Engine Stopped and Brakes Released

Leaking brake valve.

Leaking tubing or hoses.

Compressor discharge valves leaking.

Excessive leakage elsewhere in air brake supply system.

Excessive water in reservoirs.

12. Air Pressure Drops Quickly with Engine Stopped

and Brakes Fully Applied

Leaking brake chamber, actuator or brake cylinder.

Valve left open.

Leaking brake valve.

Leaking tubing or hose line.

Excessive water in reservoirs.

Compressor Knocks Continuously or

Intermittently

Loose drive pulley.

Back lash in drive gears or drive coupling.

Worn or burnt out bearings.

Excessive carbon deposits in compressor

cylinder head.

14. Safety Valve "Blows Off"

Air pressure in air brake system above

normal. Check unloader mechanism or

faulty governor.

15. Excessive Oil or Water in Brake System Drain reservoirs more often.

Compressor passing excessive oil.

Compressor air strainer restricted.

Excessive engine oil pressure.

Back pressure from engine crankcase.

Excessive oil in compressor crankcase.

GLOSSARY OF BRAKE TERMINOLOGY

Air Control Valve

The air control valve receives a signal from computer module and adjusts air pressure in brake chambers. This is an electrically actuated air valve.

Brake Activation Time

The length of time required for a given amount of air to start a mechanical movement in brake system foundation brake. An example of this can be taken from DOT requirements stating that with an initial service reservoir system air pressure of 690 kPa (100 psi), air pressure in each brake chamber shall reach 414 kPa (60 psi) in not more than 0.35 second measured from the first movement of the service brake control.

Coefficient of Friction

Friction is the resistance to relative motion between any two bodies in contact and it varies, not only with different materials, but also with the condition of material. The amount of friction developed by any two bodies in contact is said to be their coefficient of friction and this is expressed by stating the amount of force being required to move one body while it remains in contact with the other. The amount of force is expressed in relation to the weight of the moving body. Thus, if the moving body weighs 45.4 kg (100 lbs) and a force of 27.2 kg (60 lbs) is required to keep it moving while it remain in contact with another body, the coefficient of friction between two bodies is said to be .6 or 60%.

The coefficient of friction is important when related to the following. The resistance to relative motion between the tire and road surface; and friction quality of a particular lining being used on a particular type or brake design.

Computer Module

The computer module processes wheel speed information from two-wheel speed sensors on the axle and controls both brakes on the axle simultaneously. The computer module determines when wheel lockup is about to occur and energizes the air control valve accordingly. The computer module is a solid state component using custom integrated circuits.

These circuits are completely sealed.

Deceleration -FPSPS

This term expresses the actual rate at which a vehicle is losing speed and usually denotes the speed being lost each second in terms of miles per hour or feet per second. The change in rate of speed of a vehicle during a slow down or stop is expressed by first stating rate of speed being lost, such as miles per hour or feet per second, and then by stating the time required for this rate of speed to be lost. One very common method of testing brakes is the use of a decelerometer, a device that determines the maximum rate of deceleration developed during a stop.

Dual Brake Valve

An application valve (floor mounted or suspended pedal type) having separate supply and delivery circuits, providing the driver with a graduated control for applying and releasing the vehicle's brakes. This allows separate but equal application pressure to the vehicle's front brakes (secondary system) and rear brakes (primary system).

Dynamic Cycle Loads

The on and off torque loading caused by antilock action.

Energy of Motion to Heat Energy

Since friction is the resistance to relative motion between two bodies in contact and since friction results in heat, a more complete definition of a brake would be that it is a mechanical device for retarding the motion of a vehicle by friction, thereby changing the energy of motion into heat energy. Meaning, that during a stop, the heat energy must be dissipated or absorbed by the brake assembly.

This term is important due to the fact that brake fade can result from excessive heat being retained by the brake system, resulting in increased stopping distance and erratic brake action.

Exciter

The exciter is a one-piece unit made in various sizes to accommodate the various hub and drum assemblies. The exciter contains 120 slots. These slots passing by the sensor end generate an AC electrical signal that supplies wheel speed information to the computer module.



Inversion Valve

SR-1 spring brake valve is used on straight trucks only. The purpose of this valve is to supply a specific, limited hold off pressure to the spring brakes through use of the service brake valve.

Modulated Spring Brake Control

Referring to the fact that spring brakes are applied with some degree of control. When applied by the inversion valve action on a straight truck, this type of application is not as sudden or harsh as the application of a spring brake in the normal manner.

Point Sensor and Bracket Assembly

The point sensor is a permanent magnet variable reluctance device which generates wheel speed information. The point sensor is a self-setting device, which is installed in a bracket mounted to the brake spider or backing plate. The wire leads connect to the computer module.

Reaction Time

Relating to the driver, the time required from the initial thought of stopping to the activation of the brake system; i.e., the time required to lift one's foot from the throttle and place it on the brake pedal and depress it.

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FOUNDATION BRAKE-AIR

CAM-ACTUATED TYPE

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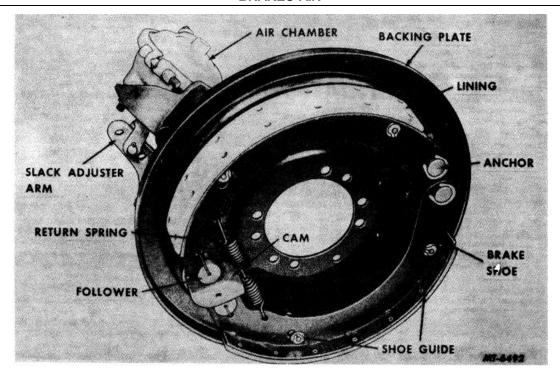


Fig. 1. Typical Front Axle Foundation Brake Group

DESCRIPTION

The foundation brake is where the real work in stopping a vehicles takes place. To provide adequate brakes on a vehicle, every square inch of brake lining-to-drum contact is needed as well as overall condition of friction surface of the drum .

The term "foundation brake" is given to those components at wheels which actually do the braking. This includes such items as brake shoes, lining, anchors, drums and spider or backing plate (Fig 1). Although the slack adjusters, cam and followers are not directly known as components of the foundation brakes, they will be covered herein.

The following paragraphs cover the step-by-step procedures in servicing these components.

The need to be properly equipped in order to perform "quality" brake service is greater now than it ever was because of the fine tolerances of brake systems.

The key to precision brake service is in the machine or truing every brake drum and fitting new brake lining and shoe to the new drum diameter .

Various tools are available which assist in servicing brake systems. These tools are:

<u>Brake Reliner</u> (SE-1272) designed to remove drill rivet and circle grind lining.

<u>Shoe Gauge</u> (SE-1572) used to measure arc diameter, determine from old shoe the diameter of drum it has been working in, and thickness of lining to use in order to insure same arc diameter as drum.

<u>Brake Drum Checker</u> (SE-1605) used to measure brake drum.

MAINTENANCE

A regular schedule for periodic cleaning, lubrication, adjustment and inspection should be established, usually based on past experience and type of vehicle operation. It is difficult to determine an exact maintenance interval (time or mileage) since vehicles will be used in a wide variety of operational applications and conditions.

To compensate for lining wear, brakes should be adjusted frequently to maintain satisfactory operation and efficient brakes. Good brake adjustment is e; en more important on vehicles with antilock system (FMVSS 121 air brake system), since poor adjustment will aggravate air consumption. Long chamber strokes will require more air to be used during each cycle (refer to the following paragraph explaining cycle), which means air reservoir pressure will be depleted faster than would be the case with good brake adjustment and short brake chamber strokes.

Cycle

The antilock system analyzes wheel speed information such as that caused during hard braking or extreme variation in wheel speed on the two wheels of an axle. If brake lockup or excessive wheel spin is detected by the antilock system, a momentary reduction of air pressure supplied to the brakes on axle affected will reduce brake power. Just as soon as the wheels return to a controlled percent of original speed, the brakes will automatically be reapplied. This is known as a cycle and may be repeated several times during a stop depending upon speed, road surface and brake force by the driver. A cycle can be felt as a lurch or same type of feeling that would be obtained when brakes are pumped during a stop.

Refer to BRAKE ADJUSTMENT for detailed adjustment procedures.

Brakes should be cleaned, inspected, lubricated each time the hubs are removed.

Drain air reservoirs regularly as required. Local conditions govern frequency. Dry climates require less attention than humid areas, where it may be necessary to drain reservoirs daily.

When draining air reservoirs, let all air bleed off and be sure all drainage stops.

For details for the air system, refer to the appropriate air brake component section.

BRAKE ADJUSTMENT

Brake adjustment can be a contributing factor of brake complaints. Proper brake adjustment must be maintained. Do not overlook brake adjustment on the trailer either. Brake balance on trucks and tractor trailers is essential for good braking and to minimize cycling of the antilock system on vehicles with FMVSS 121 air brake system .

Excessive lining-to-drum clearance will require more air to be delivered to each brake chamber since a longer stroke of the chamber is required. On vehicles with FMVSS 121 improperly adjusted brakes on an axle (one brake group adjusted properly and the brake group on opposite side of vehicle backed off) will result in an antilock cycle since one brake group will tend to lockup or slow down more rapidly than the other. This cycling of the antilock will tend to increase the stopping distance of a vehicle.

Particular attention must be given to brakes on

tractor-trailer combinations. This is even more important on vehicles with antilock system because if the tractor front axle brakes are not adjusted properly, the rear brakes must do all the braking. During bobtailed operation or with a lightly laden trailer, a firm brake application will cycle the antilock more frequently causing the rear brakes to lockup, resulting in low pressure warning due to accelerated air consumption and unnecessary cycling of the antilock system.

Periodic checking of push rod travel or brake adjustment is essential for good braking. Push rod travel should be checked every 3,000 km (2,000 miles) to determine if adjustment is necessary. Push rod travel should be kept at a minimum without brakes dragging.

Inspect brake lining every 19,000 km (12,000 miles) or every 12 months, whichever occurs first. When brake lining or blocks are worn to within 1.6 mm (1/16") of rivets, brake lining must be replaced.

If brake lining is satisfactory, adjust brakes in the following manner making brake adjustment, one wheel at a time, with all drums in place and all slack adjusters connected to chambers.

- With wheels raised and parking brake released so that wheels will rotate freely, check each brake chamber push rod to make certain that it is in fully released position. To do this, disconnect push rod at slack adjuster. If push rod moves toward (released) brake chamber, turn worm shaft and rotate slack adjuster toward push rod until clevis pin can be reinstalled.
- 2. Disengage locking sleeve on worm shaft or adjusting screw by depressing spring loaded sleeve with a wrench.
- 3. Turn vehicle wheel and at the same time rotate adjusting screw until brake shoes are tight against drum.
- 4. Back off adjusting screw just enough to eliminate drag.
- Make and hold full brake application to fully seat brake shoes against drum and note the angle between slack adjust and push rod. This angle should be a minimum of 90 degrees or more.

If the foregoing adjustment or relining of brake shoes does not establish an angle of near 90 degrees between push rod and slack adjuster with brakes applied, then maximum force against slack adjuster cannot be obtained. Readjust push rod as follows:



Fig. 2. Slack Adjuster Locking Sleeve on Adjusting Nut

 Disconnect slack adjuster and push rod. Do this carefully because slack adjuster may be turned toward brake chamber with considerable pressure.

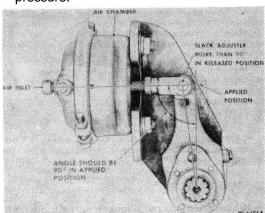


Fig. 3. Brake Chamber and Slack Adjuster

- Loosen lock nut on clevis and thread clevis onto push rod toward brake chamber for several turns.
- 3. Reconnect slack adjuster and push rod with clevis pin.
- Make a full brake application and check angle between slack adjuster and push rod. If 90

degrees or slightly more is not obtained with brakes applied, repeat adjustment until angle is satisfactory. The desirable situation is to bring brake shoes against drum just as the slack adjuster attains the 90 degree position (Fig. 3).

SLACK ADJUSTER OPERATION TEST

Slack adjusters should rotate freely without binding when the brakes are applied and when the brakes are released all slack adjusters must return to the released position freely and without binding. The slack adjusters must be adjusted so that the angles formed by brake chamber push rod and center of slack are 90 degrees as described in BRAKE ADJUSTMENT.

BRAKE CHAMBER SERVICE TEST

Operational Test

Apply and release the brakes, observing the brake chamber push rod. The chamber push rod should move out promptly and return to the released position freely without binding.

Leakage Test

- Apply the service brakes and apply soap solution to the chamber clamping area. If leakage is noted tighten the clamp ring bolts and if leakage does not stop the chamber must either be reconditioned or replaced.
- With the service brakes applied, check for leakage through the diaphragm by applying a soap solution to the push rod opening and drain holes on non-pressured side of chamber. No leakage is permissible. If leakage is evident the chamber diaphragm must either be replaced or complete chamber replaced.

LUBRICATION

Brake camshafts and slack adjusters should be lubricated every 26,000 km (16,000 miles). Refer to LUBRICATION (CTS-2412) for type of lubricant. Do not overlubricate. Slack adjusters without fittings

require no lubrication. The provision for lubrication may differ on slack adjusters. Some have zerk fittings while others utilize pipe plugs or snap-in type plugs or covers.

When brake linings are replaced, apply a thin coat of the same lubricant to brake shoe anchor pins and camshafts. Do not overlubricate.

FOUNDATION BRAKE GROUP

DISASSEMBLY

Variations in disassembly procedure may be required as different types of brakes have been used on IH vehicles. Some typical brakes used are single and double anchor as well as wedge type actuated brakes. Refer to the particular Service Manual Section for complete details pertaining to wedge-type brakes.

The disassembly instructions contained herein have been arranged as follows:

General Disassembly Instructions

Front Axle Brake Groups

Rear Axle Brake Groups

Detailed information covering disassembly and reassembly of various components such as slack adjusters, brake chambers and brake shoes will be found elsewhere in this section.

General Disassembly Instructions

- 1. Position vehicle on floor stands.
- Release parking brake. If vehicle is equipped with spring brake chambers, chambers should be manually released or "caged" to avoid an automatic application of spring brake chambers while vehicle is being serviced. Refer to proper Parking Brake, Spring Brake Chamber Section for detailed instructions covering manual release of spring brake.
- 3. It may be necessary to back off brake adjustment to obtain enough clearance for drum removal (Fig. 4).
- Remove wheel, hub and drum assembly. It is suggested that a wheel dolly be used to assist in removing and reinstalling wheel, hub and drum assembly (Fig. 5). When removing and installing wheel, hub and drum assembly with antilock system, refer to BRAKES-AIR (FMVSS)

121), General Information, CTS- 2668.

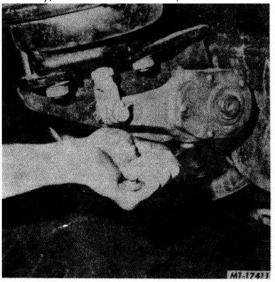


Fig. 4. Backing Off Brake Adjustment

Front Axle Brake Groups (Figs. 1 & 6)

- Remove shoe return spring or springs. This is accomplished by either expanding spring with pliers and unhooking spring between shoes, or by using a pry bar or large screwdriver and prying shoe off of cam. Then remove roller from cam end of shoe. Removing rollers first will relieve most of the tension from return springs, permitting them to be disconnected from shoes. If rollers are equipped with retainers they must be removed prior to removing rollers.
- Remove "C" washer (retainers) from guide pins.
 Then remove flat washers and bowed washers
 from guide pins. Note position of washers for
 reassembly sequence.
- 3. Remove retainers from anchor pins. Then remove washers, felt retainers and felts from anchor pins.
- 4. Lift brake shoes from anchor pins and guide pins.
- The brake shoe anchor may now be removed if desired, by removing nut and lock washer from anchor pin; then force anchor pin from backing plate.
- 6. Remove cam rollers from brake shoe if not accomplished in Step 1.

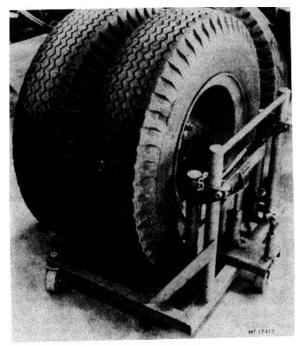


Fig. 5. Using a Wheel Dolly to Remove Wheel, Hub and Drum Assembly

- Mark position of slack adjuster in relation to camshaft and note position of adjusting screw.
 Adjusting screw may either be toward or away from brake chamber mounting surface.
- 8. Remove clevis pin connecting brake chamber push rod to slack adjuster.
- Remove lock ring retaining slack adjuster to end of camshaft and remove slack adjuster from camshaft. Note location of spacer washers for reassembly purposes.
- 10. Remove camshaft from camshaft bracket.

Rear Axle Brake Groups (Fig. 7 and 8)

Variations will be found in types of anchor pins used. Fixed anchor pins with open end anchor on brake shoes (Fig. 7) and removable anchor pins which utilize brake shoes with closed opening (hole) in anchor end of shoes (Fig. 8) are used on rear axle brake groups.

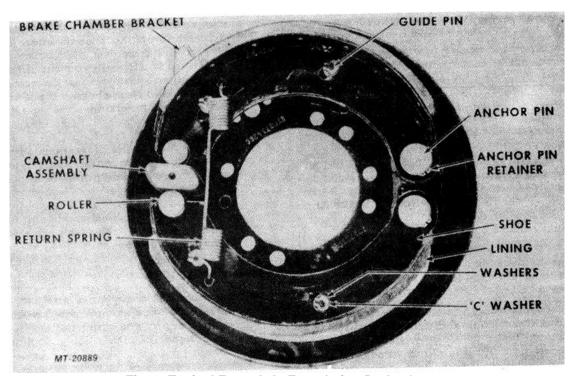


Fig. 6. Typical Front Axle Foundation Brake Group

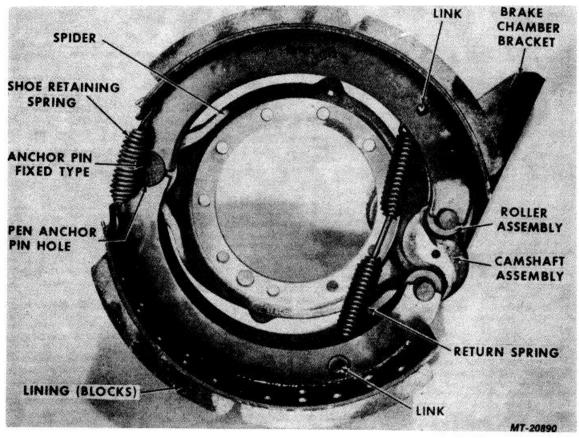


Fig. 7. Typical Rear Axle Brake Group with Fixed Anchor Pins

Fig. 9 illustrates fixed design anchor pins used with FMVSS 121 brakes. Note that the anchor pin is staked in position and is serviced only with the spider as an assembly. Prior to FMVSS 121, the anchor pin was serviced separately on this type of brake group.

Fig. 10 illustrates the latest version (with

FMVSS 121 brake system) of the removable type anchor pins. This type anchor pin can be removed by removing the lock wire between lock bolts, removing the bolts and then removing the anchor pins. Note flat area on anchor pins for set screw lock feature.

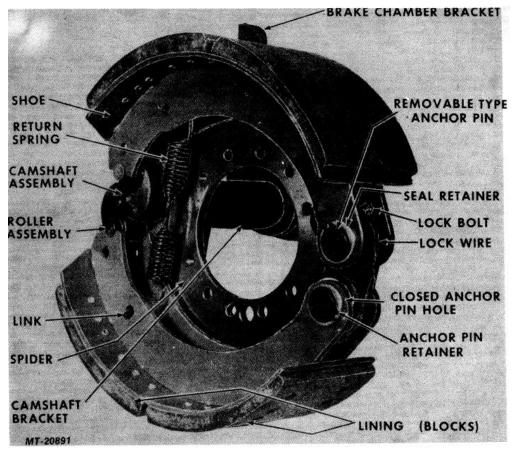


Fig. 8. Typical Rear Axle Brake Group with Removable Anchor Pins

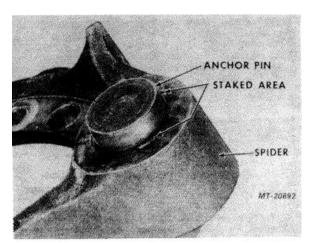


Fig. 9. Brake Spider with Fixed Anchor

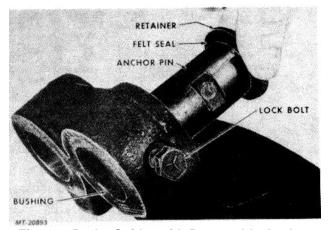


Fig. 10. Brake Spider with Removable Anchor Pins

For disassembly of rear axle brake groups proceed as follows:

- 1. Remove dust shields.
- Remove shoe return springs. With a bar or a long screwdriver pry each shoe (one at a time) away from cam. If rollers are equipped with roller retainers, push them toward cam. Then remove roller assemblies. After both roller assemblies are removed, the shoe return spring will be loose and can be slipped off the link between shoe webs.
- 3. Remove shoe retaining springs at anchor end of shoe (Fig. 7), if so equipped.
- On brake groups equipped with shoes which have closed anchor pin holes, remove anchor pin retainers from pins. Then remove felt seals and retainers from anchor pins.
- Remove anchor pins, if required, by removing lock ring, seal retainer and felt seal from end of anchor pin. Remaining felt seal, seal retainer and lock ring can be removed after pin is removed from brake group.
 - Brake groups with anchor pin lock bolts will require removal of lock wire and set screws as previously noted.
- 6. Remove brake shoes from spider assembly.
- Mark position of slack adjuster in relation to camshaft also noting position of adjusting screw. Adjuster screw may either be facing toward or away from brake chamber mounting surface.
- 8. Remove clevis pin connecting brake chamber push rod to slack adjuster.
- Remove lock ring retaining slack adjuster to end of camshaft. Note location of spacer washers for reassembly purposes.
- 10. Remove slack adjuster assembly from camshaft
- Push or tap camshaft from spider and camshaft bracket.

CLEANING AND INSPECTION

Thoroughly clean all parts except drums and brake lining material in cleaning fluid and wipe dry. Grease and solvents which leave an oil residue will affect brake performance.

Drums

Brake drums should be cleaned thoroughly with a steam cleaner or hot water. Do not use a solvent which leaves an oily residue. If inspection shows drums may be used without remachining, rub the friction

surface with fine emery cloth or sandpaper to remove any foreign deposits;. If drum has been reconditioned, clean friction surface with fine emery cloth or sandpaper and wash. Next, examine very carefully to see that no metal chips remain in drum.

Friction surface of brake drum must be smooth, true and concentric. Make sure drum is not barrel shaped, bell-mouthed, scored or eccentric. Brake drums must also be inspected for heat checking, hard or chill spots. Braking surface is reduced and uneven lining wear will result if this condition is not corrected.

Refer to WHEELS, RIMS AND TIRES (CTS-2032), Chapter II, "Brake Drums" for complete details covering inspection and refinishing of brake drums.

Brake Shoes and Lining

Brake shoes must be true and of correct radius. Wherever brake linings or blocks are worn to within 1.6 mm (1/16") of rivets, brake shoes must be removed and relined. It is recommended that all brakes be relined at the same time since this will maintain balanced braking on the vehicle. If complete replacement is not desirable or necessary, be sure that all lining on one axle (both sides) is replaced at the same time.

Examine shoes carefully and discard those which may have any of the following defects (Fig. 11):

- 1. Table twisted or distorted.
- 2. Oversize rivet holes.
- 3. Cracks in table or web.
- 4. Table not square with web 5. Anchor end worn For replacement of lining, refer to SERVICING FOUNDAT ION BRAKE GROUP COMPONENTS,

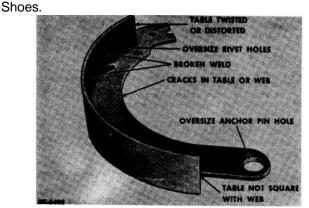


Fig. 11. Defects to be looked for on Brake Shoe

Brake Shoe Return Springs

Inspect brake shoe return springs for distortion, such as nicks, twisted shanks or spread coils. Damaged springs must be replaced. It is suggested that shoe return springs be replaced when shoes or shoe lining are replaced.

Backing Plate and Dust Shields

Inspect backing plates and dust shields. If bent or twisted, they must be replaced.

Anchor Pins

The anchors should be inspected for signs of wear. In most cases rust will be the factor in servicing brake anchors. Clean all dirt and rust from anchors and coat them with a very light coat of lubricant. Refer to LUBRICATION, CTS-2412, Brakes, for type of lubricant.

If anchor pins are worn they must be replaced. Anchor pins may be replaced on brake groups prior to FMVSS 121 brake systems. Not all anchor pins can be replaced on FMVSS 121 brake groups.

Refer to SERVICING FOUNDATION BRAKE GROUP COMPONENTS for detailed service information pertaining to replaceable anchor pins.

Camshaft Bushings and Rollers

Clean all dirt and rust from rollers and camshaft. In most cases rust will be the factor in servicing rollers. Check for dirt in splines on camshaft. Remove any small burrs from camshaft assembly to avoid damage to seals when shaft is reinstalled .

Inspect camshaft, camshaft bushings or bearings and brake shoe rollers. If noticeable signs of wear exist, replace worn parts .

Do not remove camshaft bushings from spider and/or mounting bracket unless replacement is necessary .

Apply a very light coat of lubricant to camshaft assembly and rollers. Refer to LUBRICATION, CTS-2412, Brakes, for type of lubricant.

For detailed servicing instructions pertaining to camshaft and bushings, refer to SERVICING BRAKE GROUP COMPONENTS.

REASSEMBLY

The reassembly instructions contained herein have been arranged as follows:

General Reassembly Instructions

Front Axle Brake Groups

Rear Axle Brake Groups

General Reassembly Instructions

After various components of the brake assemblies have been serviced, brakes are reassembled by reversing the disassembly procedure.

It is recommended that newly installed brake lining be circle ground before installing brake drums. Circle grinding lining to fit drum assures full contact between lining and drum. Refer to SERVICING FOUNDATION BRAKE GROUP COMPONENTS, Shoes.

When reassembling various components which are secured with bolts and/or nuts such as backing plates, spiders, camshaft brackets or anchor pins, refer to applicable TORQUE CHART.

Brake shoes must be properly located to provide designed efficiency of brake group. The primary (forward) shoe is the first shoe just past the cam in forward direction of wheel rotation.

IMPORTANT

Special attention to installation of all wheel and drum assemblies must be adhered to on vehicles with FMVSS 121 air brake system. Refer to BRAKES-AIR (FMVSS 121), CTS-2668 for the following procedures:

- 1. Pull wheel sensor to maximum outward travel (resetting sensor).
- 2. Checking exciter ring runout.
- Checking continuity of sensor.
- 4. Instructions of installing wheel hub and drum assemblies.
- 5. Wheel bearing adjustment.
- 6. Checking wheel sensor voltage output after wheel hubs and drums are installed.

Front Axle Brake Groups

- Lubricate camshaft bushings prior to installing camshaft. Refer to LUBRICATION, CTS-2412, Brakes for type of lubricant.
- Install camshaft assembly. Make sure spacer washers are reassembled in same relative position from which they were removed.

- Assemble brake shoe rollers on shoes. Be sure roller retainers are assembled at this time. Refer to Step 7 if retainers are not used.
- 4. Assemble guide pin washers and position shoes over anchor pins and guide pins.
- Assemble anchor pin washers and guide pin washers.
- Install guide pin "C" washers and anchor pin retainer rings.
- 7. Install brake shoe return springs. If roller retainers are not used on brake shoes, they can be pried back first and the rollers can be inserted on each shoe cam end. Installing rollers after shoe return springs are installed requires less effort when installing brake shoe return springs.
- Reassemble slack adjusters on camshaft aligning scribe marks and positioning spacer washers in reverse sequence when adjuster was removed.
 - Use spacer washers to provide a maximum end play of 1.59 mm (.062 ") with adjuster ring installed.
 - b. Adjuster screw may be either facing toward or away from brake chamber mounting flange to provide accessibility. In most instances the adjuster screw will be facing away from brake chamber mounting surface.
- 9. Reinstall slack adjuster retaining ring.
- Reinstall wheel and drum assembly and adjust wheel bearings.

Rear Axle Brake Groups

- 1. Lubricate camshaft bushings with lubricant type listed in LUBRICATION (CTS-2412), Brakes.
- Install camshaft assembly being sure spacer washers are assembled in reverse sequence when removed.
- 3. Install anchor pins if removed (brake group with holes in anchor end of shoe). Position shoe in place over spider; then push the pin through shoe and into spider. Repeat anchor pin installation on remaining shoe. Install felt seals, sea retainers and lock rings on anchor pins. Also be sure return spring pins are positioned between shoe webs.

It is important that anchor pins which are secured with lock bolts, are positioned so that

- flats are aligned with bolt openings and tightened bolts to 85 120 N.m (19 27 ft lbs). Install lock wires.
- On brake groups with open end anchor ends on shoes, position shoes on anchors and install shoe retaining springs at anchor end of shoes.
- 5. Install brake shoe return springs.
- Pry each shoe (one at a time) away from cam and install rollers and roller retainers, if equipped.
- 7. Reassemble slack adjusters on camshaft aligning scribe marks and repositioning spacer washers to the same location when removed
 - a. Spacer washers are to be positioned to provide a maximum end play of 1.59 mn (
 . 062 ") with adjuster ring installed .
 - b. Adjuster screw may be either facing toward or away from brake chamber mounting flange to provide accessibility. In most instances the adjuster screw will be facing away from brake chamber mounting surface.
- 8. Install slack adjuster retaining ring.
- 9. Install brake chamber if removed.
- 10. Reinstall wheel and drum assembly and adjust wheel bearings.
- Adjust brakes as outlined in BRAKE ADJUSTMENT instructions.

SERVICING FOUNDATION BRAKE COMPONENTS

DRUMS

For complete details covering servicing of brake drums, refer to WHEELS, RIMS AND TIRES (CTS-2032), Chapter II, "Brake Drums."

BRAKE SHOES AND LINING

When brake lining or blocks are worn to within 1.6 mm (1/16") of rivets, lining or blocks may be replaced as follows. Be sure to inspect shoes for defects listed in CLEANING AND INSPECTION, Brake Shoes and Lining.

When removing worn lining from shoes, drill out old rivets if possible to prevent distorting shoe table. After old linings are removed from shoes, shoes should be cleaned and buffed to remove all dirt and grease. Grease is one of the greatest deteriorating agents of linings.

Discard used lock washers after removing lining bolts. Use new washers when installing new lining. Replace bolts and nuts if signs of distortion or wear are present.

Care should be used in selecting the correct thickness of lining for each brake shoe and drum. Usually the standard thickness will be used. If drum has been turned or become worn increasing the diameter, oversize lining may be required.

If it is not known how much material has been removed from drum during the turning operation, the following simple test may be used to help select proper lining.

Hold standard size lining snugly to shoe, position it against the inner surface of drum, forcing it into contact with drum surface. The lining is now in the same position as during a brake application. If space is noted at the ends of shoe (shoe can be rocked), oversize lining is required (Fig. 12). If lining selected is too thick, only the ends of lining will contact drum (Fig. 13).

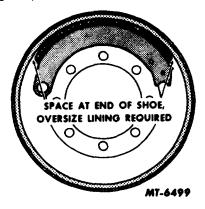
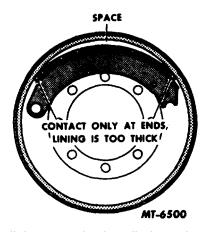


Fig. 12. Lining Selected Too Thin



The lining must be installed on shoe so that it

fits smoothly and evenly, contacting the shoe throughout the entire radius. If gaps occur between the rivets, difficulty will be met in adjusting brakes in that "spongy" or rubbery pedal may occur which makes satisfactory brake application impossible.

To insure complete contact and avoid gaps between lining and shoe, secure lining to shoe with "C" clamp so that rivet or bolt holes are in alignment. Position "C" clamp as close to holes as possible, clamping lining firmly in place.

When securing brake lining to shoes, start with center rivet or bolt and work toward ends (Fig. 14). When securing brake block lining to shoe, use sequence shown in Fig. 15, Always use new lock washers when installing bolt on lining and tighten nuts to 89 - 111 N.m (20 - 25 ft lbs) torque.

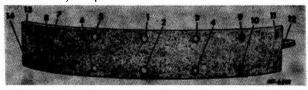


Fig. 14. Sequence in Securing Brake Lining to Shoe

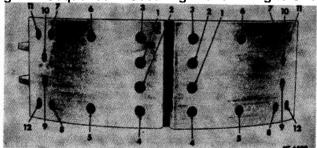


Fig. 15. Sequence in Securing Brake Block Lining to Shoe

When riveting linings, use a roll set to upset rivets. A star set may split tubular end of rivet and prevent a tight fit.

After lining is installed, check tightness of lining to shoe as follows and shown in Fig. 16.

Use a .152 mm (.006 in.) feeler gauge inserting it between the lining and shoe table. The gauge should not penetrate a gap at any three consecutive pairs of rivets nor at more than three points around the arc of shoe and lining. Nor should it be possible to insert a .2032 mm

(.008 in) feeler gauge and any point along the arc of the shoe and lining.

After installing new lining on shoes, lining should be ground in a true radius to fit drum diameter. A brake shoe grinder is provided on brake refiner (SE-1272) which is designed to dress lining in a true radius and fit drum diameter. This grinder swings the shoe in an arc across surface of an abrasive wheel.

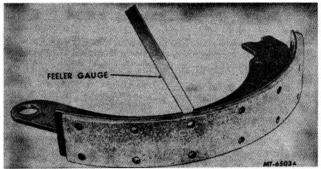


Fig. 16. Checking Tightness of Lining

A brake shoe grinder which mounts on the spindle may be used after installing shoes with new lining. The grinder rotates about on its axis and the grinding head equalizes the distance between two brake shoe lining surfaces and drum surface. Grind new lining approximately 1. 78 mm (,070 in.) less than the inside diameter of brake drum. Make certain that the brake is fully released before grinding.

ANCHOR PINS

Anchor pins provide a point where shoes can be secured to backing plate or spider and also permit positioning shoe in respect to drum.

Anchor pins are designed to withstand all braking force of slowing or stopping the vehicle.

Anchor pins which are secured to the backing plate with a lock washer and nut are replaced by using two wrenches; one wrench is positioned on the nut while the second wrench is positioned over the flats on threaded area on anchor pin. Refer to TORQUE CHART for specified torque value.

Anchor pins in spiders which are removable (similar to that shown in Fig. 10) will be equipped with bushings which are serviceable. Replaced bushings are to have a clearance of . 076- .127 mm (.003 - .005 in.) between bushing and pin.

CAMSHAFT, BUSHINGS AND FOLLOWERS

The camshaft is actuated by movement of slack adjuster. The rotating movement of cam forces shoe followers away from cam, thus forcing shoes into

contact with drum.

Removal procedure for camshaft assembly is covered in Brake Disassembly procedure. When removing camshaft from backing plate or spider, note position of spacing washers to assure correct reinstallation. Do not remove camshaft bushings from spider and/or mounting bracket unless replacement is necessary. Do not interchange right and left hand camshafts.

If camshaft bushings or needle bearings must be replaced, a suitable tool (remover) can be made locally (Fig. 17).

Apply IH 251IH EP grease or equivalent NLGI #2 multi-purpose lithium grease to outside diameter of bushings to assist in pushing them into position.

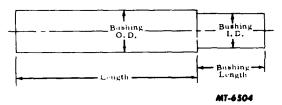


Fig. 17. Recommended Type of Camshaft Bushing Removing Tool

BRAKE CHAMBERS

Brake chambers (Fig. 18) transform energy of compressed air into mechanical force and motion to apply brakes. One chamber is used at each wheel to operate brakes.

Air pressure entering the brake chamber (Fig. 18) behind the diaphragm forces the diaphragm and push rod outward, rotating slack adjuster, brake camshaft and cam applying the brakes. The higher the air pressure admitted to chamber, the greater the force pushing brake shoes against drum.

When air pressure is released from brake chamber, brake shoe return springs and brake chamber release spring return shoes, cam, slack adjuster and brake chamber back to the released position.

The brake chamber consists of two dished metal sections; namely, pressure plate assembly and nonpressure plate, separated by a rubber diaphragm, all of which are held together by a metal, two-segment clamp. In front of the diaphragm are the push rod, push rod spring and retainer (Fig. 18) .

Several types of spring actuated type parking brakes are used in conjunction with or are attached to brake chambers while others replace the entire brake chamber.

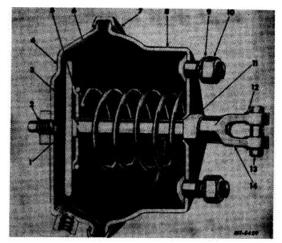


Fig. 18. Brake Chamber (Cross Sectional View)

Leaend for Fig. 18

9-::			
Key	<u>Description</u>	Key	Description
1	ROD, Push	9	WASHER, Lock
2	PLUG	10	NUT
3	DIAPHRAGM	11	NUT, Lock
4	PLATE, Pressure	12	PIN, Cotter
5	RETAINER, Spring	13	PIN, Clevis
6	SPRING	14	YOKE, Clevis
7	CLAMP		
8	PLATE, Nonpressure		

The purpose of auxiliary spring brakes is to provide an emergency brake which will stop the vehicle if air pressure drops.

These spring brake systems are covered in PARKING BRAKE section of the Service Manual. Refer to the respective section pertaining to particular spring brake chamber involved.

Remove

Disconnect air line and push rod yoke. Remove nuts from mounting studs and remove chamber .

<u>Inst</u>all

Position brake chamber on mounting bracket and install nuts on mounting studs. Install lock nut and yoke on push rod. Connect air line. Adjust yoke to slack adjuster (see ADJUSTMENT). Be sure end of push rod does not bind with slack adjuster when brakes are applied.

Disassemble

To disassemble the brake chamber (numbers in parenthesis) refer to Fig. 18:

- 1. Mark non-pressure plate (8), pressure plate (4) and clamp (7). This will make it easier to reassemble air chamber in its original position and avoid installation interference.
- 2. Remove yoke (14) and lock nut (10) from push rod (1).
- 3. Remove nuts and bolts from clamp ring. Separate plates carefully since return spring inside brake chamber is under tension.
- 4. With two sections of brake chamber separated remove push rod, spring retainer (5) and spring (6) from non-pressure plate.

Cleaning and Inspection

After brake chamber has been disassembled proceed as follows:

- 1. Using a suitable cleaning solvent, clean all metal parts thoroughly.
- 2. Examine diaphragm. If any signs of damage or deterioration are evident, replace diaphragm. When one diaphragm requires replacement. it is good practice to replace all brake chamber diaphragms in the system while vehicle is out of service. Brake chamber diaphragms must be replaced every 80,000 km (50,000 miles) or at least once a year, regardless of condition.
- Inspect push rod, spring and spring retainer. If parts are damaged, they should be replaced. Check return springs. If a load scale is available, compare their tension with new spring. Matching an old spring with a new spring will indicate condition of old part.
- 4. Check condition of non-pressure plate. If clamping flanges on plates are dented or damaged, replace plates.

Reassemble

- 1. Install nuts (10) on mounting studs and clamp non-pressure plate (8) in vise with inside of plate facing up.
- 2. Install spring (6) in spring retainer (5).



- 3. Install push rod assembly in body, press assembly down (brake applied position) to compress spring and use vise grip pliers on outside of push rod to hold spring compressed
- 4. Install diaphragm (3) in pressure plate (4).
- 5. Position brake chamber plates matching up etch marks made prior to disassembly.
- Install clamp (7) with bolts and nuts and tighten nuts to 17 N.m (150 in lbs) torque. Remove vise grip pliers.
- Install lock nut (11), yoke (14), pin (13) and cotter pins (12).
- 8. Assemble yoke and lock nut to push rod.

Test

To check for leaks, coat brake chamber around clamp with soapsuds and apply air pressure to port in pressure plate (4). No leakage allowed.

Preventive Maintenance

Every month, or every 3200 km (2000 miles), brake chamber push rod travel should be checked. Push rod travel should be kept at a minimum without brakes dragging. Excessive travel of brake chamber push rod shortens the life of the diaphragm. Over travel also slows braking response.

Every year, or every 80,000 km (50,000 miles), brake chamber should be disassembled and cleaned. New diaphragms must be installed. Be sure to use correct diaphragm return springs when reassembling chamber or uneven braking may result.

Adjustment

After brake chamber is installed, the brakes must be adjusted and checks made to be sure linkage does not bind. Adjustment of push rod length may be accomplished by altering the location of yoke. With brakes applied, the angle formed by the push rod and slack adjuster must be 90 degrees and all slack adjusters should be set at the same angle. With brakes applied, after being adjusted, this angle should still be no greater than 90 degrees. In other words, slack adjuster should not go "over center" when brakes are applied (Fig. 3).

SLACK ADJUSTERS

Slack adjusters provide method of adjusting brakes to compensate for brake lining wear and also serve as a lever during braking operation (Fig. 19).

Slack adjusters were designed to conform to the development of heavy duty, two-shoe foundation brakes.

During brake operation, the entire slack adjuster rotates bodily with camshaft. When adjusting brakes, the worm moves the gear so as to change positron of lever arms in relation to brake camshaft.

 Remove cotter key and clevis pin from slack adjuster and push rod clevis.

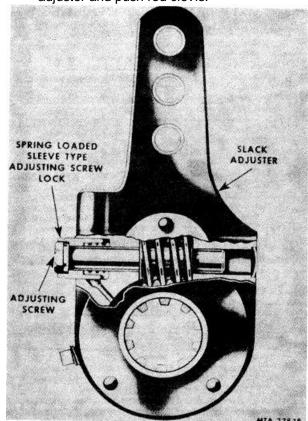


Fig. 19. Sectional View of Slack Adjuster

- 2. Remove snap ring from camshaft.
- 3. Slide slack adjuster from end of brake camshaft.

Install

Slack adjuster installation is the reverse procedure of removal.

TORQUE CHARTS

BRAKE GROUP MOUNTING BOLT-NUT

Tighten brake group mounting bolts to the torque values listed from the nut side. Since some mounting holes in the steering knuckles are of conical design, the knuckle bolts must utilize conical mounting nuts to coincide with mounting holes in the knuckle. These conical nuts have a smooth cone surface and the torque values are considerably higher than the torque values for regular nuts or prevailing type lock nuts .

FRONT AXLE BRAKE GROUP MOUNTING BOLTS WITH CONICAL TYPE NUTS

TORQUE

Bolt	Newton-meters	Foot Pounds
<u>Size</u>	<u>(N.m)</u>	<u>(ft lbs)</u>
1/2"	149 - 163	110 - 120
5/8 "	298 - 325	220 - 240
3/4"	373 - 407	275 - 300

FRONT & REAR AXLE BRAKE GROUP MOUNTING BOLTS WITH REGULAR NUTS OR PREVAILING TORQUE TYPE LOCK NUTS

TORQUE

Bolt	Newton-meters	Foot Pounds
<u>Size</u>	<u>(N.m)</u>	<u>(ft lbs)</u>
1/2"	102 - 115	75 - 85
9/16"	156 - 170	115 - 125
5/8"	217 - 237	160 - 175
3/4"	373 - 407	275 - 300

BRAKE CHAMBER MOUNTING NUTS TORQUE

TORQUE

Bolt	Newton-meters	Foot Pounds
<u>Size</u>	<u>(N.m)</u>	<u>(ft lbs)</u>
7/16"	45 - 56	34 - 42
5/8"	142 - 170	105 - 125

ANCHOR PIN LOCK BOLT (Fig. 10)

TORQUE

Bolt	Newton-meters	Foot Pounds
<u>Size</u>	<u>(N.m)</u>	(ft lbs)
3/8"	26 - 37	19 - 27

ANCHOR PIN

TORQUE

Bolt	Newton-meters	Foot Pounds
Size	<u>(N.m)</u>	(ft lbs)
3/4 UNF	129 - 176	95 - 130

CAMSHAFT BRACKET MOUNTING

TORQUE

Bol	t Newton-meters	Foot Pounds
<u>Size</u>	<u>(N.m)</u>	<u>(ft lbs)</u>
1/2"	88 - 115 65 - 85	



WEDGE ACTUATED TYPE

STOPMASTER

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STOPMASTER II

Various improvements have been made to the STOPMASTER Brakes since original production. With these improvements, the wheel brake units have been designated as STOPMASTER II while the Spring Parking Brakes are known as SUPER "B" FAIL-SAFE II. The improvements to the brake groups can be found in this manual section on Pages 28 through 40.

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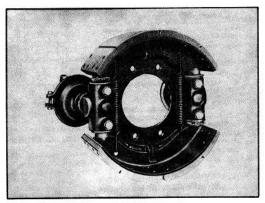
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ROCKWELL-STANDARD STOPMASTER BRAKES

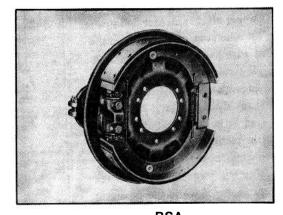
The Stopmaster Brake is a wedge actuated brake. The brake power units can be either air chambers or hydraulic cylinders. They can also be equipped with Fail-Safe units to provide parking and emergency braking. The brake power unit forces a wedge between two rollers and two plungers. This causes the plungers to spread apart and push the brake shoes against the brake drum.

There are several variations of Stopmaster Brakes in use. Some have two power units per brake and others only one. Where two power units are used, there may be a Fail-Safe unit on one or both. The brake support may be either a cast spider or a stamped backing plate. On the cast spiders, the plunger housings may be either integral or bolted on. Brake shoe adjustment may be either automatic or manual. Other minor variations are also in use.

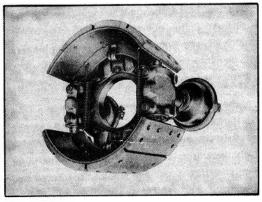
The various basic Stopmaster Brakes are identified as model RDA, RDH, RSA, or RSH with letters denoting the following: R-Stopmaster Brake, Wedge Actuated; D-Double Actuated; S-Single Actuated; A-Air operated; H-Hydraulic operated.



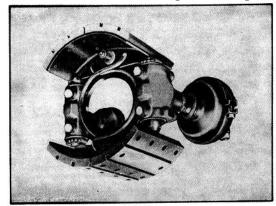
RDA
Bolted on Spider Mounted
Integral Plunger Housings



RSA
Backing Plate Mounted
Bolted on Plunger Housing



RDA
Welded on Spider Mounted
Bolted on Plunger Housings

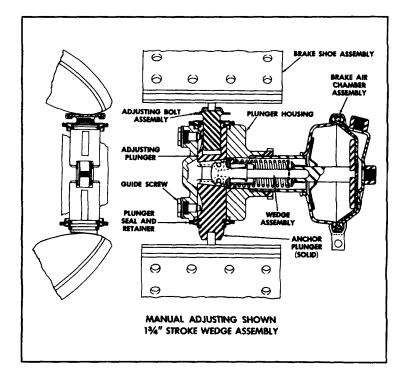


RDA
Welded on Spider Mounted
Bolted on Plunger Housings

STOPMASTER ACTUATING SYSTEM

This picture (as illustrated) shows one of the actuating systems of an air-operated double-actuated Stopmaster Brake (RDA). All parts are shown in the off position.

This system has an air chamber power unit threaded into the wedge bore of the plunger housing. The socket in the end of the diaphragm push rod connects the air chamber to the wedge rod. The wedge retracting spring acts as the return spring for both the wedge and the diaphragm. A pair of rollers are held in place on the wedge head by a retaining cage. The rollers are also engaged in corresponding slots in the inner ends of the plungers. The unslotted portions of the inner ends of the plunger are resting on abutments in the plunger housing. The outer ends of the plungers are engaged with and supporting the brake shoes.

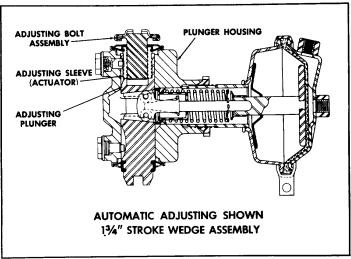


On a double-actuated brake, each of the two actuating systems has one anchor (solid) plunger and one adjustable plunger (as illustrated). On a single actuated brake the one actuating system would have two adjustable plungers. All of the plungers are retained in the housings and the roller slots are kept in proper alignment by means of guide screws which engage slots in the side of the plungers. A hydraulic brake would have a hydraulic cylinder threaded into the plunger housing (in place of the air chamber). The hydraulic piston would connect with the wedge rod.

When the brake is actuated, the air chamber pushes the wedge head deeper in between the rollers. This spreads the rollers and plungers apart and pushes the brake shoes outward. Initially all the plungers are lifted off of the plunger abutments and momentarily suspended. As the shoes (linings) contact the drums, the drum drags the shoes and the suspended plungers around with it. This causes the plunger at the trailing end of each shoe to reseat on its abutment and thus absorb and transfer the brake torque to the brake support. When the brake is released, the wedge spring returns the wedge and diaphragm to the off position. At the same time, the shoe return springs push the raised plungers back to their abutments.

BRAKE ADJUSTMENT

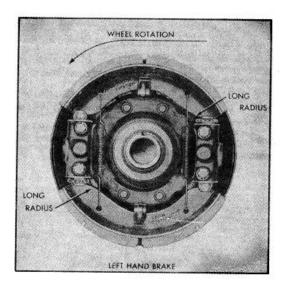
Two types of adjustable plungers are in use - manual and automatic. The manually adjusted plunger has an adjusting bolt threaded into the plunger proper. The bolt head is scalloped to facilitate adjustment



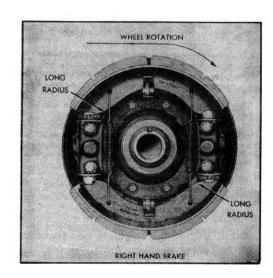
and carries a detent arrangement which engages the brake shoe web and prevents accidental rotation of the bolt. On the automatically adjusted plunger, the adjusting bolt is threaded into an adjusting sleeve which in turn is free-fitted inside the plunger proper. The plunger guide screw is replaced by a hollow cap screw, a spring, and an adjusting pawl which also serves as the plunger guide. The end of the adjusting pawl has saw-tooth type teeth which engage corresponding helical teeth on the outside of the adjusting sleeve. As the brake is actuated; the plunger, sleeve, and bolt move outward and the sloping face of the teeth on the adjusting sleeve

lifts the adjusting pawl (against the spring). When the brake is released, all the parts return to their starting points. As the lining wears, the plunger stroke and resulting pawl lift gradually increases until the pawl climbs over and drops into the next tooth space. This time, when the brake is released and the plunger is pushed back in its bore, the upright face of the pawl teeth causes the adjusting sleeve to rotate and advance the adjusting bolt. This reduces the lining clearance and the cycle starts over again. The automatic adjuster operates only in forward vehicle direction.

PLUNGER AND SHOE POSITION



STOPMASTER BRAKES (Bolted on Spider Mounted Integral Plunger Housings)



On double-actuated brakes, the anchor (solid) plungers should be positioned at the trailing end of each shoe (where they will absorb the brake torque during forward wheel rotation). This will position ' the adjustable plungers at the leading end of the shoes. Also note that the shoe web is unsymetrical. The long-radius end should be engaged with the adjustable plungers.

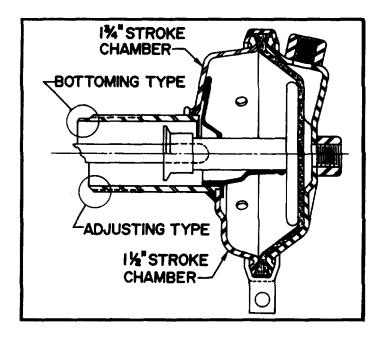
POWER UNIT ADJUSTMENT

The air chamber (or hydraulic cylinder) should be screwed into the wedge bore of the plunger housing to a depth such that the wedge is ready to lift the plungers off of the abutment seats at the first

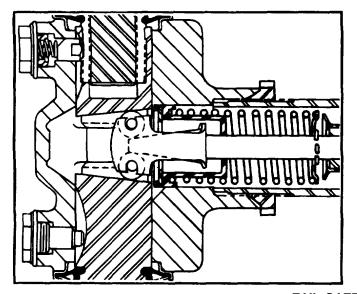
such that the wedge is ready to lift the plungers off of the abutment seats at the first movement of the diaphragm (or piston). This provides the least lost motion and maximum useful chamber (or

piston) stroke.

Current power units are designed to "bottomout" in the wedge bore and provide this optimum adjustment automatically. (The bottoming type units have a short unthreaded portion on the leading end.) Earlier power units must be adjusted manually by screwing the power unit into the wedge bore deep enough for the wedge to spread the plungers so they can be pushed back and forth in the plunger housing. Then the power unit is backed out until the back and forth plunger movement disappears. The newer bottoming type units can be used as replacements for the earlier units to obtain the bottoming feature.



WEDGE ALIGNMENT



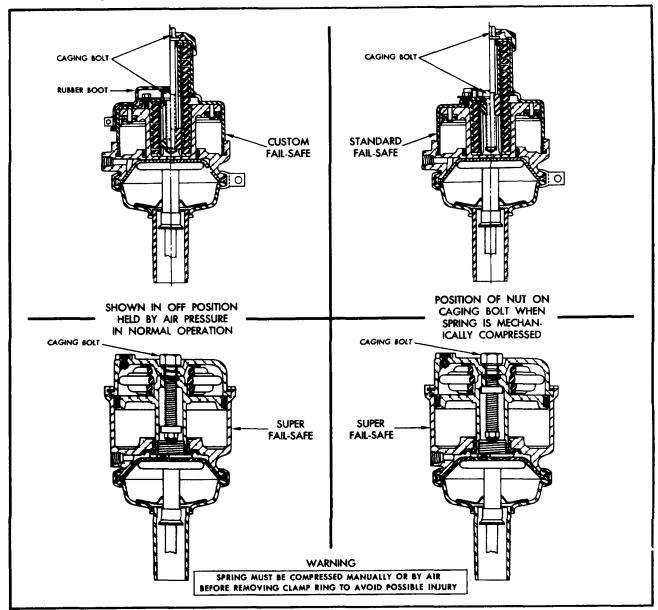
Whenever the power unit is removed from the brake, the wedge assembly may also become dislodged. Before reinstalling the power unit, reposition the wedge assembly so that the rollers and roller cage are engaged in the plunger slots. On newer brake assemblies this is accomplished automatically by simply aligning the two ears on wedge spring retainer with corresponding grooves in the wedge bore of the plunger housing. On older assemblies, the wedge head must be aligned manually so that the rollers engage the plunger slots properly. In either case, proper alignment can be checked by pushing on the wedge rod while visually checking for shoe and plunger lift.

FAIL-SAFE UNITS

The Fail-Safe unit is a spring powered brake actuator that assembles piggy-back on the air chamber. Fail-Safe units are produced in three types: Custom, Standard and Super. When 70 psi or more air pressure is applied against the piston, the spring will be held in a compressed position. When the air pressure is removed, the spring will push the piston against the diaphragm plate and apply the brake.

On the Super Fail-Safe units an internal venting system working in conjunction with a one-way breathing arrangement on the cap allows system air to fill the vacuum behind the piston when the Fail-Safe is actuated and keeps the unit sealed from direct atmospheric contamination.

All Fail-Safe units are equipped with manual caging bolts to permit safe handling for service work. These bolts are sealed and prevented from rotating due to vibration.



SERVICE RECOMMENDATIONS

<u>Safety Precaution:</u> When the brakes are equipped with Fail-Safe units (or other auxiliary spring power units), cage the power springs before starting any disassembly or removal of wheels and drums. After parts are all reassembled and in place, uncage the power springs before returning the vehicle to service.

When a vehicle is disabled due to low or lost air pressure, block wheels and cage the power springs before

moving the vehicle.

Manually Caging and Uncaging Fail-Safe Units: On the custom Fail-Safe, the head of the caging bolt is exposed at all times beyond the plastic cap. However, the cap should be backed off 3 turns before turning caging bolt otherwise the bolt may damage the cap. On the standard Fail-Safe, first loosen the boot clamp screw and remove the rubber boot (if one is used). Then loosen the caging bolt-lock screws and swing the lock out of the way.



The power spring in the super, custom and standard units are manually caged (compressed) by turning the caging bolt clockwise approximately 18 to 21 full turns. Do not force the bolt beyond its normal stop. Uncaging (releasing) the spring is accomplished by reversing the procedure again do not force the bolt beyond its normal stop. If desired, both the manual caging and uncaging operation can be made easier by applying air pressure to the Fail-Safe chamber to take the spring load off the caging bolt. Fail-Safe Units can also be caged by air using the vehicle emergency air system or other available air supply. Apply and hold 70 psi air pressure through the parking port of the Fail-Safe Unit to hold the power spring compressed.

On custom Fail-Safe units, after manually uncaging the spring, retighten the plastic cap by hand. On standard Fail-Safe units, after manually uncaging the spring, swing bolt-lock back and secure in place. Clean cap and boot and install boot with vent slot at bottom.

Recommended Preventive Maintenance

- A. Periodic inspections-25,000 to 30,000 mile intervals or every two months:
 - 1. Check lining wear to determine proper reline time.
 - 2. When automatic adjusters are used, check lining to drum clearance-if clearance is .060" or less, adjusters are working properly.
 - 3. Check service and Fail-Safe air systems by cycling respective application valves.
- B. At 100,000 miles or once yearly:
 - 1. Cage Fail-Safe spring and remove all wheels and drums.
 - a. Inspect plunger seals.
 - b. If seals are cut, torn, or leaking--disassemble and overhaul brake actuating components.
 - c. If seals are in good condition, remove upper adjusting plunger and its seal and check internal condition.
 - d. If grease is contaminated or hardened, or if parts are dry--disassemble and overhaul brake actuating components.
 - e. If internal condition is satisfactory, reassemble adjusting plunger and replace seal and run until next inspection.
- C. At each brake reline:
 - 1. If reline period is 100,000 miles or greater disassemble and overhaul all brake actuating components.

NOTE Do not use combination linings.

- 2. If reline period is appreciably less than 100,000 miles:
 - a. Remove adjusting plungers and related parts.
 - b. Clean and regrease adjusting bolt and sleeve (or plunger).
 - c. Check internal condition-if satisfactory reassemble-if unsatisfactory overhaul entire actuating system.

Recommended Grease

A high temperature water-proof grease, IH 251 HE.P. grease or equivalent to NLGI #2 multi-purpose grease is recommended for lubricating the brake actuating system.

The following greases meet all of these recommendations:

Texaco Thermotex EP #1 Shell Darina #1 Marathon 528 H.D. Sunaplex #1 EP Amdex #1 EP Philube B #1

NOTE

Vehicles operating in extremely cold weather (below -40°F) may require a grease conforming to MIL-G-25013C.

Replacing Air Chamber Diaphragm: The air chamber diaphragm and push rod boot may be serviced in either of two ways-removing the complete chamber from the brake, or removing the clamp ring and pressure half only and leaving the non-pressure half attached to the brake. The latter method is recommended but, since the wedge assembly is left inside the tube, certain precautions must be taken to prevent the wedge assembly from being pulled out of position and becoming misaligned with the plungers.

The proper procedure is given under Servicing Air Chamber Diaphragm, page 13.

The proper procedure is given under Servicing Air Chamber Diaphragm, page 13.

TROUBLE SHOOTING GUIDE

If brakes are poor or do not apply - check system pressure at source and at brakes - possible restriction or leak in brake lines, valves, etc. - brakes out of adjustment - leaking diaphragm or wheel cylinder cup.

Uneven braking or lining wear -- ruptured diaphragm -- wedge rod out of push rod socket -- rollers and cage out of plunger socket -- corroded or frozen plungers -- brakes out of adjustment -- grease on lining -- glazed lining -- shoes installed backward - - combination linings.

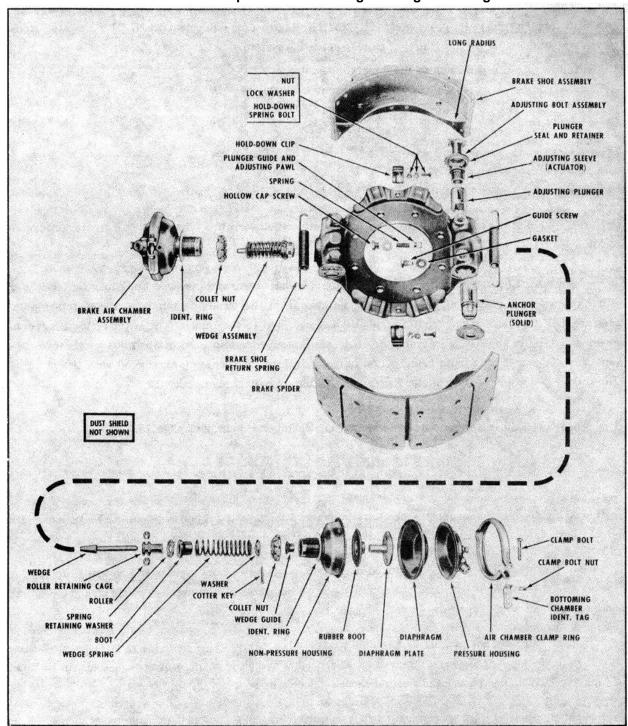
Automatic Adjusters not working -- adjusting pawl installed backward -- pawl spring collapsed or missing -bolt frozen in adjusting sleeve -- detent damaged and allowing bolt to rotate with sleeve -- adjusting plunger in wrong position (should be at leading end of shoe) -- double lip seals not installed correctly.

Fail-Safe not holding -- power spring not fully released (uncaged) -- brakes out of adjustment -- hold-off air not releasing fully -- power spring broken.

Brake dragging -- low Fail-Safe hold-off air pressure (need 70 psi minimum) -- improper connection of service line at Fail-Safe -- leaking lines or Fail-Safe seals.



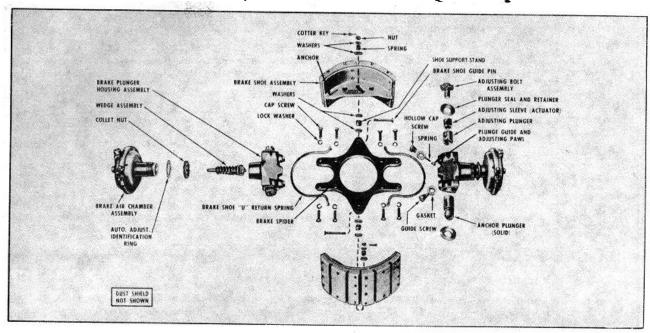
RDA Bolted on Spider Mounted Integral Plunger Housings



The RDA Brake shown, with integral plunger housings, employs a cast spider mounting which bolts to a flange on the axle housing. Adjusters may be manual or automatic (automatic shown). Dust shields are the one or two piece type.



RDA Welded on Spider Mounted Bolted on Plunger Housings

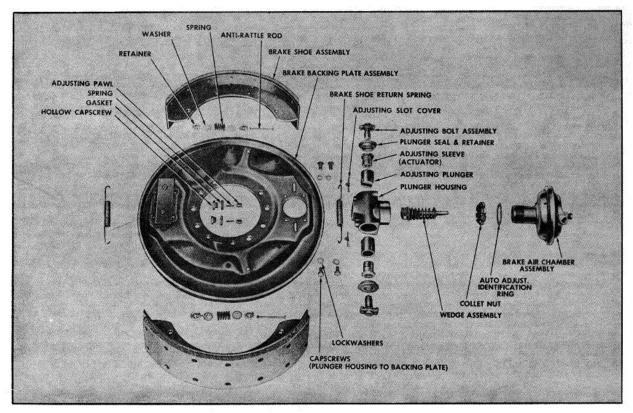


The RDA Brake shown, with separate plunger housings employs a cast open end spider which is welded to the axle. The actuation system is removed by removing four attaching cap screws. This is the 12Y4" diameter trailer brake and employs the automatic adjuster. Dust shields are of the four-piece type to facilitate removal.

BRAKE SHOE ASSEMBLY LONG RADIUS RRAKE SPIDER HOLD DOWN CLIE BRAKE PLUNGER HOUSING ASSEMBLY LOCK WASHER COLLET MUT HOLD DOWN SPRING BOLT HOLLOW CAP SCREW SPRING LOCK WASHER BRAKE SHOE CAP SCREW WEDGE ASSEMBLY LOCK WASHER SUPPORT BRACKET

RDA Welded on Spider Mounted Bolted on Plunger Housings

The RDA Brake shown with separate plunger housings, employs a cast opened end spider which is welded to the axle. The opened end spider type permits removal of the complete actuation system at disassembly. This brake employs the automatic adjusters. Dust shields are of the four-piece type to facilitate removal.



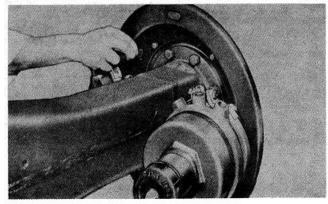
RSA Backing Plate Mounted Bolted on Plunger Housing

The RSA Brake shown with a separate plunger housing has a stamped backing plate mount which bolts to a flange on the axle housing. The backing plate also serves as a dust shield. Adjuster may be manual or automatic (automatic shown).

GENERAL MAINTENANCE

BRAKE ADJUSTMENT

- A. Manual Adjusters.
 - 1. Jack or hoist wheels free of ground.
 - 2. Remove dust cover from adjusting slot two places on each brake.
 - On RS type brakes the adjusting slots are above and below the single power unit.
 - On RD type brakes the adjusting slots are below the forward and above the rear power unit.
 - If star-wheel adjusting bolts are not found at these positions, the brake had been assembled on the wrong side of the vehicle.
 - Adjusting bolts have right hand threads. With an adjusting spoon, turn the star-wheel until a heavy drum drag is developed. Then back off the bolt to a very light drag on the drum. Repeat for other shoe on the brake Replace dust covers in adjusting slots. Re peat for other brakes.



NOTE
Recommended adjusting spoons, are
Snap-On-Blue-Point S-9523, Wizard
4-H-2530 and Proto 2006.

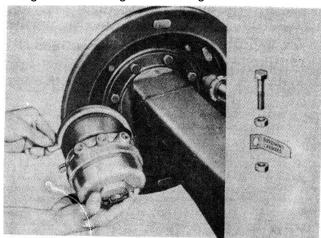


- B. Automatic Adjusters
 - Check drum to lining clearance with feeler gage.
 If the clearance is more than .060", adjust brake
 manually (same as above) and schedule the
 vehicle for brake service.

SERVICING POWER UNITS AIR CHAMBER DIAPHRAGM

The following procedures are used to replace the diaphragm and boot with the non-pressure housing on the brake assembly.

- A. Cage the power spring manually or by air if Fail-Safe unit is used.
- B. Remove air lines and tag emergency line.
- C. Remove clamp ring nuts, bolt and Fail-Safe warning tag and bottoming chamber tags if used.



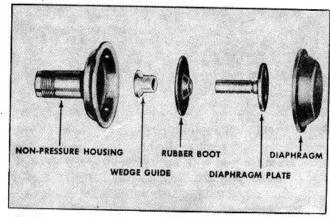
- D. Spread the clamp ring. Hold the diaphragm on the non-pressure half and remove the pressure half or Fail-Safe head.
- E. Carefully remove the diaphragm while holding diaphragm plate against the wedge rod. This will prevent the wedge assembly from coming out of engagement with the plungers.

NOTE

If wedge assembly backs out of plunger anytime during this entire procedure, remove non-pressure

housing from brake to replace diaphragm.

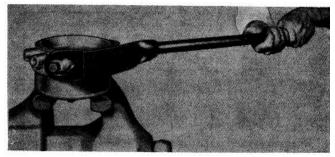
F. Continue to hold plate and inspect boot. If boot is torn or not attached to housing, strip old boot free from housing and carefully remove plate assembly off wedge rod and out of non-pressure housing tube. (Boot and wedge guide will remain on plate push rod.)



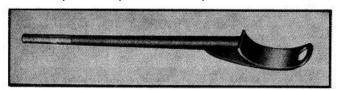
- G. Remove wedge guide and old boot from push rod. Inspect guide for wear and replace if necessary.
- H. Install new boot on diaphragm plate push rod and press wedge guide all the way onto end of push rod.
- J. Clean non-pressure housing with cement thinner or similar material in area where boot is to be cemented.
- K. Apply cement to housing around tube end. Position the plate-push rod assembly into tube. Carefully engage wedge rod so as to not pull it out of plungers.
- L. While holding plate against wedge, press boot into position for cementing.
- M. Install new diaphragm over plate and onto nonpressure housing while pushing plate against wedge. Assemble pressure half and clamp ring in reverse manner of disassembly.
- N. Connect air lines to proper chamber and Fail-Safe ports. Make a full-pressure brake application and check for air leaks. Road test for brake performance.

FAIL-SAFE UNIT DISASSEMBLE STANDARD AND CUSTOM

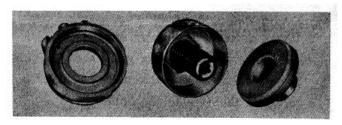
 A. Follow procedures A through D of diaphragm replacement. (Page 13)



B. Secure Fail-Safe unit by hexagon part of cap in a vise and remove the housing by unscrewing it from the cap with a spanner or strap wrench.



NOTE
Wrench can be purchased from
Rockwell-Standard Company,
Blueprints are also available and can
be obtained from Rockwell-Standard,
Brake Plant, Ashtabula, Ohio; under
part number 3787-E-707.



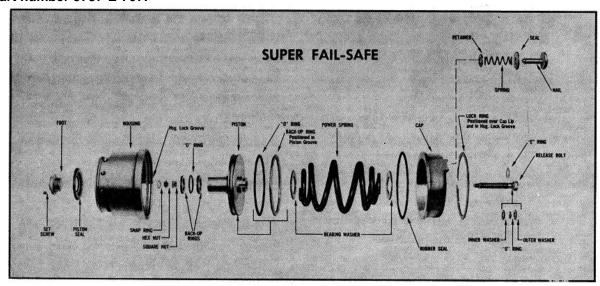
C. Pull the piston assembly out of the cap. The piston can be pushed out by turning caging bolt and releasing power spring.



D. Remove the rubber washer and "0" ring from the Fail-Safe unit (use small screwdriver or other pointed tool).

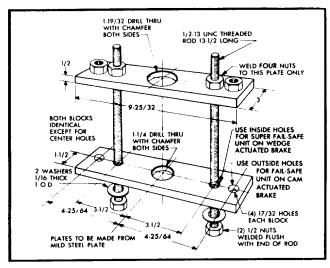
NOTE

DO NOT DISASSEMBLE THE CAP
AND SPRING ASSEMBLY OR THE
PISTON ASSEMBLY. IF PARTS ARE
DAMAGED, THE COMPLETE
ASSEMBLIES MUST BE REPLACED.



- A. Follow procedures A thru D of diaphragm replacement, page 13.
- B. Release foot set screw and unscrew foot from piston. Remove piston seal and sealing compound if used, located at front joint between cap and housing.

- C. Take out lock ring and separate cap, spring and piston assembly from housing. Remove rubber seal from housing if used.
 - D. Remove hex nut and snap ring from release bolt. Secure cap, spring and piston assembly in arbor press or disassembly fixture (as shown).



NOTE

Fixtures shown may be purchased from Rockwell-Standard Company. Blueprints are also available and can be obtained from Rockwell-Standard Brake Plant, Ashtabula, Ohio under part no. 3787-N-1028.

CAUTION

- It is absolutely necessary to hold the power spring compressed for disassembly.
- E. Turn release bolt until square nut falls free, release pressure of press or fixture until spring is unloaded. Assembly can be removed from press or fixture at this time and cap separated from spring and piston assemblies.
- F. Back up ring and "O" ring should be removed from the piston groove at this time for inspection.
- G. Remove two small back-up rings and "O" ring from I.D. in bottom of housing, and the two bearing

- spring washers, located at top of piston and inside top of cap.
- H. Take out cotter pin or remove snap ring (whichever used) from release bolt. This will permit the inner washer to be removed from the release bolt.
- J. Take the release bolt out of the cap.
- K. Remove "O" ring from groove of release bolt and take off outer flat washer.

IMPORTANT DO NOT REMOVE BREATHER ASSEMBLY FROM CAP UNLESS NECESSARY TO SERVICE.

ASSEMBLE

Inspect and check for worn parts that may need replacement. Inspect the threads, bore and the end of the cap and spring assembly carefully for nicks or scratches that would affect sealing. Clean all parts. *DO NOT* use solvent to clean leather piston seal, rubber boot, back-up rings, "O" rings or plastic cap (on Custom Fail-Safe units). Use hot soapy water.

Wipe the internal parts clean with a soft cloth and re-grease thoroughly with recommended grease. The power spring and all mating parts should be packed with grease. However, do not lubricate the Super Fail-Safe cap in the area of the breather assembly.

SUPER FAIL-SAFE

Follow procedures A and B to assemble breather assembly if necessary.

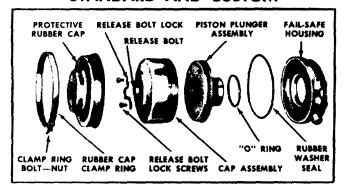
- A. Install nail through breather seal and position nail with seal through opening in top of the cap.
- B. Position the spring over nail and lock up the assembly by forcing the retainer over flared end of nail.
- C. Position outer flat washer onto release bolt and install "O" ring in groove under bolt head.
- D. Install release bolt through top opening in piston cap.
- E. Position inner flat washer over release bolt and against inside of cap. Lock up release bolt by installing snap ring or cotter pin (whichever used)

- F. Install the two small back-up rings and "O" ring in I.D. of housing bottom. Position "O" ring between back-up rings.
- G. Assemble "O" ring and back-up ring into piston groove.
- H. Install bearing spring washers, one on top of piston and one inside top of cap, and secure piston, power spring and cap with bearing washers in position into arbor press or disassembly fixture.

CAUTION IT IS ABSOLUTELY NECESSARY TO HOLD THE POWER SPRING COMPRESSED FOR REASSEMBLY.

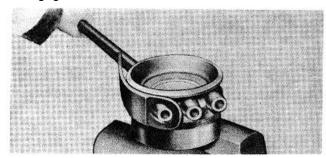
- J. Compress assembly and thread square nut onto release bolt. Turn release bolt until square nut bottoms in piston stem. The assembly can be removed from press or fixture at this time.
- K. Thread hex nut onto release bolt and install snap ring.
- L. Install rubber seal on shoulder in housing.
- M. Position cap, spring and piston into housing and install lock ring. Apply sealing compound, if rubber seal is not used, to housing and cap joint.
- N. Install piston seal onto end of piston stem and thread foot into end of stem. Thread set screw into end of piston foot. Apply a sealer on the foot set screw and cover the head with plastic tape until sealer sets.

STANDARD AND CUSTOM



A. Install new rubber washer and "0" ring seal in proper grooves of Fail-Safe housing. The rubber washer must fit completely and squarely in its groove.

- B. Install piston and seal assembly half way into the cap.
- C. Clamp hexagon part of cap securely in a vise and place Fail-Safe housing onto piston and seal assembly. Push housing down to engage threads on cap.
- D. To start threads turn housing counter-clockwise until thread engagement is felt, then turn housing at least 3 full turns clockwise to insure proper thread engagement.



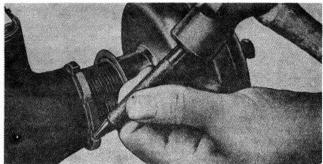
- E. Tighten housing onto cap until it bottoms, using wrench used for disassembly.
- F. Bench test for leaks. Plug one Fail-Safe port and apply air pressure (150 psi maximum) to other Fail-Safe port. Apply soapy water to check for leaks in three places. Bubbles at release bolt indicate leakage at leather piston seal and bubbles at piston plunger indicate leakage at "O" ring. These leaks can generally be corrected by cycling the piston (with spring uncaged) by applying and releasing air pressure. Bubbles at the cap threads indicate leakage past the rubber washer. This leakage is corrected by reassembling cap and housing and properly installing the rubber washer.
- G. To install Fail-Safe unit onto non-pressure half of power unit assemble in the reverse manner in which it was disassembled.

REMOVING POWER UNIT (AIR OR HYDRAULIC) FROM BRAKE ASSEMBLY.

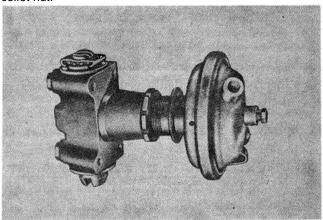
- A. Cage the power spring, if Fail-Safe unit is used. Remove brake lines and tag emergency line.
- B. Determine the type of power unit used, bottoming or adjusting type. (Bottoming air chambers have an identification tag fastened to the clamp ring bolt and bottoming hydraulic cylinders have "bottoming" cast on housing.



C. If adjusting type unit is used, carefully mark the position of the assembly on the first exposed thread on the housing tube with a scribe or punch and hammer to aid reassembly.

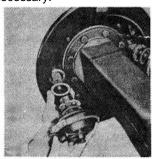


D. Using a drift or other blunt tool and hammer, loosen the collet nut.

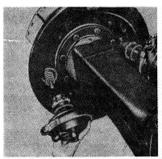


NOTE: On welded on spider mounted brakes with open ends the entire actuation system can be taken off at this time if desired as one assembly by removing four spider to plunger housing capscrews. However, the hub and drum and dust shield will have to be taken off before removing the actuation system.

E. Unscrew the power unit out of the plunger housing. At this time remove and inspect the wedge assembly. Service if necessary.

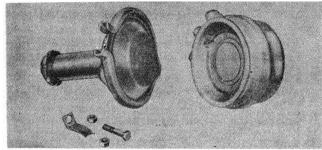


SERVICE AIR CHAMBERS



CURRENT

DISASSEMBLE



A. To disassemble air chamber follow procedures A thru F of Servicing Air Chamber Diaphragm, Page 13, disregarding wedge assembly precautions.

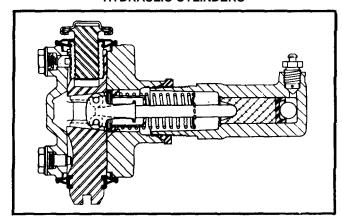
ASSEMBLE

NOTE: Adjusting type non-pressure housing is interchangeable with bottoming type housing and may be converted at this time.

A. To install boot and guide and reassemble chamber, follow procedures H thru L of Servicing Air Chamber Diaphragm, page 13, disregarding wedge assembly precautions.

B. Test for leaks.

HYDRAULIC CYLINDERS



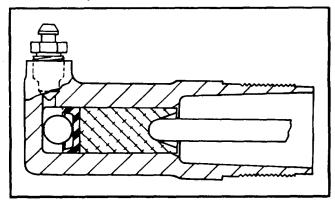
DISASSEMBLE

- A. After removing cylinder from brake, remove bleeder screw and drain all hydraulic fluid.
- B. Place threaded end of cylinder on a cloth or wood surface and push internal parts out with air pressure. If parts are frozen, hydraulic pressure may be necessary.

C. Remove piston, cup seal and ball spacer from the cylinder. Early piston design use a post to retain the cup seal and act as a spacer. To service remove the piston post extension.

ASSEMBLE

- A. Clean all parts in hydraulic fluid, all parts must be absolutely clean. If cylinder bore is corroded, scored or scratched, replace. Inspect piston for nicks, scoring or corrosion and polish with crocus cloth. Inspect end of bleeder screw for marks that would prevent it from sealing.
- B. Lubricate cylinder bore with clean hydraulic fluid that is to be used in the system.

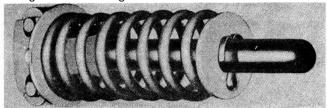


- C. Install ball spacer in bottom of cylinder.
- D. Install cup seal into cylinder, carefully entering lip of cup seal into cylinder bore, flat end of cup out.
- E. Install piston, flat end first, into cylinder and push piston and cup down to bottom of bore, and install bleeder screw.

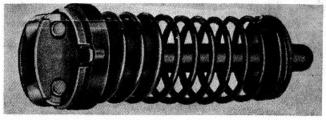
WEDGE ASSEMBLY DISASSEMBLE



A. Remove wedge assembly from plunger housing by pulling it straight out of housing.

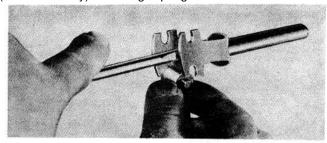


1 1/2" Stroke Wedge Assembly



1 3/4" Stroke Wedge Assembly

- B. Remove cotter or "E" washer (earlier design not shown) from wedge shaft while holding spring compressed by hand.
- C. Remove wedge spring washer, wedge spring, rubber boot (13/4" assembly) and wedge spring retainer.



D. Insert a thin bladed screwdriver between one flat of the wedge head and roller retainer cage.

Spread the cage open just far enough to remove the rollers.

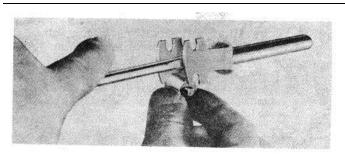
IMPORTANT: <u>DO NOT</u> ATTEMPT TO DRIVE THE WEDGE THROUGH THE ROLLERS AND CAGE OR FORCE THE ROLLERS THROUGH THE SLIGHTLY CLOSED SLOTS OF THE CAGE. THIS WILL PERMANENTLY DAMAGE THE CAGE.

E. Remove the roller retainer cage by sliding it off the wedge shaft.

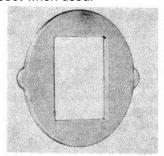
Do not mix components from 1 /2 and 13/4 stroke wedge assemblies.

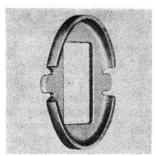
ASSEMBLE

- A. Clean all parts thoroughly and inspect. Check angled faces of wedge to see that they are free from pits or marks. If "E" washer type lock is used, inspect wedge shaft lock groove to see that it is sharp and clean. Inspect roller retainer cage to make sure it will contain rollers properly and inspect the spring for marks that would cause breakage. Replace parts if necessary.
- B. Insert wedge shaft into roller retainer cage so angled faces of the wedge head are exposed.

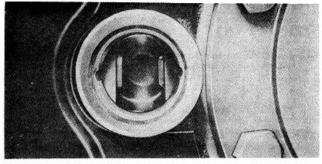


- C. Insert a thin bladed screwdriver between flat of the wedge head and roller retainer cage. Spread cage open just far enough to insert roller (journal hub into cage slot). Tip roller into cage and position other journal hub into slot of retainer. Install other roller in same manner and remove screwdriver. DO NOT force rollers thru ends of the cage slots.
- D. Install spring retainer over wedge shaft and position centrally over cage and roller assembly. Install rubber boot when used.





Current production and service replacement use a spring retainer that has two tabs or protrusions on the O.D.



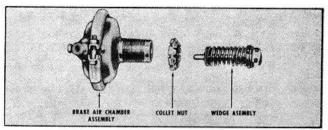
These tabs serve to align the wedge assembly as it is installed into the plunger housing by engaging grooves in the wedge bore. If the plunger housing is not equipped with such grooves, remove the tabs at the breakoff marks and file the O.D. of the retainer smooth.

E. Install wedge spring over wedge shaft, large coil diameter first. Add spring washer and compress spring by hand far enough to expose cotter key hole or "E" lock groove and install lock (cotter key or "E" washer).

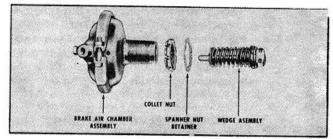
F. Install the wedge assembly into the plunger housing. Check for correct roller-plunger engagement by (1) pushing on wedge rod by hand while checking for plunger and shoe lift, and (2) measuring the standout of the wedge rod from the end of the threaded housing bore. When properly assembled, the wedge standout is 2-1/4".

INSTALLING POWER UNIT ONTO BRAKE ASSEMBLY

A. Check position of the wedge in plunger housing to make certain wedge assembly is properly seated. Be sure to replace automatic adjusting identification ring (if used) on power unit tube. Thread spanner nut or collet nut onto power unit tube and install spanner nut retainer if used.



This is the correct position of the collet nut when used with current brake spider having a conical counterbore.



This is the correct "reversed" position of collet nut and retainer when brake spider does not have conical counterbore.

B. INSTALLING BOTTOMING TYPE POWER UNIT.

- 1. Assemble brake chamber (collet nut loose) until it bottoms in actuator housing.
 - 2. Tighten collet nut finger tight.
- 3. Loosen service brake chamber clamp so that hosing ports may be aligned. It is permissible to back off service brake chamber up to one full turn (no more). Do Not back off spring brake chambers.
- 4. Connect brake lines and tighten chamber clamps.



- 5. Make and hold a full pressure brake application. (At this time position spanner nut retainer if used so it will engage plunger housing slot).
- 6. On current assemblies, drive collet nut with a drift and hammer 1-1/2 teeth (169.5 N-m or 125 ft. lbs.). Release brake pressure.
- 7. On older assemblies using retainer and "reverse" collet nut, drive collet with drift and hammer until it is tight against retainer.

Using a drift or other blunt tool, peen section of the. retainer into one slot of the collet nut. Release brake pressure.

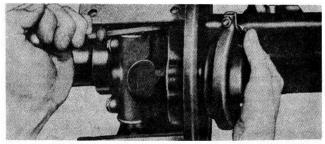
- 8. Check for leaks at all connections.
- 9. On hydraulic brakes, bleed system.
- 10. After installing drums, uncage Fail-Safe units.

C. INSTALLING ADJUSTING TYPE POWER UNIT WITH DEPTH MARK

- 1. Follow procedures in paragraph "A".
- 2. Screw power unit into the plunger housing several turns. Turn spanner nut toward plunger housing so depth mark on threads is just exposed. Continue turning power unit into plunger housing until it bottoms on spanner nut and retainer. (Collet nut can be substituted for spanner nut when needed).
- 3. Follow procedures 4 thru 8 of INSTALLING BOTTOMING TYPE POWER UNIT.

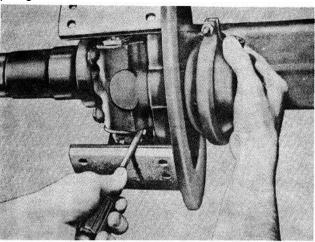
D. INSTALLING ADJUSTING TYPE POWER UNIT WITHOUT DEPTH MARK

1. Follow procedures in paragraph "A", page 19.



2. Screw the power unit into the plunger housing until it bottoms. This will push wedge assembly between plungers and lift them off their seats inside the housing.

By pushing on one shoe or plunger, the second shoe or plunger will be seen to move.



- 3. Unscrew the power unit one turn. Push on one shoe or plunger and then the other alternately, observing movement of the opposite plunger. If there is movement of the opposite plunger, unscrew the power unit another turn and continue this procedure until no plunger movement can be detected. This point is usually two or three turns from the bottomed position.
- 4. Follow procedures 4 thru 8 of INSTALLING BOTTOMING TYPE POWER UNIT.

SERVICING DUST SHIELDS

- A. Welded on spider brakes have dust shields of the four-piece type attached to the spider with capscrews and lockwashers. Either one or all of the sections can be removed directly from the brake by removing the capscrews and lockwashers.
- B. Most bolted on spider brakes with two-piece dust shields can be serviced as described in paragraph "A" after removing wheels, drums and brake shoes.
- C. Bolted on spider brakes with one-piece dust shields will have to be taken off the vehicle for servicing. To remove dust shield from brake first remove power units then remove shield to spider capscrews and lockwashers. The shields can be replaced with a one or two piece dust shield.

D. On backing plate mounted brakes the backing plate serves.as a support for the plunger housing and anchor block as well as a dust shield. For servicing the complete backing plate will have to be taken off the vehicle by removing the plate to spindle flange bolts, nuts and lockwashers.

SERVICING BRAKE SHOES REMOVE SHOES

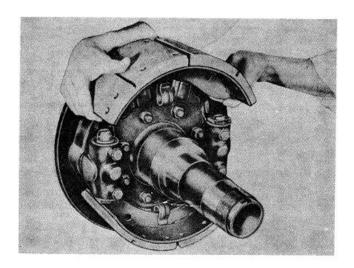
A. Cage the power spring if Fail-Safe unit is used.

NOTE: If necessary back off shoes away from drum manually by turning adjusting bolt assemblies.

- B. Remove wheel, hub and drum assemblies.
- C. Remove brake shoe return springs, using one of the following two methods:

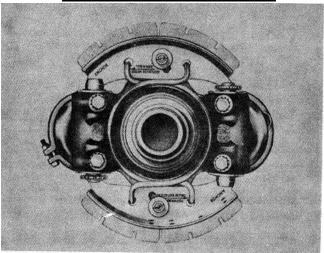
"COIL" RETURN SPRING

1. Use brake spring pliers. (DO NOT use screwdriver.) On backing plate mounted brakes, remove the anti-rattle rod assembly by pushing on rod head on back side, while depressing spring and cap. Turn cap Y4 turn and remove caps, spring and rod.



Remove brake shoe assemblies. <u>DO NOT</u> remove brake shoe hold down clip, support bracket, lockwashers and capscrews, or wear buttons unless in need of service.

"HORSESHOE" RETURN SPRING



2. Remove dust shield, cotter key and nut from brake shoe guide pin. Remove guide pin, spring and washers. Lift brake shoe out of plunger slots, and tilt brake shoe to unhook the return springs.

ASSEMBLE SHOES ONTO BRAKE:

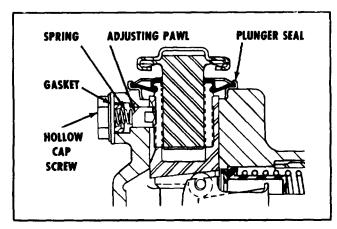
- A. If necessary, reline brake shoes. Apply film of grease to the shoe rest pads and the plunger and bolt slots. Caution: Do not use combination linings.
- B. Rotate adjusting bolts to align slots in bolt retainer with brake shoe webs, being certain that bolts are not bottomed in adjusting plungers.
- C. Assemble brake shoes in reverse manner in which they were disassembled. Be sure that the long radius of the shoe web fits into slot in adjusting bolt retainer, and that the arrow stamped on the brake shoe web points to the anchor plunger in forward wheel rotation.

Care should be taken with horseshoe return springs, that the long hook overlaps the short hook on both springs. See page 5 for correct position of brake shoes and plungers.

D. Install brake drums and adjust brakes. Uncage Fail-Safe units.

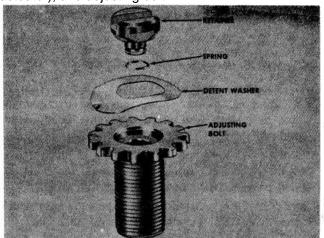
SERVICING PLUNGER HOUSING DISASSEMBLE

A. With brake shoes removed, remove guide screws and gaskets from the plunger, housing.



If brake is automatic adjusting remove hollow capscrew, gasket, spring, and adjusting pawl. Use a small magnet to remove pawl.

B. Pry plunger seals loose and remove anchor (solid) plungers, adjusting plungers, adjusting sleeves (actuator), and adjusting bolt.



If a four-piece adjusting bolt assembly is employed it should also be disassembled.

ASSEMBLE

A. Thoroughly inspect and clean all parts including the housing plunger and seal bores and shoe rest pads. <u>DO NOT</u> solvent clean any rubber parts (plunger seals or gaskets). Wire brush plunger parts and adjusting bolt threads to remove caked on dirt and corrosion.

Carefully inspect plunger seals and gaskets for tears, cuts or deterioration, and replace if necessary. Also check the angled plunger roller faces for pits, grooves or nicks and replace if necessary.

NOTE: RD spider mounted brakes have one adjusting plunger and one anchor (solid) plunger per plunger housing. The anchor plungers are marked on the shoe slot end, "R" for right hand brakes and "L" for left hand brakes. DO NOT mix at reassembly.

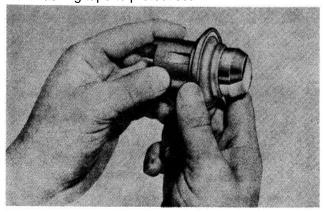
B. ASSEMBLE SEALS ONTO PLUNGERS

IMPORTANT: <u>DO NOT</u> ASSEMBLE SEALS INTO PLUNGER HOUSING FIRST. THIS WILL RESULT IN COMPLETE LACK OF SEALING OF INTERNAL PLUNGER HOUSING COMPONENTS.

1. Apply film of grease to inside surfaces of seals.



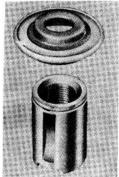
2. On <u>anchor (solid) plungers</u>--inspect nose for burrs. Mask brake shoe web slot in the plunger nose with masking tape to protect seal.



Carefully push the double lip seal onto the plunger, stretching the outer seal lip over the plunger nose end, until the inner seal

lip is completely in the second plunger groove and the outer seal lip is in the first plunger groove. Remove masking tape. (Brakes employing single grooved plungers and single lip seals should be assembled in the same manner except masking tape is not used.)

3. On <u>manual adjusting plungers</u>--push the inner seal lip over the threaded hole end of the plunger until the lip completely enters the plunger seal groove. See paragraph 4 on page 24 for automatic adjusting plungers.



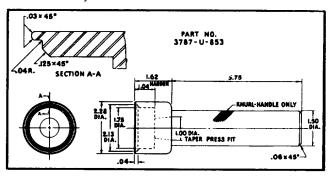
C. INSTALL PLUNGERS INTO PLUNGER HOUSING.

NOTE: For RS brakes (single plunger housing) follow paragraph 3 or 4, page 24, for installing adjusting plungers.

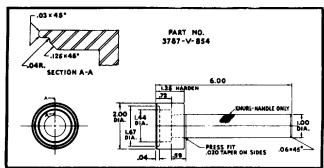
- 1. Coat all plunger bores with grease.
- 2. Anchor (solid) plungers--make sure anchor plungers marked "L" are installed in left hand brake and anchor plungers marked "R" are installed in the right hand brake. See page 5 for correct location of anchor plungers in the plunger housings.
- a. Coat entire anchor plunger with grease, packing cavity behind seal, and insert plunger and seal into housing with plunger key-way slot aligned with guide screw hole. Make certain the plunger goes all the way into the plunger bore and seats on bosses at the bottom.
- b. Seat plunger seal in plunger housing with correct seal driver tool.



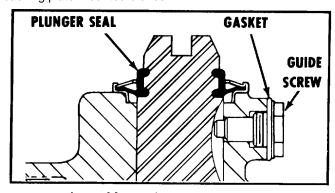
Driver must be centered over seal retainer to prevent damage to seal assembly.



Driver for spider mounted brakes.



Driver for backing plate mounted brakes. If seal driver is not available a 13/4" wrench socket can be used for spider mounted brakes and 13/8" wrench socket can be used for backing plate mounted brakes.



c. Assemble gasket and guide screw into plunger housing.

Make certain guide screw end enters the plunger key-way slot so plunger can slide freely in housing bore. Tighten guide screws to 15-20 ft. lbs. torque.

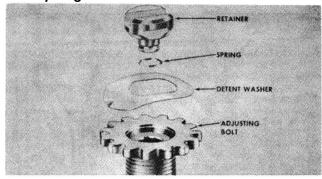
3. MANUAL ADJUSTING PLUNGERS

a. Apply grease to outside of plunger and install plunger and seal into plunger housing in same manner as described in paragraph "2a", page 23, for anchor plungers. Also follow procedures in paragraph "2b" and "2c" for seating plunger seal and assembling gasket and guide screw.



b. Coat adjusting bolt threads with grease and turn bolt into the adjusting plunger by working it through the hole in the outer seal flap, being careful not to pinch the seal on the threads. Turn adjusting bolt in just short of the seal. DO NOT bottom bolt on the seal.

NOTE: If four-piece adjusting bolt assembly is used, assemble parts in following manner after the adjusting bolt has been installed into the plunger.



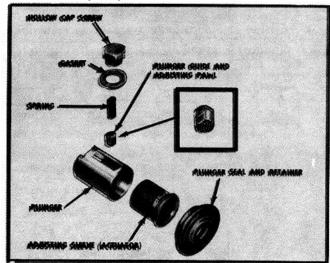
- a. Install detent washer on retainer, making sure flats are aligned, then install spring ring in groove in retainer.
- b. Turn open end of spring ring so that it faces the dimple in the detent washer.

c. Install detent and retainer assembly so that open end of spring ring and detent dimple engages the bolt last. Push assembly into bolt with thumb pressure only. <u>DO NOT FORCE</u> as it will damage the spring ring.

4. AUTOMATIC ADJUSTING PLUNGERS

a. Grease coat the inside and outside surfaces of both the adjusting plunger and the adjusting sleeve. Place the plunger into the plunger housing aligning plunger key-way slot with the guide hole and assemble adjusting pawl* Push pawl back flush with inside of plunger and hold in this position with a small screwdriver while installing grease coated adjusting sleeve.

*NOTE: The adjusting pawl has teeth and flats on one end and a chamfered edge on the other end. Coat pawl with grease and insert it into the guide hole, teeth first, and—IMPORTANT--with chamfer toward the brake shoe. This aligns the pawl and sleeve teeth and the flats with the key-way slot.

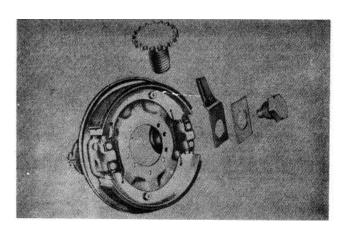


b. Insert the sleeve into the plunger until it bottoms. Install gasket, spring and hollow capscrew into the plunger housing. Tighten capscrew finger tight.

- c. Proper meshing of the pawl and sleeve teeth can be checked at this point. Grease coat adjusting bolt threads and thread it into the adjusting sleeve until it bottoms. A clicking sound and a ratcheting feel will indicate meshing of the teeth. Turn the bolt out three turns, if there is no clicking sound or ratcheting feel, this indicates proper meshing. Remove adjusting bolt after check. Tighten hollow capscrew to 15-20 ft. lbs. torque.
- d. Pack a small amount of grease into underside of seal and seal lips. Assemble the plunger seal over the adjusting sleeve in the plunger housing by pushing the seal over end of adjusting sleeve so the inner lip enters seal groove. Check by lightly pulling up on seal.
- e. Using the proper tool seat the seal into the plunger housing as in paragraph "2b" on Page 23.



f. Coat adjusting bolt threads with grease and thread it into the sleeve after working it through the seal flap hole, being careful not to pinch the seal on the threads. Turn bolt in to just short of the seal. DO NOT bottom it on the seal.

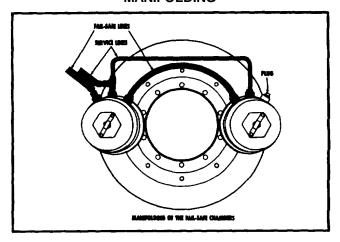


NOTE: On earlier models of front brakes (backing plate mounted) a finger spring type of adjusting bolt lock was used.

To assemble, first install plunger parts, press in seal, turn bolt into plunger or adjusting sleeve and then install finger spring and guide bolt. Lock guide bolt by peening lock plate to bolt boss and head.

The installation of plungers with single lip seals is the same as for double lip seals except with automatic adjusters. The single lip seal is installed on the adjusting sleeve first. Grease the sleeve, seal and adjusting plunger and install in the plunger housing. Then assemble the adjusting pawl, spring and hollow capscrew with gasket. Drive the seal into the housing. Screw the adjusting bolt into the sleeve until it bottoms and perform the check for adjusting pawl tooth mesh. Then back the bolt out about % turn.

MANIFOLDING

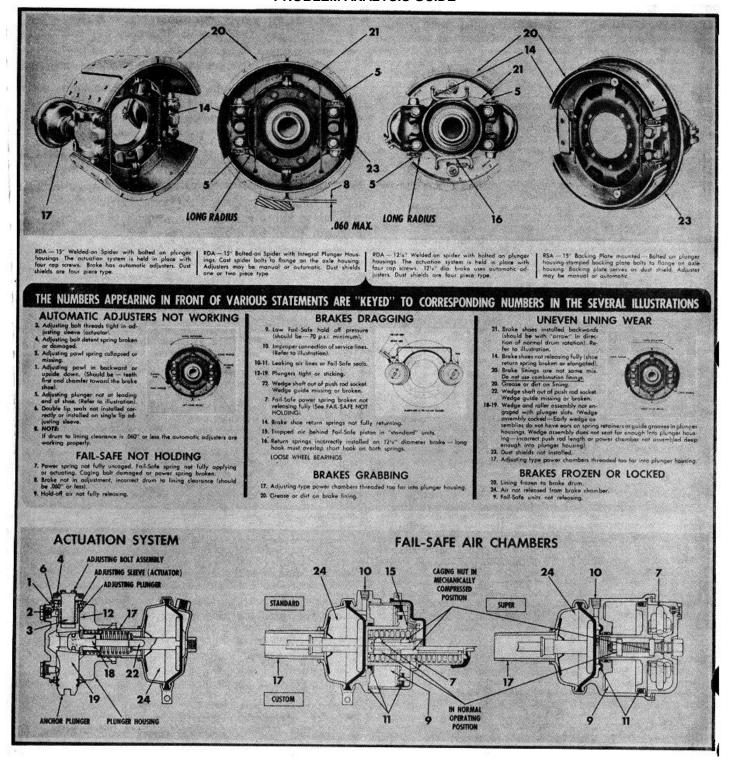


For all tandem axle applications we recommend four Standard Fail-Safe chambers on one axle of the tandem OR four Custom Fail-Safe chambers located one (per brake) at each corner of the tandem.

Any single Fail-Safe chamber configuration, either Standard, Custom or Super, requires automatic shoe adjustment to work within the range of the lift provided by single wedge.

Before operating the vehicle, the caging bolt must be turned counter-clockwise as far as it will go (approximately 18 to 21 turns) to release the Fail-Safe spring. This allows the Fail-Safe unit to function in the event of air pressure failure. Do not force bolt beyond normal stop.

STOPMASTERW BRAKES PROBLEM ANALYSIS GUIDE



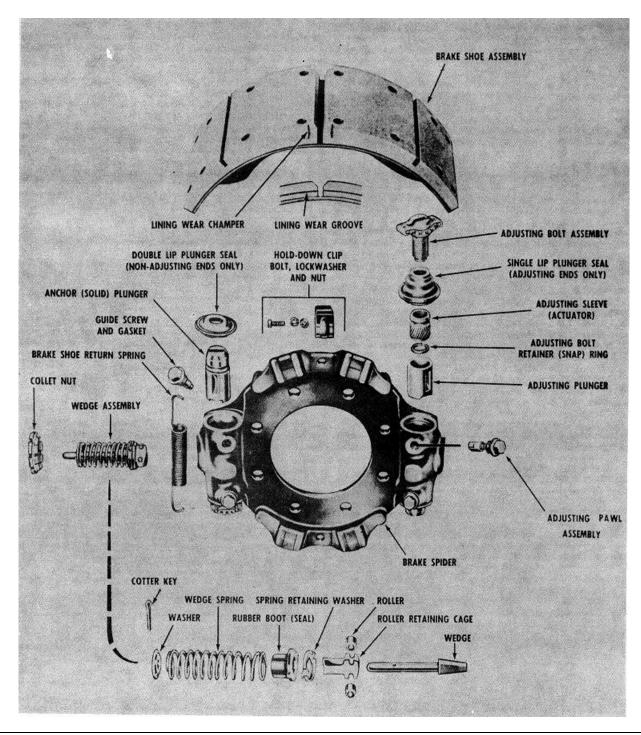


STOPMASTER BRAKES MAINTENANCE GUIDE MANUAL ADJUSTING BRAKE **AUTOMATIC ADJUSTING BRAKE** esting both here sight hand strends. With an adjusting spa drag is developed. Then back off the both to a very jobs drags. BASIC STOPMASTER BRAKES - denoting E-STOPMASTER BRAKE, D-BOUGHE ACTIVATED, A-AN OPERATED, B-STOPMASTER BRAKE, D-STOPMASTER BRAKE, D-STOPMASTER BRAKE, D-STOPMASTER BRAKE, D-STOPMASTER BRAKE, D-STOPMASTER BRAKES, D-STOPMASTER BRAKES BBA - Bohed on Spider bragged Hungar Housings - Cast spider mounting before to flamps on the calle handing. Adjusters may be assumed in WEDGE ACTUATED, EITHER AIR OR HYDRAULIC OPERATED. FAIL-

SAFE UNITS PROVIDE PARKING OR EMERGENCY BRAKING, ONE OR TWO UNITS PER BRAKE.



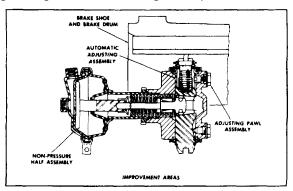
RDA STOPMASTER





STOPMASTER IT WEDGE BRAKE DESIGN IMPROVEMENTS

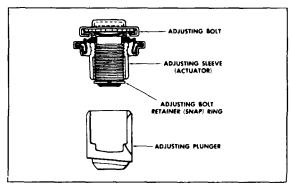
The Stopmaster II Wedge brake now incorporates a series of design changes based on the original Stopmaster brake.



Major design improvements have been made in four general areas of the brake: (1) The automatic adjusting assembly; (2) The adjusting pawl assembly; (3) The non-pressure half of the air chamber; and (4) The brake shoe and drum.

AUTOMATIC ADJUSTING BOLT ASSEMBLY Limited Travel Adjusting Bolt

The automatic adjusting assembly for the Stopmaster II employs a limited travel adjusting bolt which cannot over adjust or cock when the brake lining has been extremely worn.



This is accomplished with the addition of a snap ring at the foot of the bolt and a redesigned adjusting sleeve (actuator) and plunger.

The adjusting sleeve has been counterbored on the I.D. to accept the redesigned adjusting bolt. Thus, when the lining is worn, the counterbored shoulder of the adjusting sleeve stops the bolt from advancing further. Consequently, the bolt is prevented from over adjusting.

To accommodate these changes, the I.D. of the adjusting plunger has also been counterbored to make room for the snap ring.

WARNING

Once a condition exists of worn linings and the adjusting bolt is totally extended, continued braking will result in a gradual deterioration of that wheels braking ability. Periodic inspection

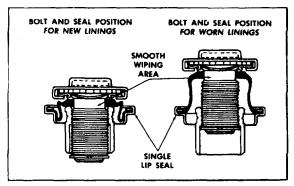
in accordance with the recommended preventive maintenance is necessary to retain maximum braking performance.

If the original adjusting sleeve (actuator) which does not have the new counterbore (has internal threads the full length) is to be used, do not employ the adjusting bolt retainer (snap) ring. Use of the retainer (snap) ring with the old style adjusting sleeve (actuator) and new style adjusting bolt would prevent the adjusting bolt from moving outward and making the necessary lining wear adjustment.

In addition, the adjusting bolt now has a machined smooth wiping surface under the head to accept a new single lip plunger seal.

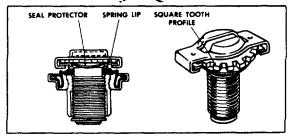
Single Lip Plunger Seal

The adjusting assembly also employs a new single lip plunger seal to provide more protection for the bolt threads and improved sealing for the actuation housing components. The lip of this seal wipes against the smooth machined surface beneath the head of the bolt.



This seal is designed to allow more flexibility and will provide additional protection for the adjusting assembly when the bolt is extended outward In brake application. Thus, this will reduce the possibility of the adjusting bolt freezing, due to any corrosion or dirt inside the actuation housing.

Adjusting Bolt



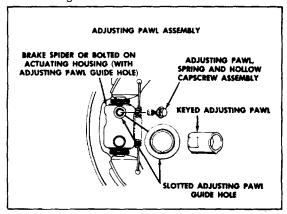
To protect the plunger seal, the head of the adjusting bolt incorporates a redesigned stamped seal protector and rolled spring lips. The seal protector

is angled downward to act as a shield over the plunger seal. This prevents contact between the seal and the adjusting spoon when the brake is being adjusted manually. The spring lip serves to protect the plunger seal when the bolt is in the bottomed position.

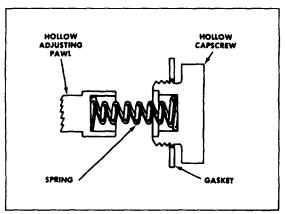
To further facilitate the initial manual adjustment, the star wheel portion of the adjusting bolt head employs square teeth.

ADJUSTING PAWL ASSEMBLY

The adjusting pawl for the Stopmaster II Wedge brake employs an integral key which mates with a slot in the adjusting pawl guide hole of the redesigned brake spider or actuation housing.



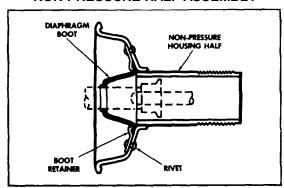
The keyed pawl and slotted guide hole assures correct positioning of the pawl inside the plunger to allow the brake to adjust automatically. This design makes it necessary for the keyed pawl assembly to be used only with brake spiders and bolted on actuation housings which employ slotted pawl guide holes.



The keyed adjusting pawl, spring and hollow capscrew are pre-snapped together as one assembly to facilitate reassembly of these parts Into the spider and bolted on actuation housings. To achieve this, both the capscrew and pawl have hollow ends, and the spring has one large diameter coil at each end which force fits (presnaps) into the open ends of the pawl and capscrew.

The keyed adjusting pawl assembly is not Interchangeable with the original adjusting pawl assembly because of the keyed pawl. However, the individual spring, gasket and hollow capscrew are interchangeable with original parts.

NON-PRESSURE HALF ASSEMBLY



The power unit of the Stopmaster II employs a larger, and more flexible diaphragm boot seal. It also employs a boot retainer clamp which is riveted to the wall of the non-pressure half of the housing. The lip of the diaphragm boot is positioned beneath the boot retainer clamp, and is thus held tightly against the wall of the nonpressure housing. This provides Improved sealing for the air chamber tube by preventing road contaminates from entering the wedge area and contaminating the lubricant. Further, the mechanical attachment of the boot retainer clamp prevents possible separation of the diaphragm boot from the housing.

CHAMFERED BRAKE DRUM

Other design improvements for the Stopmaster II include a chamfer on the brake drum on the inside outer edge to facilitate removal when brake service is necessary. The chamfer allows the brake lining to overlap the drum edge by approximately 1/16". This, in turn, prevents the development of scored wear rings on I.D. of the drum, which could interfere with disassembly.

BRALES-AIR

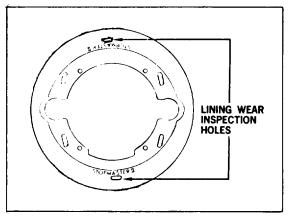
GROOVED BRAKE LINING



For visual inspection of brake lining wear, the linings of the Stopmaster II can be grooved on the side, as shown, as customer option. Also, as an option, the lining could be chamfered on the 4 inner corners, as shown.

This makes it easier to determine how much the lining has been worn, and when the vehicle should be scheduled for relining. When the lining has worn down to the groove, or when the chamfered corners have been worn away, replacement is necessary. A visual check may be made through the inspection holes in the dust shields.

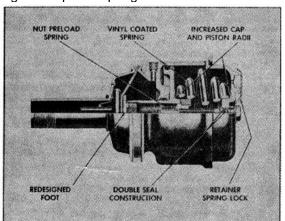
DUST SHIELDS



To further facilitate visual inspection of brake linings, dust shields of the Stopmaster II employ two inspection holes as shown. This allows the linings to be inspected without removing the dust shields from the brake. These dust shields have been stamped, above the inspection holes with the letters and numerals, "Stopmaster II" for identification of service parts.

SUPER "B" FAIL-SAFE IT DESIGN IMPROVEMENTS

The Super "B" Fail-Safe II is an emergency and parking brake power unit designed to be used with Stopmaster wedge brakes. This Fail-Safe unit also incorporates a series of changes (based on the original Super Fail-Safe unit) that will provide improved service life and simplified maintenance. These improvements have been made to six components: The nut pre-load spring; a redesigned foot; the cap and piston radii; the retainer spring lock; the double seal construction, and; a vinyl coating on the power spring.



CAGING BOLT DOUBLE SEAL CONSTRUCTION

The caging bolt employs a double seal construction beneath the head of the bolt for improved sealing. This keeps road contaminates from entering the Fail-Safe unit and corroding the inside of the chamber. Further, this double bolt seal design also provides more support and better alignment for the caging bolt assembly.

NUT PRELOAD SPRING

The caging bolt and nut assembly employs a nut preload spring to replace the original hex nut. This preload spring applies continuous pressure against the caging (square) nut, holding the nut adjacent to the last thread of the bolt. The assurance of thread engagement, provided by this caging bolt design facilitates caging the Fail-Safe unit when brake service is necessary.

FOOT ASSEMBLY

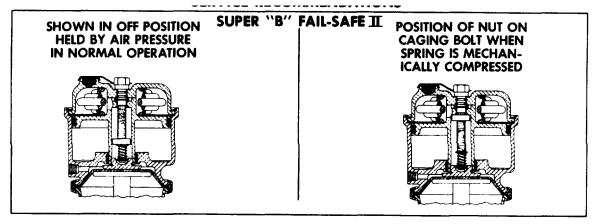
The piston foot incorporates a machined bore to accommodate the caging bolt and nut preload spring assembly. It also employs an "0" ring for added sealing. Further, the foot and seal assembly is threaded into the piston, and held securely in place with the use of loctite sealant. This eliminates the need for a set screw.

RETAINER SPRING LOCK

The bolt retainer spring lock allows the Fail-Safe unit to be caged or uncaged without being removed from the cap. This is accomplished by pressing the retainer lock down far enough to cage or uncage the unit with a socket wrench. After the caging or uncaging procedure is complete, the lock will return to its original position to serve as a bolt retainer.

VINYL COATED SPRING AND INCREASED CAP AND PISTON RADII

The phosphate coated power spring has an additional vinyl coating for longer life, and the radius of the Fail-Safe cap and piston have been strengthened to relieve the stress of the power spring.



Fail-Safe Units

<u>Safety Precaution:</u> When the brakes are equipped with Fail-Safe units (or other auxiliary spring power units) cage the power springs before starting any disassembly or removal of wheels and drums. After parts are all reassembled and in place, uncage the power springs before returning the vehicle to service.

When a vehicle is disabled due to low or lost air pressure, block wheels and cage the power springs before moving the vehicle.

Caging and Uncaging Super "B" Fail-Safe II: The power spring of the Super "B" Fail-Safe II can be manually caged by turning the caging bolt clockwise approximately 25 full turns. DO NOT FORCE THE BOLT BEYOND ITS NORMAL STOP, as this will result in stripping the threads on the caging bolt inside the chamber. Uncage (releasing) the spring by reversing the procedure. The Super "B" II employs a nonstrippable (spring loaded) nut for the uncaged position, it is important that the caging bolt be turned a minimum of 25 turns counterclockwise to assure a complete release of the power spring. The caging and uncaging operation can be made easier by holding 70 psi air pressure through the parking port of the Fall-Safe unit to hold the power spring. This can be done with the use of the vehicle emergency air system or other available air supply.

Recommended Preventive Maintenance

- A. Periodic inspections 25,000 to 30,000 mile Intervals or every two months:
- 1. Check lining wear to determine proper reline time.

- 2. When automatic adjusters are used, check lining to drum clearance if clearance is .060" or less, adjusters are working properly.
- 3. Check service and Fail-Safe air systems by cycling respective application valves.
- B. At 100,000 miles or once yearly:
- 1. Cage Fail-Safe spring and remove all wheels and drums.
 - a. Inspect plunger seals.
- b. If seals are cut, torn, or leaking disassemble and overhaul brake actuating components.
- c. If seals are in good condition, remove upper adjusting plunger and its seal and check internal condition.
- d. If grease is contaminated or hardened, or if parts are dry disassemble and overhaul brake actuating components.
- e. If Internal condition is satisfactory, reassemble adjusting plunger and replace seal and run until next Inspection.

C. At each brake reline:

- 1. If reline period is 100,000 miles or greater disassemble and overhaul all brake actuating components. **NOTE: Do not use combination linings.**
- 2. If reline period is appreciably less than 100,000 miles:
 - a. Remove adjusting plungers and related parts.
- b. Clean and regrease adjusting bolt and sleeve (or plunger).
- c. Check internal condition if satisfactory reassemble if unsatisfactory overhaul entire actuating system.

BRAKES AIR

Recommended Grease

A high temperature water-proof grease IH 251 HE.P.

grease or equivalent to NLGI t 2 multi-purpose lithium grease is recommended for lubricating the brake actuating system.

The following greases meet all of these recommendations:

Texaco Thermotex EP #1 Shell Darina #1 Marathon 528 H.D. Sunaplex #1 EP Amdex :#1 EP Philube B #1

NOTE:

Vehicles operating in extremely cold weather (below 40°F) may require a grease conforming to MIL-G-25013C.

TROUBLE SHOOTING GUIDE

If brakes are poor or do not apply - check system pressure at source and at brakes - possible restriction or leak in brake lines, valves, etc. - brakes out of adjustment - leaking diaphragm or wheel cylinder cup.

Uneven braking or lining wear - ruptured diaphragm wedge rod out of push rod socket - rollers and cage out of plunger socket - corroded or frozen plungers - brakes out of adjustment - grease on lining - glazed lining - shoes installed backward - combination linings.

Automatic Adjusters not working - adjusting pawl installed backward - pawl spring collapsed or missing - bolt frozen in adjusting sleeve - detent damaged and allowing bolt to rotate with sleeve - adjusting plunger in wrong position in the spider (should be at leading end of shoe) - double lip seals not installed correctly.

Fail-Safe not holding - power spring not fully released (uncaged) - brakes out of adjustment - hold-off air not releasing fully - power spring broken.

Brake dragging - low Fail-Safe hold-off air pressure (need 70 psi minimum) - improper connection of service line at Fall-Safe - leaking lines or Fail-Safe seals.

GENERAL MAINTENANCE

This section of maintenance instructions Is outlined specifically for the major design improvements of the Stopmaster II, and the Super "B" Fail-Sate II.

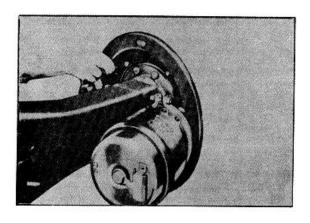
BRAKE ADJUSTMENT

The following procedures can be used for the initial manual adjustment of Stopmaster II wedge brakes.

Since the Stopmaster II is an automatic adjusting brake, periodic manual adjustment is not necessary.

- A. Jack or hoist wheels free of ground.
- B. Make several brake applications to seat brake shoes.
- C. Remove dust cover from adjusting slot two places on each brake.

On RS (single actuated) type brakes the adjusting slots are above and below the single power unit. On RD (double actuated) type brakes the adjusting slots are below the forward and above the rear power unit.



D. Adjusting bolts have right hand thread. With an adjusting spoon, turn the star-wheel until a light drag is felt. Then back off starwheel until free wheel is obtained. Never back off adjusting bolt more than 5 notches maximum. Repeat for other shoe on the brake. Replace dust covers in adjusting slots. Repeat for other brakes.

SERVICING POWER UNITS

AIR CHAMBER DIAPHRAGM

The following procedures can be used to replace the diaphragm boot and retainer clamp assembly,

diaphragm plate and wedge guide of the brake air chamber.

REMOVE POWER UNIT FROM BRAKE

ASSEMBLY

If a Fall-Safe or power spring Is used, proceed to page 10, refer to "Remove Fall-Safe Unit."

A. Remove brake lines and emergency lines. If Fail-Safe is used, at this time remove the clamp ring and place the Fall-Safe unit on the bench.

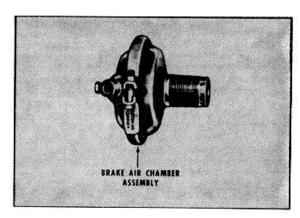
CAUTION:

IT IS ABSOLUTELY NECESSARY TO HOLD POWER SPRING COMPRESSED FOR DISASSEMBLY, IF FAIL-SAFE UNIT IS USED.

B. Using a drift or other blunt tool and hammer, loosen the collet nut.

NOTE:

With welded on spider mounted brakes employing open ends, the entire actuation system can be taken off at this time, if desired, as one assembly by removing four spider to plunger housing capscrews. However, the hub, drum and dust shield will have to be taken off before removing the actuation system.



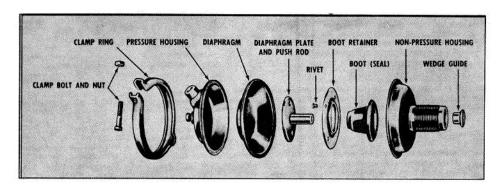
C. Unthread the power unit out of plunger housing.

NOTE:

The wedge assembly can be removed and serviced at this time if desired. Refer to Rockwell-Standard Field Maintenance Manual #4R for detailed Information.

DISASSEMBLE AIR CHAMBER

- A. With power unit removed from brake assembly, remove clamp ring nuts, bolt, Fall-Safe warning tag, and bottoming chamber tags if used.
- B. Spread clamp ring and remove pressure half or Fall-Safe head from non-pressure half.
- C. Remove diaphragm, diaphragm plate and wedge guide from non-pressure housing.



- D. Remove rivets and separate boot and retainer clamp from non-pressure housing using the following:
 - Carefully center punch rivets in center of head.
 - 2. Use drill 1/32" smaller than body of rivet (9/64" dia. drill) to drill through head.
 - Press out rivets.
 - Remove old diaphragm boot and retainer clamp from housing.

REASSEMBLE AIR CHAMBER

- A. Position the lip of new retainer clamp over lip of new diaphragm boot and place complete assembly into non-pressure housing so that rivet holes are In alignment.
- B. Install appropriate size bolts and nuts In two rivet holes 180° apart and fasten retainer

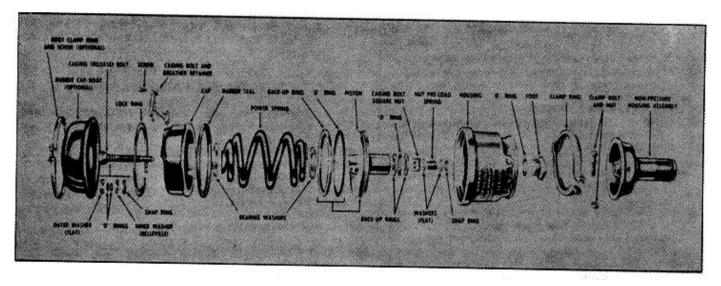
- clamp and boot assembly to non-pressure housing.
- C. Make certain clamp and boot assembly is firmly fastened to non-pressure housing and tap rivets from outside non-pressure housing squarely into remaining 2 rivet holes with a fiat head drift.
- D. Form the rivet head with correct rivet set.
- E. Remove bolts and nuts and repeat riveting procedure for two remaining holes.
- F. Install diaphragm plate push rod through new boot and press wedge guide all the way onto end of push rod.

NOTE:

Replace wedge guide if necessary.

G. Install diaphragm over plate and onto nonpressure housing. Assemble pressure half (or Fall-Safe head) and clamp ring in reverse manner of disassembly.

SUPER "B" FAIL-SAFE II



When preventive maintenance is necessary for the Super "B" Fail-Safe II, follow these procedures:

REMOVE FAIL-SAFE UNIT

A. Remove caging bolt retainer from Fail-Safe cap. Then, cage the power spring.

NOTE:

To facilitate the caging operation, apply and hold 70 psi air pressure through the parking port of the Fail-Safe unit to hold the power spring compressed. This can be done by using the vehicle emergency air system or other available air supply. Then, mechanically cage the power spring by turning the caging bolt clockwise approximately 18 to 25 full turns. DO NOT FORCE THE BOLT BEYOND ITS NORMAL STOP, as this will result in stripping the threads on the caging bolt inside the chamber.

CAUTION:

IT IS ABSOLUTELY NECESSARY TO HOLD THE POWER SPRING COMPRESSED FOR DISASSEMBLY. IF TORQUE IN EXCESS OF 40 LB. FT. IS REQUIRED TO CAGE THE POWER SPRING, DAMAGE COULD OCCUR TO

TO CAGE THE POWER SPRING, DAMAGE COULD OCCUR TO INTERNAL PARTS. SHOULD THIS HAPPEN, PROCEED WITH EXTREME CARE WHEN REMOVING CLAMF RING.

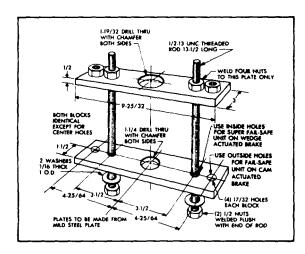
- B. Remove brake lines and tag emergency lines.
- C. Remove clamp ring nuts and bolts.
- D. Spread the clamp ring. Then, hold the diaphragm on the non-pressure half and remove the Fall-Safe unit.

DISASSEMBLE FAIL-SAFE UNIT

CAUTION:

IF EXCESSIVE TORQUE WAS USED TO CAGE THE POWER SPRING AND INTERNAL DAMAGE OCCURRED, IT IS NECESSARY TO SECURE THE FAIL-SAFE UNIT IN A PRESS OR DISASSEMBLY **FIXTURE BEFORE** PROCEEDING TO STEP "A".

- A. Unthread foot and "0" ring assembly from piston. Then, remove piston seal.
- B. Use a suitable pair of snap ring pliers and remove cap to housing lock ring. Then, separate cap assembly and rubber seal from housing.
- C. With cap assembly separated from housing, compress nut preload spring far enough to remove snap ring from caging bolt. Then, remove flat washers and nut pre-load spring.
- D. Clamp the cap assembly (with spring and piston) securely in an arbor press or an appropriate cap and spring disassembly fixture.



CAUTION:

IT IS ABSOLUTELY NECESSARY TO SECURE CAP ASSEMBLY IN ARBOR PRESS OR DISASSEMBLY FIXTURE FOR DISASSEMBLY.

- E. Turn the caging bolt until caging nut falls free. Then, gradually release pressure of the press or disassembly fixture until spring Is unloaded.
- F. Remove assembly from press or disassembly fixture and separate cap from spring and piston.
- G. Remove bearing washers from top of piston and from Inside top of cap.
- H. Remove back-up ring and "0" ring from piston groove. Then, remove two back-up rings and "O" ring from bottom I.D. of housing.
- Remove the snap ring from the caging bolt. This will permit the Inner Belleville washer to be removed from the caging bolt.

K. Remove caging bolt from cap. Then, remove the two "O" rings and outer fiat washer from caging bolt.

PREPARE TO REASSEMBLE

A. Clean and inspect all parts for wear and Make deterioration. replacements where necessary.

IMPORTANT:

Do not use solvent to clean leather piston seal, rubber boot, backup rings or "O" rings. Use hot soapy water.

- B. Inspect caging bolt threads for damage. Also check housing and cap bores for nicks and scratches that would affect sealing.
- C. Remove breather foam filter from cap and wash with soap and water. Inspect foam filter for cuts, nicks, tears or deterioration. Replace if necessary. Make certain breather holes In Fall-Safe cap are thoroughly clean before replacing foam filter.
- D. Wipe internal parts clean with a soft cloth, and regrease thoroughly with recommended grease. The power spring and all mating parts should be packed with grease. However, do not lubricate Fail-Safe cap In area of-breather assembly.

REASSEMBLE FAIL-SAFE UNIT

- A. Position outer flat washer onto caging bolt. Then Install two "0" rings In grooves under the head of the bolt.
- B. Insert caging bolt through top of Fall-Safe cap.
- C. Position inner Belleville washer over caging bolt and against Inside of cap. Lock up caging bolt by installing snap ring.
- D. Install two back-up rings and an "0" ring In bottom I.D. of housing. Position "O" ring between back-up rings.
- E. Assemble "0" ring and back-up ring into piston groove. The "O" ring should be towards the foot end of the piston.
- F. Install bearing spring washers, one on top of piston and one on inside top of cap.
- G. Place piston, power spring and cap (with bearing washers) securely into arbor press or disassembly fixture.
- H. Compress the complete assembly and thread the caging nut onto the caging bolt. Turn caging bolt until nut bottoms in piston stem. The assembly can be removed from press or disassembly fixtures at this time.

CAUTION: ABSOLUTELY NECESSARY

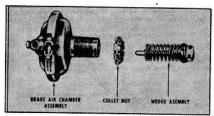
IΤ IS TOHOLD POWER THE **SPRING** COMPRESSED FOR REASSEMBLY.

- J. Install flat washer on bottom end of bolt, towards caging nut. Then install nut pre-load spring and outer flat washer on caging bolt. Lock up washers and spring with snap ring.
- K. Install rubber seal on shoulder in housing.

- L. Position cap assembly (with spring and piston) into housing and install lock ring.
- M. Install piston seal onto groove in foot and thread foot into end of piston stem.
- N. Assemble Fail-Safe unit onto brake assembly in reverse manner of disassembly. Then, uncage Fail-Safe unit before returning vehicle to service.

INSTALLING POWER UNIT ONTO BRAKE ASSEMBLY

A. Check position of the wedge in plunger housing to make certain wedge assembly is properly seated. Then, thread collet nut onto power unit tube.



This is the correct position of the collet nut when used with current brake spider having a conical counterbore.

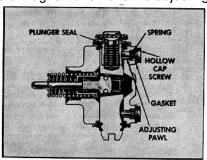
- B. Thread the power unit (collet nut loose) into the plunger housing until it bottoms in actuator housing.
- C. Tighten collet nut finger tight.
- D. Loosen service brake chamber clamp so that ports may be aligned. Align connection ports with brake lines. It is permissable to back off service not more than one full turn. Do Not back off spring Brake Chambers.
- E. Connect air brake lines and tighten chamber clamps.
- F. Make and hold a full brake application.
- G. Tighten collet nut with a drift and hammer 1-1/2 teeth (169.5 N-m or 125 ft. lbs.) and release brake pressure.
- H. Check for leaks at all connections.
- J. Uncage Fail-Safe unit before returning vehicle to service.

SERVICING PLUNGER HOUSING

The following maintenance instructions can be used to service the automatic adjusting assembly of the Stopmaster II wedge brake.

REMOVE AND DISASSEMBLE AUTOMATIC ADJUSTING ASSEMBLY

- A. Remove brake shoes from brake spider.
- B. Remove adjusting pawl assembly (hollow capscrew, gasket, spring and adjusting pawl) from plunger housing. It may be necessary to use a magnet to remove the adjusting pawl.



- C. Using a suitable screwdriver, pry the plunger seal loose from the plunger housing, then, remove the adjusting plunger (with adjusting sleeve, adjusting bolt, and plunger seal) from the plunger housing.
- D. Remove the adjusting bolt, with sleeve (actuator) and plunger seal from adjusting plunger.
- E. Thread adjusting sleeve all the way onto the adjusting bolt until it bottoms against plunger seal. Then, use a suitable pair of snap ring pliers and remove snap ring from end of adjusting bolts.
- F. Unthread adjusting sleeve from adjusting bolt.
- G. Remove plunger seal from adjusting bolt by gradually working the bolt through the seal hole.

PREPARE FOR REASSEMBLY

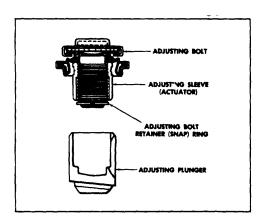
A. Thoroughly clean and inspect all parts, including the housing plunger, seal bores, and shoe rest pads. Wire brush plunger parts and adjusting bolt threads to remove caked-on dirt and corrosion.

IMPORTANT:

DO NOT use solvent to clean any rubber parts (plunger seals or gaskets).

B. Carefully inspect plunger seals and gaskets for tears, cuts or deterioration and replace if necessary. Also, check the angled plunger roller faces for pits, grooves or nicks. Replace if necessary.

REASSEMBLE ADJUSTING ASSEMBLY

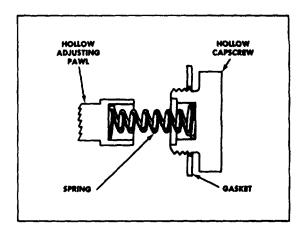


- A. Grease coat the adjusting bolt threads with recommended grease.
- B. Install plunger seal onto the adjusting bolt by working the bolt through the seal hole. Be careful not to damage the seal lip on the bolt threads. Also, make certain the seal lip Is seated against the smooth machined surface beneath the head of the bolt.
- C. Grease coat the Inside and outside surfaces of both the adjusting plunger and the adjusting sleeve.
- D. Thread the adjusting sleeve all the way onto the adjusting bolt until it bottoms against the plunger seal.
- E. Use a suitable pair of snap ring pliers and install snap ring In place on end of adjusting bolt.
- F. Install the adjusting plunger Into the plunger housing, aligning plunger key-way slot with capscrew hole of housing.
- G. Insert adjusting bolt (with adjusting sleeve and plunger seal) into the adjusting plunger. Make certain adjusting sleeve bottoms against Inside shoulder of plunger.
- H. Use an appropriate seal driver and seat plunger seal retainer into plunger housing.

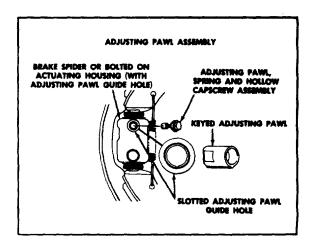
NOTE:

Make certain seal driver is centered over seal retainer to prevent damage to seal assembly.

J. Grease coat the teeth of the hollow adjusting pawl with recommended grease. Then assemble adjusting pawl spring and pawl by forcing one end of spring into the hollow end of pawl.



K. Install hollow capscrew gasket over capscrew. Then, assemble open end of adjusting pawl spring Into hollow end of capscrew.



- L. Align the key of the adjusting pawl with the corresponding guide hole seat of the plunger housing. Then, assemble the complete adjusting pawl assembly (pawl, spring, gasket, hollow capscrew) into the plunger housing. Tighten the hollow capscrew finger tight.
- M. Proper meshing of the pawl and sleeve teeth can be checked at this point. Turn the adjusting bolt out about three turns. If there is clicking sound or ratcheting feel, the teeth are meshing properly. If teeth are not meshing properly, continue to turn the bolt in and out until proper meshing is achieved.
- N. Tighten hollow capscrew 15-20 lbs. ft. torque, and reassemble brake shoe assembly in reverse of disassembly.

DESIGN CHANGE OF 15x7 RDA ADJUSTING BOLT AND ACTUATOR

Since the release of the limited travel adjusting bolt found on page 29; changes have been made to the Stopmaster actuator and adjusting bolt to permit full wear of the brake lining with normally worn drums. Where the drum diameter exceeds 382.524 mm (15.060") a longer length adjusting bolt can be used.

IMPORTANT

Rockwell does not recommend turning brake drums. Further, certain states do not permit the use of drums with internal diameters exceeding 384.048 mm (15.120").

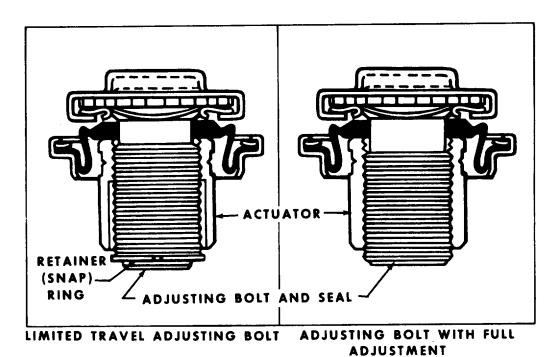
A new adjusting bolt and seal assembly has been used with a longer neck and without a snap ring, along with an actuator which has also been redesigned. The new bolt cannot be used with the original actuator. However, the redesigned bolt can only be used when drum inside diameter falls within the tolerance range of 381 mm 384.048 mm (15"-15.120").

A serviced adjusting bolt and seal assembly and new actuator has also been designed to be utilized in place of the limited travel adjusting bolt when the drum inside diameter is not controlled to 384.048 mm (15.120"). The service adjusting bolt can be used when the brake inside diameter exceeds 382.524 mm (15.060"). Remember that the service bolt assembly cannot be used with new drums since the inside diameter will be less than 382.524 mm (15.060").

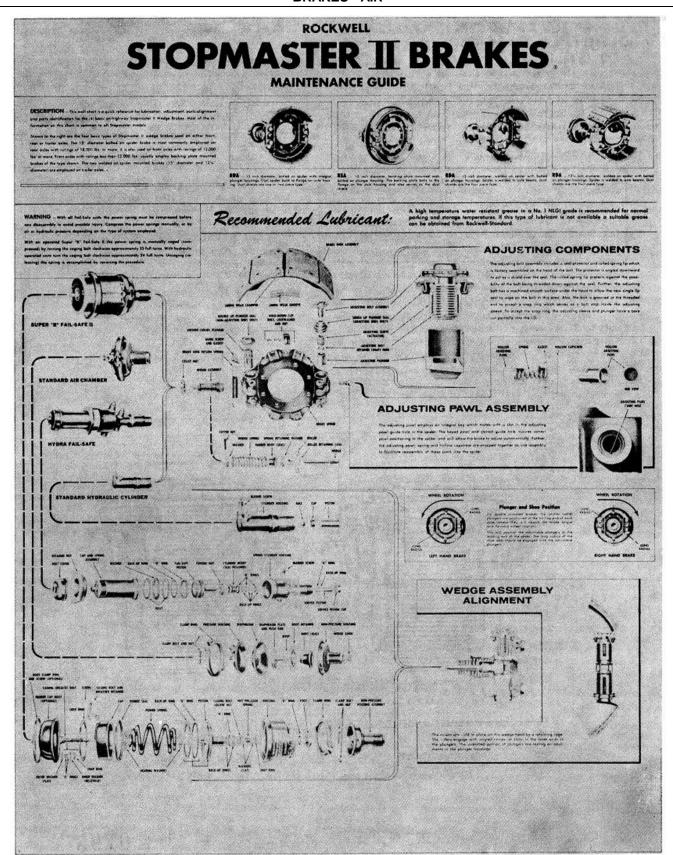
Full lining wear may be obtained on limited travel automatic adjusting bolt assemblies found on page 29 by removing the adjusting bolt snap ring at the first reline of brakes, The automatic adjusting bolt less snap ring may be used on drums up to, but not exceeding 384.048 (15.120") inside diameter.

For identification purposes of adjusting bolts:

- A. Original is photostatized (black) with a snap ring groove.
- B. New is phosphatized (black) with no snap ring groove.
- C. Serviced is zinc dichromate (gold) with a large "S" on bottom.



AUTOMATIC ADJUSTING BOLTS WITH ACTUATOR MT-21549





BRAKES AIR RECONDITIONING BRAKE DRUMS AND SHOES

The text herein is to provide the actual reconditioning of brake drums and shoes. For the disassembly and reassembly of brake groups and servicing of other particular components, refer to appropriate section of the Service Manual.

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DRUM BRAKES INSPECTION OF DRUMS

The friction surface of brake drums must be smooth, true and concentric. Make certain with a visual check that drums are not barrel shaped, bellmouthed, scored or eccentric.

Hard or chill spots, Fig. 1, in brake drum may produce pedal pulsation and roughness or brake surge. If these effects are present, drum should be replaced.

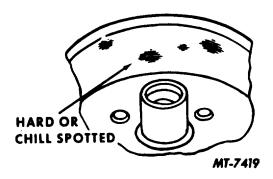


Fig. 1 Hard or Chill Spotted Drum

A barrel shaped drum (Fig. 2) results from overheating. If this barrel shaped condition is not corrected, the braking surface is reduced and uneven lining wear results.

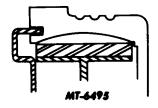


Fig. 2 Barrel Shaped Drum

Extreme pressure which over a period of time will create a bellmouthed drum as shown in Fig. 3. Brake linings on a bellmouthed brake drum will make contact only on the inner surface of the drum. In addition to cutting the braking surface to a minimum, it will also cause uneven and rapid wear.

Scored drums are the result of worn linings to the point where the drum-to-shoe contact is made or an accumulation of small steel particles imbed themselves in the brake lining (Fig. 4). The steel particles form a tough scale which is sometimes harder than the drum. As a result deep grooves are formed in friction surface of drum.

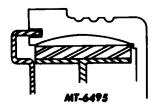


Fig. 3 Bellmouthed Drum

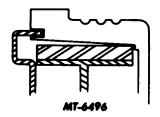


Fig. 4 Scored Drum

Brake drum scoring never improves but continually gets worse until both lining and brake drum are useless. Attempting to reline brakes without turning scored brake drum surface will quickly destroy new lining and make effective braking impossible.

Brake lining in an eccentric or out-ofround drum cannot make full contact with the drum resulting in rapid or uneven lining wear and could even cause brakes to seize or chatter. Maximum allowable out-of-round or eccentricity should be .25 mm (.010 in.).

If inspection shows that any of the preceding conditions exist, brake drum should be either turned or replaced. To assure a balanced braking system, always install turned or new brake drums in pairs on each axle.

Any time a new brake drum is to be installed on a vehicle, the runout should be checked as follows. Place the new brake drum with hub and wheel assembled in lathe making certain drum is centered. Mount Dial Indicator SE-1848 on lathe and -check runout about 12.7 mm (.5") in from edge of drum as shown in Fig. 5. Runout must not exceed .25 mm (.010").

Before assembling drum, hub and wheel, all parts must be clean and free of foreign matter.

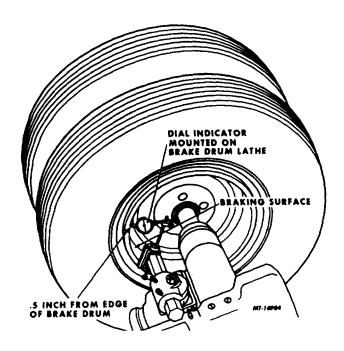


Fig. 5 Checking Drum Runout on Brake Drum Lathe

Special attention to the installation of all wheel and drum assemblies must be adhered to on vehicles with antilock.

Refer to Air Brake System (FMVSS121), CTS-2668 for installation of exciter ring and checking runout, also installation of wheel and drums.

REFINISHING BRAKE DRUMS

On brake drums manufactured after January 1, 1971, the maximum diameter to which drum can be worn is stamped or cast into drum. Drum should be discarded if worn beyond this limit.

Minor scores on brake drum can be removed with fine emery cloth or steel wool, but always clean emery or steel wool particles from drum after this operation. More heavily damaged or out-of-round drums should be ground or turned on brake drum lathe.

If depth of scoring, bellmouth or barrel shaping exceeds .13 mm (.005"), measured with micrometer across part or all of brake surface, drum should be refinished. Reboring limits (see drum) must not be exceeded and no heat checks, cracks or bluing is evident.

Use a micrometer also to check for an out-of-round drum. Make check by measuring drum brake surface diameter at various points, 450 apart around circumference. Eccentricity (out-of-round) should not exceed .25 mm (.010") on diameter.

Remember that each time brake drums are turned, less metal remains to absorb the heat developed by braking action. Brake drums containing less metal will operate at a higher temperature. As a result, brake fade, slow recovery and erratic wear will be more noticeable. Also, extremely high temperatures shorten lining life and cause heat checks and cracks (Fig. 6) to form on inner surface of drums. These conditions will become progressively worse until drum-fail.



Fig. 6 Cracked Drum

REMACHINING DRUMS

Brake drums that are otherwise in good condition can be turned in a lathe. However, it must be remembered that the recommended remachining or rebore limit for brake drums with a diameter over 355 mm (14") may not be increased more than 2.03 mm (.080") diameter (total cut) and discarded at 3.05 mm (.120") over normal diameter.

These dimensions hold true for both drums which have maximum diameter identification, as well as the drums which are not.

IMPORTANT

The dimension located on the drum is discard dimension. Never remachine drums to maximum wear or discard diameter.

To recondition a brake drum in a lathe (Fig. 7), the drum must be mounted so that it is centered. Use proper size cone to provide accurate centering. Turn drum, taking only light cuts and remove just enough material to clean up drum. Then grind the finished surface if grinder is available or use emery cloth on a straight piece of wood and polish the drum friction surface.

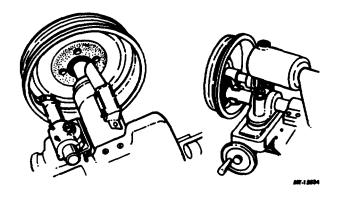


Fig. 7 Reconditioning Drum on Brake Drum Lathe

Brake drums should be cleaned thoroughly with a steam cleaner or hot water. Do not use a solvent which leaves an oily residue. If inspection shows the drums may be used without remachining, rub friction surface with fine emery cloth or sandpaper to remove any foreign deposits. If drum has been reconditioned, clean friction surface with fine emery cloth or sandpaper and wash. Next examine very carefully to see that no metal chips remain in drum.

INSPECTION OF SHOES

When brake linings or blocks are worn to within 1.6 mm (1/16") on medium and heavy duty trucks of rivets, the brake shoes must be removed and relined. It is recommended that all the brakes be relined at the same time since this will maintain balanced braking on the vehicle. If complete replacement is not desirable or necessary, be sure that all lining on one axle (both sides) is replaced at the same time.

Examine shoes carefully and discard those which have any defects as shown in Fig. 8.

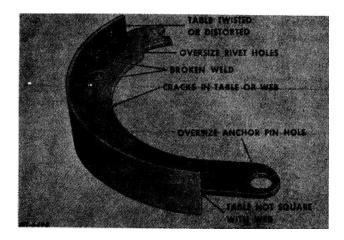


Fig. 8 Defects to be Looked for on Brake Shoe

REPLACING LINING ON SHOES

When removing worn lining from shoes, drill out old rivets if possible to prevent distorting shoe table. After the old linings are removed from the shoes, the shoes should be cleaned and buffed to remove all dirt and grease. Grease is one of the greatest deteriorating agents of lining.

Discard used lock washers after removing lining bolts. Use new washers when installing new lining. Replace bolts and nuts if signs of distortion or wear are present.

Do not handle new brake linings or relined shoes with greasy hands or allow linings to come in contact with mineral oil or grease.

Care should be used in selecting the correct thickness of lining for each brake shoe and drum. Usually the standard thickness will be used. If the drum has been turned or become worn, increasing the diameter, oversize lining may be required.

If it is not known how much material has been removed from the drum during the turning operation, the following simple test may be used to help select the proper lining.

Hold standard size lining snugly to the shoe, position it against the inner surface of the drum, forcing it into contact with the drum surface. The lining is now in the same position as during a brake application. If space is noted at the ends of the shoe (shoe can be rocked), oversize lining is required (Fig. 9). If lining selected is too thick, only the ends of the lining will contact the drum. See Fig. 10.

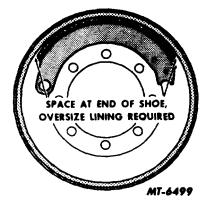


Fig. 9 Lining Selected Too Thin

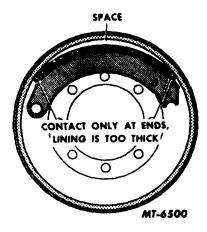


Fig. 10 Lining Selected Too Thick

The lining must be installed on the shoe so that if fits smoothly and evenly, contacting the shoe throughout the entire radius. If gaps occur between the rivets, difficulty will be met in adjusting the brakes in that "spongy" or rubbery pedal may occur which makes satisfactory brake application impossible.

To insure complete contact and avoid gaps between lining and shoe, secure lining to shoe with "C" clamp so that rivet or bolt holes are

in alignment. Position "C" clamp as close to the holes as possible, clamping the lining firmly in place.

When securing brake lining to shoes, start with the center rivet or bolt and work toward the ends as shown in Fig. 11. When securing brake block lining to shoe, use the sequence as shown in Fig. 12. Always use new lock washers when installing bolt on lining and tighten nuts to 89-111 Nm (20-25 ft. lbs.) torque.

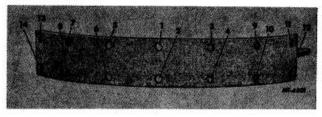


Fig. 11 Sequence in Securing Brake Lining to Shoe

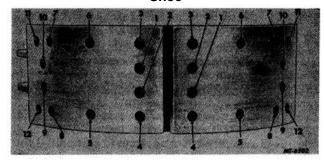


Fig. 12 Sequence in Securing Brake Block Lining to Shoe

When riveting linings, use a roll set to upset the rivets. A star set may split the tubular end of rivet and prevent a tight fit.

After the lining is installed, check tightness of lining to shoe, (Fig. 13) with a .203 mm (.008 in.) feeler gauge at any point along the arc of shoe and lining.

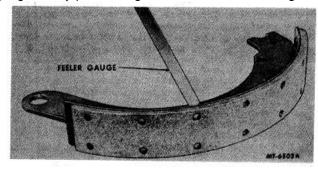


Fig. 13 Checking Tightness of Lining

After installing the new lining on the shoes, the lining should be ground in a true radius to fit the drum diameter. A brake shoe grinder is provided on brake reliner (SE-1272) which is designed to dress the lining in a true radius and fit the drum diameter. This grinder swings the shoe in an arc across the surface of an abrasive wheel.

A brake shoe grinder which mounts on the spindle may be used after installing shoes with new lining. The grinder rotates about on its axis and the grinding head equalizes the distance between the two brake shoe lining surfaces and drum surface. Grind new lining approximately 1.78 mm (.070 in.) less than the inside diameter of brake drum. Make certain that the brake is fully released before grinding.

DRUM REPLACEMENT MEDIUM AND HEAVY DUTY VEHICLES

Drum replacement on medium and heavy duty vehicles requires the removal of nuts from bolts securing hub and drum together. The hub and drum can then be separated.

MOUNTING NEW DRUM TO HUB

Clean exposed hub or axle mounting flange with wire brush or coarse file. Use straight edge across surface of flange to make sure it is not bent. Remove excess paint from edge of drum hub hole and wash rust preventive sealer from drum with solvent.

Before installing a replacement drum wash the drum thoroughly with high grade denatured alcohol to remove <u>all</u> protective grease, oil or other residue. <u>DO</u> NOT use gasoline, mineral spirits or oil.

When assemblying hub and drum together, pay special attention to the bolt heads so that they are aligned proprerly in the drum (Fig. 14).



Fig. 14 Drum Bolt Alignment

Refer to Torque Chart for bolt tightening sequence and proper torque values of hub to drum mounting bolts as well as rim and wheel mountings.

IMPORTANT

Special attention must be given to vehicles with Antilock, where the exciter ring runout must be checked Refer to AIR BRAKE SYSTEM, General Information, CTS-2668.



TORQUE CHART

HUB TO DRUM

Nominal		TORQUE	
<u>Size</u>		<u>N.m</u>	Ft Lbs
1/2" 9/16"		95 - 115 144 - 170	70 - 85 105 - 125
5/8"		194 - 170 194 - 237	105 - 125 145 - 175
3/4"		346 - 407	250 - 300
	Tighten hub-to-drum bolts alternately, across from each other.		
RIM AND WHE	EEL MOUNTINGS		
	Cast Wheels (Rim Clamp)		
5/8"		217 - 237	160 - 157
3/4"		237 - 271	175 - 200
	Disc Wheels - Light Truck		
5/8"	In-Out Coined Mounting	237 - 304	175 - 225
5/8"	Flanged Nut Mounting	373 - 439	275 - 325
	Disc Wheels - Standard Mounting		
11/16"	Flanged Nut Mounting	475 - 542	350 - 400
3/4"	Standard Square Cap Nut Mounting (13/16" Across Flats)	610 - 678	450 - 500
3/4"	Standard Hex Cap Nut Mounting (1-1/2" Across Flats)	610 - 678	450 - 500
1-1/8"	Standard Hex Cap Nut Mounting (1-1/2" Across Flats)	610 - 678	450 - 500
	Disc Wheels - Heavy Duty Mounting		
1-1/8"	HD Hex Cap Nut Mounting (1-3/4" Across Flats)	882 - 949	650 - 700
15/16"	HD Square Cap Nut Mounting (15/16" Across Flats)	1017 - 1220	750 - 900
1-5/16"	HD Hex Cap Nut Mounting (1-3/4" Across Flats)	1017 - 1220	750 - 900



AUTOMATIC SLACK ADJUSTER CODE 04753 (FRONT) 04754 (REAR) (ROCKWELL INTERNATIONAL)

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Illustrations and Text prepared with Cooperation of Rockwell International, Automotive Operations, Troy, Michigan



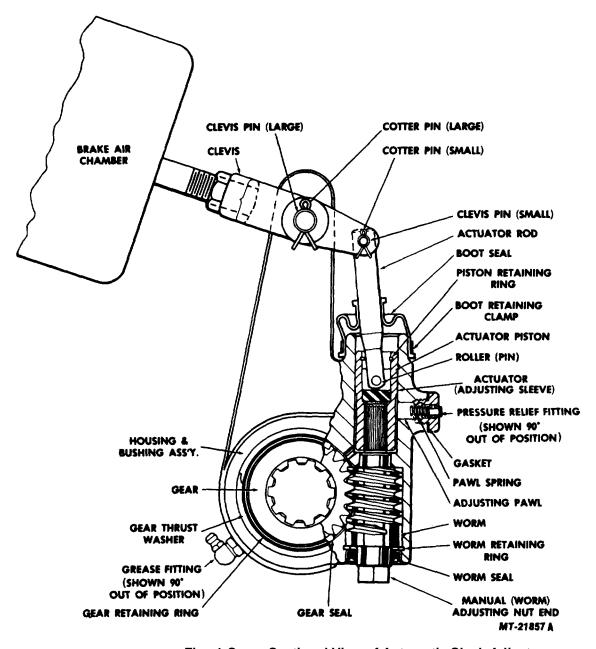


Fig. 1 Cross Sectional View of Automatic Slack Adjuster

DESCRIPTION

The automatic slack adjuster (Fig. 2) is designed to maintain proper cam brake chamber stroke adjustment and lining to drum clearance during the normal service life of the brake lining.

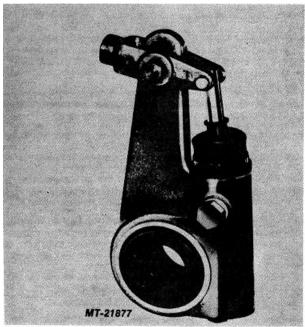


Fig. 2 Automatic Slack Adjuster OPERATION (Fig. 1)

The brake chamber push rod is equipped with a clevis which has two sets of holes permitting the connection of the slack adjuster arm and actuator rod. When the brakes are applied the brake chamber push rod moves the slack adjuster arm, which in turn rotates the brake cam shaft thus applying the brakes.

At the same time the brakes are applied the brake chamber push rod clevis lifts the actuator rod, which is connected to the actuator piston by a roll pin.

The actuator piston moves up and down each time the brakes are applied and released.

As the brake lining wears more travel of brake chamber push rod stroke is required and the actuator piston will also travel further, contacting a retaining ring in the bore of the actuator. The actuator has internal splines and helical type teeth on the external surface.

The adjusting pawl is indexed to the external teeth on the actuator and tooth contact is assured

through spring tension of the hollow cap screw and pawl spring (Fig. 3).

As the actuator is lifted through movement of the actuator piston and actuator rod, the adjusting pawl will index in another set of teeth on the actuator, advancing it and in turn rotating the worm assembly through the mating splines in the actuator and on the worm assembly. As the worm advances the gear which is mounted on the brake group cam shaft, all advances thus maintaining the lining to drum clearance.



Fig. 3 Capscrew, Pawl Spring and Adjusting Pawl LUBRICATION

Refer to LUBRICATION section, CTS-2412 for proper lubrication for brake cam shafts and slack adjusters.

Some automatic slack adjusters will be equipped with lubrication fittings while other slack adjusters will not.

With Lube Fitting

Use a conventional type grease gun and recommended lube. Apply lube through fitting filling inside of slack adjuster until grease flows from the pressure relief fitting in the pawl capscrew.

With Lube Plug

- Remove the hollow capscrew, spring and pawl assembly from the slack adjuster. If the pawl assembly is not removed damage to seals may result.
- 2. Remove the lube plug from the housing and install regular hydraulic type lubrication fitting with a 1/8-27 pipe thread.
- Using a conventional type grease gun with recommended grease, fill the inside of the slack adjuster until grease flows from the pawl opening.



- 4. Remove the grease fitting and reinstall the lube plug.
- Reassemble the pawl, spring and hollow capscrew. Tighten capscrew to 20-27 Nm (15-20 lb. ft.) torque.

MAINTENANCE

38,000 km (24,000 miles) or Every 5 Months

- 1. Check brake lining wear to determine if brake lining requires replacement.
- 2. Check for correct chamber stroke.
- 3. Check condition of boot seal at actuator rod for cuts, tears and replace if necessary.
- 4. Lubricate slack adjusters (refer to LUBRICATION).

76,000 km (48,000 miles) or Every 10 Months

Remove pawl capscrew, pawl spring and pawl assembly. Examine pawl for grease retention. If grease is in good condition, perform normal lubrication operation as described.

If grease is hardened or pawl is dry and shows extreme wear, remove slack adjuster, disassemble, clean and inspect all internal parts, relube and install new minor repair kit. Be sure slack adjuster has been lubricated.

160,000 km (100,000 miles) or Once Each Year

Remove the slack adjusters, disassemble, clean and inspect all internal parts. It is suggested that both the minor and major repair kits be used to repair the slack adjusters. If any damage is found on the worm, gear or housing, the complete slack adjuster must be replaced.

REMOVE

If it is desired to raise vehicle in order to remove the slack adjusters, be sure to position vehicle on floor stands. If vehicle is not positioned on floor stands, be sure to block wheels.

CAUTION

To avoid personal injury, do not attempt to disassemble brake components with vehicle supported by jack only.

The following instructions are used for both automatic slack adjusters on an axle with the vehicle

brakes in the off (no application) position unless otherwise stated.

CAUTION

To avoid personal injury, the spring brake chamber must be manually released or "caged" to avoid an automatic application of spring brake chambers while vehicle is being serviced. Refer to proper Parking Brake, Spring Brake Chamber Section for detailed instructions covering the manual release of spring brakes.

 Mark or measure the position of the clevis on the air chamber push rod before removal (Fig. 4). (This will eliminate the need to adjust the clevis at reassembly). It is also suggested to mark the position of the slack adjuster in relation to cam shaft.

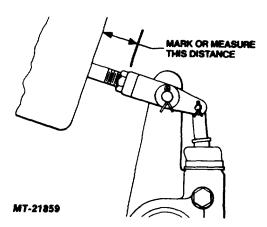


Fig. 4 Check Position of Clevis

2. Disconnect the slack adjuster from clevis by removing both large and small cotter pins and pull both clevis pins from the assembly.

If the front axle slack adjusters are equipped with the external spring (Fig. 5), loosen the jam nut adapter bushing on the push rod and thread the adapter bushing up the chamber push rod to disconnect it from the clevis. It is not necessary to remove clevis from slack adjusters. If the clevis is removed, it could cause reassembly problems with the spring tension.

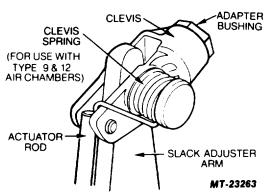


Fig. 5 Front Axle Slack Adjuster Offset Clevis used with Type 9 and 12 Air Chambers

 Remove the capscrew, spring and pawl assembly from side of slack housing (Fig. 3).
 Set aside to disassemble later. Using a wrench, turn the manual adjusting nut end of worm clockwise until slack adjuster arm moves out from clevis.

IMPORTANT

Before turning worm clockwise, always remove the capscrew, spring, and pawl assembly first to eliminate spring tension.

 Remove the slack adjuster from the brake cam shaft by disassembling snap ring and spacing washers. Also remove the clevis from chamber push rod, if required. Remove the adapter bushing from front axle slack adjuster.

If the clevis does not require replacement and the original automatic slack adjuster is to be reinstalled, removal of clevis is not necessary.

If a new automatic slack adjuster is to be installed, continue with installation procedures. If disassembly of slack adjuster is required, continue with the disassembly instructions.

INSTALL

 Check the condition of the brake camshaft, specifically the splines, for wear or corrosion. Make sure the camshaft can be rotated by hand without binding.

Also check the chamber return spring for adequate tension.

Be sure the clevis is in same position on chamber push rod as marked or measured when slack adjuster was removed. Installation templates along with the instructions are supplied with new automatic slack adjusters to assist in adjusting the clevis.

For front axle slack adjusters equipped with an external spring: prior to threading the adapter into the clevis, thread the jam nut and adapter on the chamber push rod as close to the chamber as possible. This will allow the slack adjuster to be positioned correctly for the next step.

- A. For front axle slack adjusters equipped with an offset clevis and external spring bottom the push rod and thread the adapter into the clevis until it bottoms. Tighten the jam nut.
- B. For front axle slack adjusters equipped with a straight clevis and external spring, rotate the slack adjuster until the push rod extends no more than 3.175 mm (1/8") through the clevis. Thread the adapter into the clevis tight, and then tighten the jam nut.

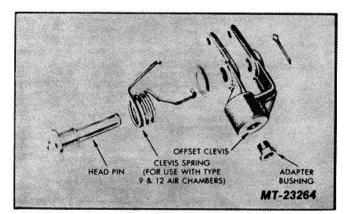


Fig. 6 Offset Clevis Assembly used with Type 9 and 12 Air Chambers

IMPORTANT

There must be full thread contact between clevis and push rod. Push rod must not extend more than 3.175 mm (1/8") past threaded hole of clevis.

3. After adjusting the clevis, continue by assembling the slack adjuster onto camshaft splined end in such a way that the arm clears the clevis on air chamber push rod.

IMPORTANT

Always install slack adjuster so that pawl capscrews, on side of slack housing, face toward inside of axle (Fig. 7).

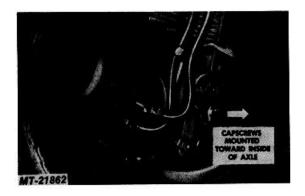


Fig. 7 Capscrew Positioned Toward Center of Vehicle

4. Secure the slack adjuster on camshaft by assembling spacing washers and snap ring.

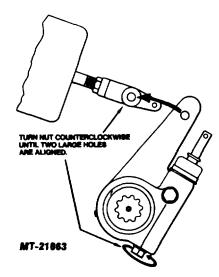


Fig. 8 Aligning Slack Adjuster with Clevis

5. To align slack adjuster arm with clevis, turn the manual adjusting nut end of worm counterclockwise until

clevis pin hole in slack arm is aligned with large hole in clevis (Fig. 8). Insert large clevis pin and retain with large cotter pin.

IMPORTANT DO NOT TURN MANUAL ADJUSTING NUT CLOCKWISE. If clockwise rotation of nut is required, first remove the pawl capscrew to relieve pawl spring tension.

- Next, pull out the actuator rod until hole in top of rod is aligned with small hole in clevis. Insert small clevis pin and retain with small cotter pin.
- 7. If pawl capscrew was loosened or removed, reinstall into slack housing. Tighten capscrew to 19-27 Nm (15-20 lb. ft.) torque.
- 8. Prior to releasing the vehicle for service, perform initial brake adjustment as outlined.

INITIAL BRAKE ADJUSTMENT

One initial adjustment is necessary on each brake employing the automatic slack adjuster before putting the vehicle into service. However, before making the adjustment, check for proper clearance and operation of each new automatic slack installed. Apply brakes and allow air chambers to bottom at maximum stroke. Clearance must exist between the slack and all adjacent chassis components such as axle housing, suspension brackets, etc.

Release brakes and observe that the slack manual adjusting nut rotates counterclockwise as chamber returns to off position.

a. With brakes in full released position, turn the manual adjusting nut end of worm counterclockwise 2 or 3 turns and measure the distance from threaded end of clevis to the bottom of the chamber (Fig. 9).

Fig. 9 Initial Brake Adjustment

b. Make and hold a full brake application. Again measure the distance from threaded end of clevis to the bottom of the chamber. The difference between the two measurements is the chamber stroke. The correct stroke for the specific air chamber employed must be less than those listed below. Repeat procedures a and b until the stroke is correctly adjusted.

CHAMBER TYPE	ADJUSTED STROKE
20	less than 44.5mm (1-3/4")
24	less than 44.5mm (1-3/4")
30	less than 50.8mm (2")
36	less than 63.5mm (2-1/2")

DISASSEMBLY

- Remove the hollow cap screw pawl spring and pawl assembly if it was reassembled after the removal of the slack adjuster.
- 2. Separate the capscrew, pawl spring and adjusting pawl by pulling apart. Exercise care so that the pawl spring is not enlongated. A pointed tool may be required to separate spring from cap and pawl.
- 3. Cut boot retaining clamp and remove.
- Remove the actuator (adjusting sleeve) and internal adjusting parts from the housing bore by pulling on the actuator rod (Fig. 10). It may be necessary to first work the boot seal off the housing before removal.
- 5. Two different methods of disassembling the actuator assembly are:



Fig. 10 Removing Actuator and Adjusting Sleeve Assembly

A. On the original design slack adjuster, remove the internal piston retaining ring from its groove in the I.D. of actuator by placing a screwdriver in the slot in actuator wall (Fig. 11). Press inward and upward against the ring for removal.

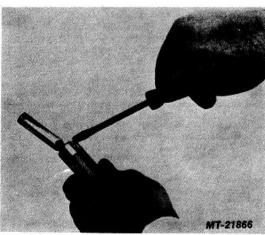


Fig. 11 Removing Piston Retaining Ring on Original Design Slack Adjuster

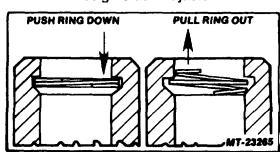


Fig. 12 Removing Current Design Slack Adjuster Piston Retaining Ring

- B. On current design slack adjusters (without a slot in the actuation wall) remove the internal piston retaining ring from its groove in the I.D. of the actuator by pushing down the side of the ring with a screwdriver. When the ring has dropped down enough to clear the rim groove (Fig. 12), spread the coil and pull it out with pliers.
- 6. Pull the actuator rod with piston and pin from the actuator.
- 7. Use a small hammer and brass drift punch (Fig. 13) to disassemble the piston from the rod by tapping out the piston pin from both parts.



Fig. 13 Removing Piston from Actuator Rod

- Remove the worm (grease) seal from the housing by prying the seal out with a small screwdriver or other suitable pointed tool (Fig. 14). Discard the seal since a new seal will be used at reassembly.
- 9. Using internal snap ring pliers remove the worm retaining snap ring from groove in I.D. of worm bore in housing (Fig. 15). Pull out worm from bore.

If worm binds in bore when removing, use a wrench on the adjusting nut end of worm if it should bind in the bore and wind out the worm clockwise.



Fig. 14 Removing Worm Grease Seal

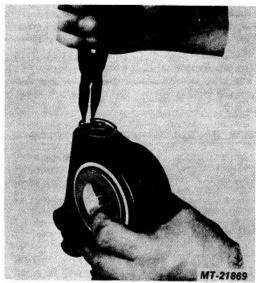


Fig. 15 Removing Worm Retaining Ring

10. Remove the gear from housing by first disassembling the two gear retaining rings, one on either side of the gear. Fit a thin bladed screwdriver into the notch at end of retaining ring while pulling it from groove in gear.

Once the end of the retaining ring is pulled out from the groove, continue winding out the ring by hand (Fig. 16).

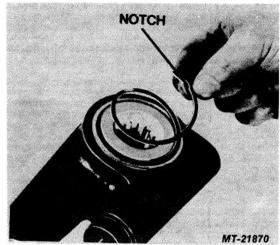


Fig. 16 Pulling Gear Retaining Ring From Housing

 Remove the two gear thrust washers from either side of the gear and tap out the gear from bore in housing.

It will be necessary to tap around the complete diameter of the gear to eliminate cocking and binding in the bore.

- 12. Remove the two gear to body seals from grooves in the gear O.D. and discard.
- 13. Inspect the large clevis pin bushing in arm of slack adjuster for fit and condition. Remove only if necessary. To remove bushing, tap out the large clevis pin bushing from arm, using a piece of round metal stock 14.29 mm (9/16") in diameter and a rawhide mallet.

CLEAN AND INSPECTION

Clean all parts of the automatic slack adjuster and inspect for wear and deterioration. Make replacements where necessary.

Clean parts having ground and polished surfaces, such as the worm, worm gear and inner bores of the housing with solvent type cleaners which would include emulsion cleaners, or petroleum solvents, excluding gasoline. Do not clean these parts in a hot solution tank or with water and alkaline solutions such as sodium hydroxide, arthosilicates or phosphates. Do not use solvent type cleaners on any non-metallic parts.

CAUTION

Exercise care to avoid skin rashes, fire hazards and inhalation of vapors when using solvent type cleaners.

Parts should be thoroughly dried immediately after cleaning. Use soft, clean, lintless absorbent paper towels or wiping rags free of abrasive material such as lapping compound, metal fillings or contaminated oil.

Parts that have been cleaned, dried, inspected and are to be immediately reassembled should be coated with the recommended grease to prevent corrosion. If these parts are to be stored for any length of time, they should be treated with a good RUST PREVENTIVE and wrapped in special paper or other material designed to prevent corrosion.

It is impossible to overstress the importance of careful and thorough inspection of all slack adjuster parts prior to reassembly. Thorough visual inspection for indications of wear or stress, and the replacement of such parts as are necessary will eliminate costly and avoidable future failures.

A minor and major repair kit has been made available for overhauling the automatic slack adjusters.

The minor repair kit will be used whenever a slack adjuster is to be reassembled since it contains seals, retaining rings, clevis pins, which should normally be replaced.

The major repair kit contains a new clevis, actuator rod and actuator which normally do not require replacement.

If the housing, worm or gear should require replacement, the complete slack adjuster must be replaced.

REASSEMBLY

Except for the following, reassembling the automatic slack adjuster is the reverse of disassembling.

- 1. Lightly coat the gear bore in the housing with the recommended lube.
- Insert the gear <u>ONLY</u> into its bore in the housing. It may be necessary to use a small rawhide mallet to tap in gear. <u>AVOID</u> <u>COCKING</u>.

IMPORTANT

Do not insert the gear into housing with seals assembled. Damage to seals will occur when they pass the sharp edges of the intersecting worm bore.

- 3. Push the gear out from the housing far enough to install one seal into the large groove in gear O.D. (Fig. 17).
- 4. Lightly coat the seal with the recommended grease and press gear with seal back into the housing. It may be necessary to use a small rawhide mallet to tap in gear while compressing the seal in its groove.



Fig. 17 Installing Seal on Gear Groove

- 5. Push the gear out the opposite side of the housing far enough to install the second seal and repeat step "4", centering the gear in the housing.
- 6. Coat thrust washers with grease and position washers around the gear, against housing.
- Install gear retaining rings into small grooves in gear O.D. Expand ring coils and start bottom end of ring into groove. Continue by tucking coils into groove around the gear (Fig. 18).
- Position the worm into bore in housing (splined end first) and push inward until worm bottoms in bore.
 - If there is too much resistance on the worm, use a wrench on the adjusting nut end and wind in counterclockwise.
- 9. After inserting the worm retaining snap ring, install the worm (grease) seal.



Fig. 18 Install Gear Retaining Rings

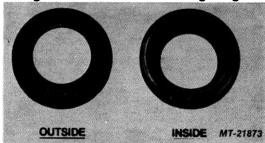


Fig. 19 Worm Seal Identifications

Position the grease seal over the worm bore with <u>SEAL ELEMENT FACING OUTWARD</u>, <u>METAL RETAINER INWARD</u>. (Refer to Fig. 19 for seal identification and Fig. 1 for seal installation).

 Using a hammer and wrench socket or sleeve 46 mm (1-3/16") in diameter, tap seal squarely into bore until it bottoms (Fig. 20). DO NOT

EXERT PRESSURE ON SEAL AFTER BOTTOMING.



Fig. 20 Installing Worm Seal

- 11. After assembling the actuator rod to piston, insert the assembly into actuator (adjusting sleeve) and retain with snap ring (Fig. 21).
 - A. To install snap ring on the original design actuator assembly; Slide ring over the rod and compress it enough to fit into actuator I.D. Using a small screwdriver or other suitable pointed tool, start one end of the ring into the groove. Continue by pressing on ring around the inside of actuator until ring is completely in groove.



Fig. 21 Installing Original Design Piston Retaining Ring

B. On the current design slack adjusters, spread the retaining ring coil and insert one end of ring into groove. Keep the coil separated and spiral each turn progressively into the actuator housing. When the last turn enters the groove there will be a snap indicating the retaining ring is assembled properly (Fig. 22).

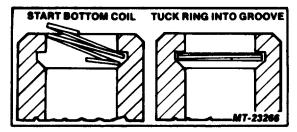


Fig. 22 Installing Current Design Slack Adjuster
Piston Retaining Ring

- 12. To facilitate installing the boot seal over actuator rod, lightly coat the rod with water and slip the boot over rod. Then install new boot retaining clamp.
- 13. Lubricate slack adjuster as outlined in the LUBRICATION portion of this text.
 - Remember that Current designed slack adjusters are equipped with lube fitting and pressure relief valve in the pawl cap screw. Early designed slack adjusters will require the installation of pawl and plug after lubrication, unless a pressure relief equipped pawl capscrew is installed.
- 14. Install the adjusting pawl, pawl spring and hollow capscrew with new gasket. Torque capscrew to 20-27 N m (15-20 lb. ft.)

1 Perform slack adjuster torque check as outlined.

SLACK ADJUSTER TORQUE CHECK

- 1. Use a torque wrench on the manual (worm) adjusting nut and rotate worm counterclockwise observing the torque scale. Rotate gear 3600 (Fig. 23).
- If torque valve reading is lower than 2.8 N m (25 lb. in.) the unit is satisfactory. If torque valve is 2.8 N m (25 lb. in.) or more there is too much resistance within the slack adjuster and further inspection will be required.

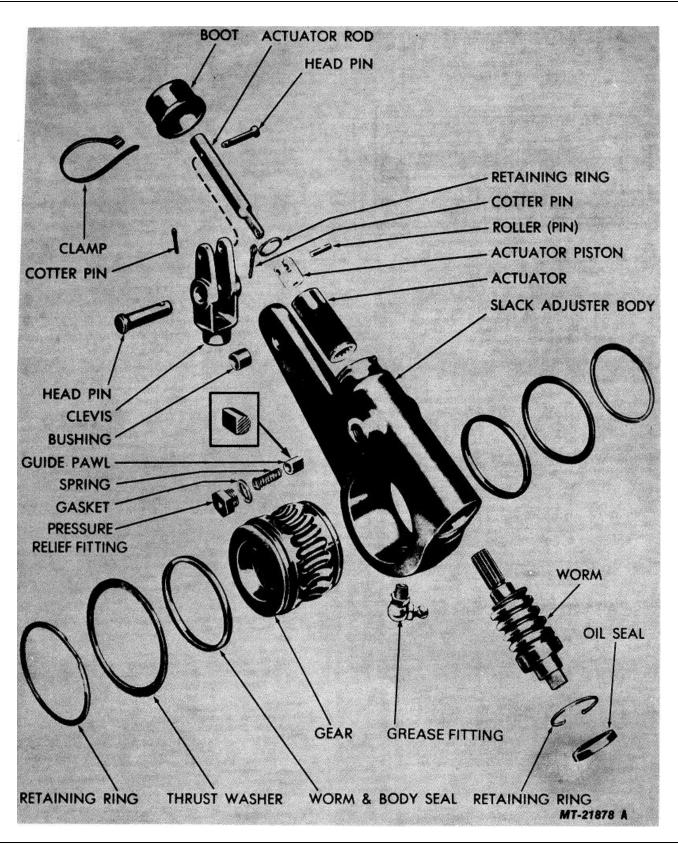
Check for correct reassembly and concentricity of parts.



Fig. 23 Torque Check Slack Adjuster

An exploded view of the automatic slack adjuster can be found on page 12.





BRAKES-HYDRAULIC



BRAKES-HYDRAULIC

HY-POWER BRAKE BOOSTER WITH SPLIT HYDRAULIC BRAKE SYSTEM

CODE 04044, 04059

For service information regarding the hydraulic pump not covered in this section refer to the specific power steering pump sections of the CTS-2001 Service Manual.

Service information pertaining to inspection and refinishing brake drums can be found in Section RECONDITIONING BRAKE DRUMS, SHOES, ROTORS AND PADS, CTS-2779.

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CHAPTER I

DESCRIPTION, MAINTENANCE CHECKS AND SPECIAL FLUID PRECAUTIONS

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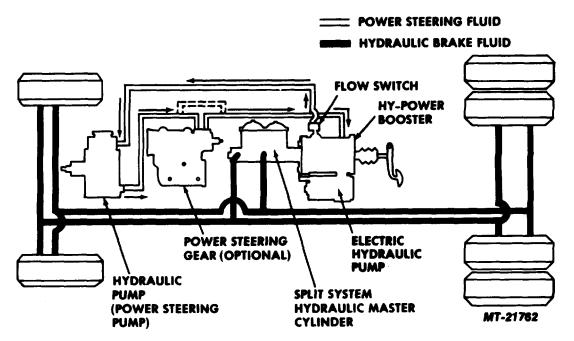


Fig. 1 Typical Schematic of Hy-Power Brake Booster System

DESCRIPTION (BRAKE SYSTEM)

2.

The Hy-Power brake booster system (Fig. 1) features a split hydraulic brake system and master cylinder assembly. The master cylinder is in turn equipped with booster assembly which increases pressure output upon brake pedal application. The booster assembly power source is from a separate hydraulic pump (power steering). The system also has a back up power assist, in the event of a malfunction in the hydraulic power pump system, through the use of an electric hydraulic pump.

The system uses two types of fluids as shown in Fig.

- Hydraulic brake fluid in the master cylinder and hydraulic brake system to wheel brakes and filled at the master cylinder.
- Power steering fluid in the hydraulic pump, steering gear (if equipped with power steering gear) and booster and electric pump units. The booster system is filled at the hydraulic pump reservoir

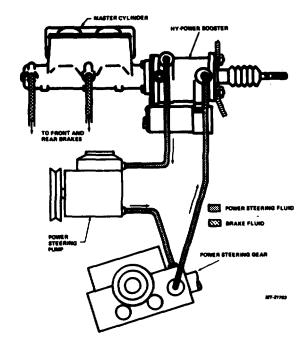


Fig. 2 Two Hydraulic Systems

The purpose of the split hydraulic brake system is to safeguard against complete loss of brakes if a failure should occur in either of the partial sections of the hydraulic system.

The hydraulic brake system has been divided into two independent brake systems utilizing a tandem or two section integral master cylinder.

The tandem master cylinder design provides two separate brake fluid systems, therefore, one section of the master cylinder will continue to operate should a failure occur in the other section.

The Hy-Power booster (Fig. 3) consists of a push rod and valve assembly, a power piston assembly, and an output piston rod, all contained in a cast iron body. Return springs, an inlet check valve and a pressure relief valve are provided within the casting. A bypass for pressure relief and/or electric hydraulic pump fluid supply from low pressure side of booster is also provided. Mounted on the underside of the casting is an electric-hydraulic (EH) pump to provide stand-by hydraulic flow to the booster in the event there is no flow from the hydraulic pump.

The split system is designed so that each partial braking system is individual. During normal brake applications both sections function as a single system. The split brake system provides ability to stop if failure occurs in one of the partial systems. However, stopping ability is reduced by such failure.

The complete loss of vehicle brakes with the split system is considered unlikely during normal operation.

However, accidental major damage to the vehicle could result in complete brake failure as could negligent continued operation with one failed system or failure to provide periodic brake maintenance based upon type and severity of vehicle service.

Figures 4, 5 and 6 illustrate the three typical split hydraulic brake systems used with the Hy-Power booster.

Fig. 4 illustrates code 04059 split hydraulic system used on light medium duty 4x2 vehicles. You will note that both wheel cylinders on both front axle brake groups and one wheel cylinder at each rear axle brake group makes up half of the split brake system. The remaining portion of split system is one wheel cylinder at each rear axle brake group. This split system may be referred to as a (1 axle + 1/2 axle) x (1/2 axle) split.

Fig. 5 illustrates code 04044 split brake system used on medium duty 4x2 vehicles where one wheel cylinder at each brake group is in one half of the split hydraulic brake system. This split system may be referred to as a (1/2 axle + 1/2 axle) x (1/2 axle + 1/2 axle) split.

Fig. 6 illustrates code 04044 split brake system used on medium duty 6x4 vehicles where one wheel cylinder at each front axle brake group is in half of the split hydraulic brake system and each rear axle is applied to each half of the split hydraulic brake system. This split hydraulic system could be referred to as a (1/2 axle + 1 axle) x (1/2 axle + 1 axle) split.

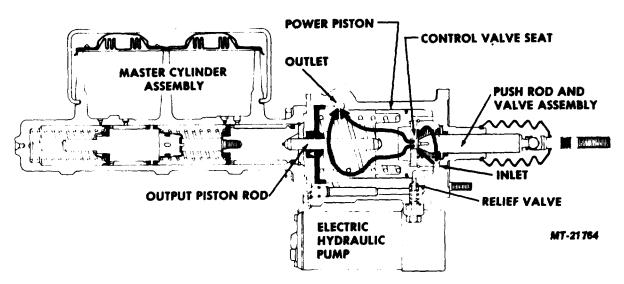


Fig. 3 Cross Section View of Hy-Power Booster With a Typical Split Hydraulic System Master Cylinder.

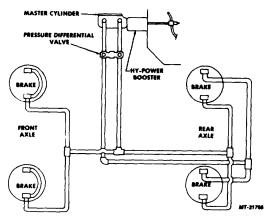


Fig. 4 Brake Code 04059 (4x2) Split System (1 axle + 1/2 axle) x (1/2 axle)

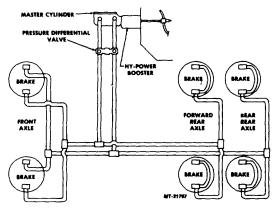


Fig. 6 Brake Code 04044 (6x4 vehicles) Split System (1/2 axle + 1 axle) x (1/2 axle + 1 axle)

MAINTENANCE CHECKS

The brake system should be checked periodically for evidence of needed repairs. Before starting to check out the brake system itself, the following related components on the vehicle should be examined and serviced if found defective.

- 1. Tires.
- 2. Shock absorbers.
- 3. Wheel bearings.
- 4. Suspension.
- 5. Wheel alignment.

The following procedure is given as an aid in checking out the brake system.

BRAKE INDICATOR LIGHTS

Both trucks and busses will have a BRAKE PRESSURE indicator light. All bus chassis and Fig. 5 Brake Code 04044 (4x2 vehicle) Split System (1/2 axle + 1/2 axle) x (1/2 axle + 1/2 axle) some trucks will have

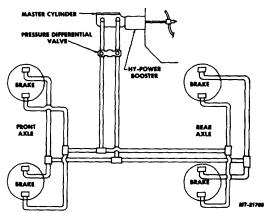


Fig. 5 Brake Code 04044 (4x2 vehicle) Split System (1/2 axle + 1/2 axle) x (1/2 axle + 1/2 axle)

a PARK BRAKE indicator light. Refer to Electric Controlled Circuit in Chapter II.

BRAKE PRESSURE INDICATOR (All Vehicles)

When the key switch is turned to "ON" position with engine off, the "BRAKE PRESSURE" light should illuminate indicating that the light bulb is functioning.

With the key switch in "START" mode both the "BRAKE PRESSURE" indicator should illuminate and the electric hydraulic pump should operate. This feature was incorporated into the system so that the pump is exercised periodically.

After the engine has started, the "BRAKE PRESSURE" light should go off indicating that both the hydraulic brake system and booster systems are functioning properly. Illumination of "BRAKE PRESSURE" indicator could be caused by either a loss of power booster assist or a faulty condition in one of split hydraulic systems.

Should the "BRAKE PRESSURE" light come on during vehicle operation when the brakes are not applied, the problem is in the booster system. If the light should come on during brake application only, the problem could be either in one of the split hydraulic systems or in the booster system.

Should the "BRAKE PRESSURE" light illuminate, the vehicle should be operated only with extreme caution to reach a repair facility, in view of the reduced braking capability. If a failure should result in both the hydraulic booster system and the electric hydraulic pump, manual application of the master cylinder alone will provide very limited stopping ability. However, the vehicle should not be operated without an effective hydraulic brake booster.

If a failure is experienced in one of the split hydraulic systems, the vehicle will still have the remaining portion of the split system to allow stopping the vehicle; however, the vehicle should be operated only with extreme caution to reach a repair facility since the braking capabilities will be reduced.

PARK BRAKE INDICATOR (Bus Only)

The "PARK BRAKE" indicator is operated in conjunction with the parking brake. During engine cranking period the "PARK BRAKE" indicator should illuminate. This light will go out after engine is started providing the parking brake is not applied. If parking brake is applied, this light will stay on after engine has started. If light does not illuminate during starting period, the light bulb may be defective. It is normal for the "PARK BRAKE" indicator light to illuminate when the service brakes are applied when the key switch is "ON" and the engine is not operating.

BRAKE PEDAL

- Pedal return should be unrestricted when pedal is fully released (see BRAKE PEDAL ADJUSTMENT in Chapter II).
- Excessive side movement indicates worn pedal mounting.
- 3. Interference should not occur when pedal is depressed.
- 4. There should be ample clearance between pedal and toe board when pedal is fully depressed (brakes applied).

MASTER CYLINDER

- 1. Fluid level should be 6.4 to 12.7 mm (1/4" to 1/2") from top of reservoir.
- Check for external leaks at hydraulic line connections or at master cylinder mounting flange.
- Check compensating valve by watching for surge of fluid in reservor when pedal is depressed.
- Internal wear or leaks are indicated by pedal fading away under steady foot pressure (also sign of leak elsewhere in hydraulic brake system).
- 5. To check residual check valve operation, depress and release brake pedal. Open bleeder

valve and check for spurt of fluid indicating pressure in lines.

STOP LIGHT SWITCH

If stop lights are inoperative, it would indicate either defective bulbs, defective switch, loose or broken connections, or switch improperly positioned.

BRAKE LINES, FITTINGS AND HOSES

- 1. Check lines for kinks, dents or rupture.
- Check hoses for abrasion, kinks, soft spots, rupture, collapse, cracks, twists or loose frame supports.
- 3. Examine all connections for leaks.
- 4. Carefully check for incomplete ruptures indicated by a bubble between the plys of the flexible hose or a torn inner line (Fig. 7).

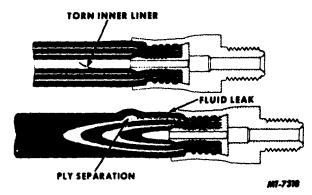


Fig. 7 Flexible Hose Damage

- 5. Brake line fittings will sometimes become rusted or corroded to the wheel cylinder and/or brake line. Be careful not to twist the line causing a line fracture during removal or installation. Brake line open ends should be capped to prevent the entrance of foreign material.
 - Always use correct type and size of wrench on fittings (Fig. 8).
 - Avoid damage to female fittings by supporting fitting with a spare tube nut during removal and installation (Fig. 9).
- 6. Use only steel tubing when replacement of tubing is required. Use old tubing as a pattern for forming and routing the new. Avoid kinks and sharp bends when forming tube. Use tubing cutter to cut tubing to required length making allowance for flare at each end of tube.

Assemble tube nuts on tubing before flaring. After flaring tube, blow out with air pressure to remove any particles of dirt or chips. Do not discard old tube nuts until you are certain that new ones are available.

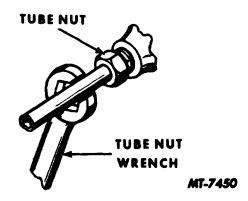
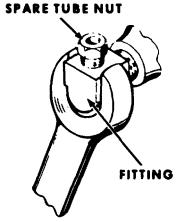


Fig. 8 Use of Tube Nut Wrench



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Fig. 9 Protecting Fitting Against Damage

WHEEL CYLINDERS

Pull back rubber boots and check for leaks. If cylinders are disassembled, look for dirt, corrosion or pitting. If leakage is evident, the hydraulic cylinder should be repaired or replaced as required.

HYDRAULIC BRAKE FLUID

As a result of use, brake fluid becomes contaminated and loses some of its original qualities. It is good practice to bleed brake system until all old fluid is removed when performing major brake work. Also, old fluid should be bled from the system and replaced with clean brake fluid if any hydraulic system parts are corroded, fluid is discolored, contains water or is dirty.

If any rubber parts of the hydraulic system are soft or swollen, old fluid should be removed and hydraulic system should be flushed and refilled with brake fluid. All cups and seals should also be replaced. Do not reuse old brake fluid. For type of fluid, refer to CTS-2412 in your Service Manual under LUBRICATION.

It is recommended that the hydraulic system be flushed when hydraulic cylinders are repaired or replaced to assure that hydraulic fluid is not contaminated. To flush hydraulic system, utilize normal bleeding procedures (refer to BLEEDING BRAKE SYSTEM in Chapter IV) and flush system thoroughly until it appears clean.

BRAKE GROUPS

 Check linings for being too thin, uneven wear, damaged, soiled with grease or brake fluid, or for being loose on shoes. Whenever brake lining or blocks are worn to within 1.6 mm (1/16") on medium and heavy duty trucks of rivets, brake shoes must be removed and relined.

It is recommended that all brakes be relined at the same time since this will maintain balanced braking of the vehicle. If complete replacement is not desirable or necessary, be sure that all lining on one axle (both sides) is replaced at the same time.

CAUTION

Intermixing of various types of lining material other than that specified is not recommended.

- 2. Examine brake shoes for worn anchor ends, damaged rims or webs, or cracked or broken welds.
- Mechanical parts should be checked for heat damage, broken ends or loss of tension in shoe return springs, wear or corrosion of shoe holddown pins, springs and cups, wear on adjusting screw, looseness of mounting or anchors and worn shoe ledges on backing plate.

DRUMS

- Check brake drums for scores, heat checks, outof-roundness and oversize.
- Wheel bearings should be checked for wear. Also, check grease seals for evidence of grease leaks. Refer to WHEEL Service Manual sections.

CAUTION

An accident could result if the vehicle is operated while any of the foregoing items need attention, or if any other brake system service requirements are suspected.

SPECIAL FLUID PRECAUTIONS

CAUTION

The Hy-Power Brake System consists of two completely separate hydraulic systems operating on two different and incompatible fluids; power steering fluid and hydraulic brake fluid. Failure to observe all precautions preventing the contamination of either system with fluid from the other will result in the swelling and deterioration of rubber parts leading to reduced brake performance and eventual failure of the brake system and could result in a vehicle accident.

The Hy-Power installation consists of two separate hydraulic systems operating with different and

incompatible fluids. To avoid fluid contamination, the following should be observed:

- 1. Use only fluids specified (or equivalent). Refer to CTS 2412 LUBRICATION manual section.
- Make sure that fluids are properly identified. Store only in original containers and carefully check the label before using.
- 3. Add fluids only to the following locations:
 - Power steering fluid to the hydraulic pump reservoir.
 - b. Brake fluid to the brake master cylinder.
- 4. Discard do not attempt to reuse any fluid drained from either system.
- Anytime a fluid hose or line is disconnected for maintenance, cover the open fittings and/or ports to prevent contamination of fluid.
- 6. Overhaul components in a clean work area, with clean tools and hands. Hands or tools exposed to one fluid could contaminate parts which operate in the other fluid.
- Denatured alcohol may be used to clean parts. However, do not clean parts operating in one fluid with alcohol previously used to clean parts operating in the other fluid.

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CHAPTER II

OPERATION

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GENERAL

The Hy-Power booster assembly (Fig. 1), converts hydraulic pressure to mechanical force, when applied. However, the hydraulic pressure is controlled by brake pedal force. The mechanical force from the power booster assembly is transmitted to the master cylinder assembly which is mounted on the booster (Fig. 1).

The master cylinder is essentially a hydraulic pump which converts mechanical force to hydraulic pressure. The master cylinder used with the Hy-Power brake booster is known as a tandem type, which can be identified by the two hydraulic fluid outlets on the side of the cylinder bore.

The Hy-Power booster assembly is powered by a hydraulic vane type pump. The vane pump in most instances will be the power steering pump. If the vehicle is not equipped with power steering the same type pump will be used.

The booster assembly also incorporates an electrically powered hydraulic reserve pump. The reserve or back-up pump is also a vane type pump, driven by a 12 volt DC permanent magnet motor. The Hy-Power booster reserve pump is mounted on the bottom of the booster assembly.

MASTER CYLINDER

The basic component parts of the master cylinder used with the Hy-Power booster system differ from those used in other master cylinders, however, the function is basically the same.

An exploded view of the master cylinder can be found in Chapter III of this section.

When the master cylinder is in the released position (Fig. 2), the actuator of the primary and secondary pistons are in contact with the compensating valve stems, which project into the cylinder bore, keeping the valves off their seats, allowing hydraulic fluid in the reservoirs to enter the cylinder bore.

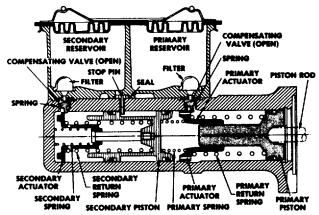


Fig. 2 Released Position

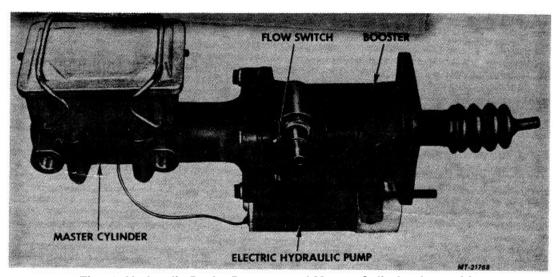


Fig. 1 Hydraulic Brake Booster and Master Cylinder Assembly

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The initial forward movement of the primary piston moves the primary actuator, permitting compensating valve to seat, closing off the passage between the pressure chamber in the cylinder bore (Fig. 3). Further movement of the piston rod causes the hydraulic pressure within the cylinder to move the secondary actuator allowing the secondary compensating valve to close (Fig. 4) and secondary piston is no longer resting on the stop pin.

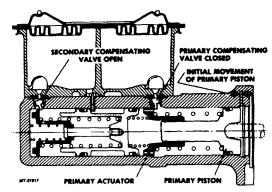


Fig. 3 Primary Compensating Valve Closed

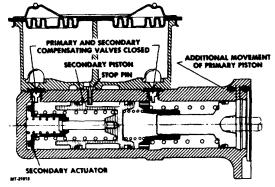


Fig. 4 Primary and Secondary Compensating Valves Closed

When the primary and secondary systems are at midstroke position (Fig. 5), the primary piston and primary return spring has moved the primary actuator to the point where the actuator has contacted the secondary piston and secondary return spring force has bottomed the secondary actuator in the master cylinder bore.

When the master cylinder has obtained the full stroke mode in both primary and secondary systems (Fig. 6), both the primary and secondary pistons have traveled their maximum travel and the primary and secondary actuators have bottomed out. The full stroke mode condition would only exist if both primary and secondary systems should fail or if a very poor brake adjustment condition should occur.

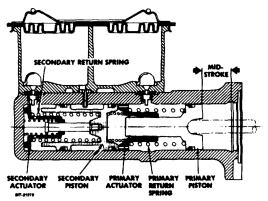


Fig. 5 Primary and Secondary Systems at Mid-Stroke

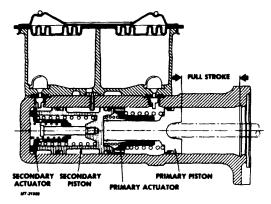


Fig. 6 Primary and Secondary Systems at Full Stroke

If the primary system should fail (Fig. 7), there will be no fluid pressure in that portion of the brake system, therefore, the primary piston will bottom out the primary actuator. However, the secondary piston will develop fluid pressure in that system thus stopping capabilities are still available in that portion of the brake system.

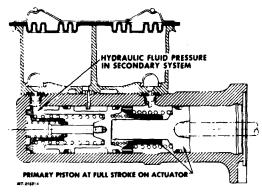


Fig. 7 Secondary System at Mid-Stroke with Primary System Failed

If a failure should occur in the secondary system (Fig. 8), the secondary piston will bottom out in that side of the master cylinder, while the primary section will maintain the capabilities to enable stopping the vehicle.

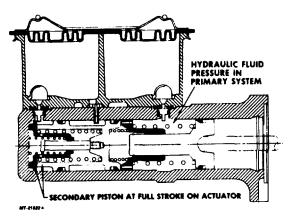


Fig. 8 Primary System at Mid-Stroke with Secondary System Failed

It must be remembered that increased stopping distance will be required if a failure should occur in one of the two systems.

BRAKE BOOSTER

NORMAL OPERATION, BRAKES NOT APPLIED (Fig. 9)

Power steering pump fluid enters the power booster assembly through a check valve at the inlet port at approximately 15.14 litres per minute (4 gpm) and into chamber "A". The fluid then flows around the control valve past the control valve seat into chamber "B", then through the outlet port and flow switch, returning to the power steering pump reservoir. Refer to Fig. 10 for a flow diagram.

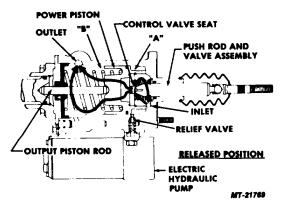


Fig. 9 Hydraulic Fluid Flow During Normal Engine Operation w/Brakes Released

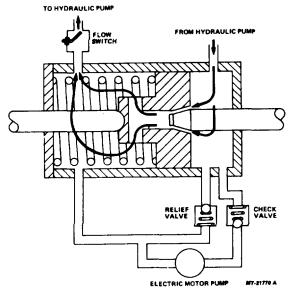


Fig. 10 Fluid Flow thru Booster with Brakes Released.

NORMAL OPERATION, BRAKES APPLIED (Fig. 11)

When the brake pedal is applied. the opening between the control valve and control valve seat is reduced causing pressure to increase in chamber "A". The pressure differential on the piston, when sufficient, will overcome the force of the return spring, causing the piston and the piston rod to move, and apply pressure to the master cylinder pistons, creating pressure to apply the brakes.

During normal braking situations the control valve will not be closed off completely as shown in Fig. 12 by dotted lines of fluid with brakes applied.

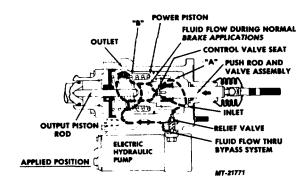


Fig. 11 Hydraulic Fluid Flow During Brake Pedal Application.

A pressure relief valve (Fig. 12) is provided in the power booster to permit fluid flow by passing the power piston, if the pressure should reach approximately 6,205 kPa (0000 psi). At that time the relief valve will open providing a flow path from inlet to outlet

which bypasses the piston (Figs. 11 & 12). This will normally only occur if brake line pressure should reach 13,780 kPa (2,000 psi) during a full brake application. The fluid flow of 15.14 litres per minute (4 gpm) is maintained through the Hy-Power unit at all times regardless of whether the brakes are applied or released.

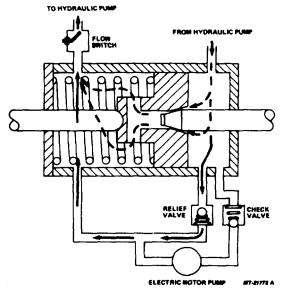


Fig. 12 Fluid Flow Thru Booster With Brakes Applied

Hydraulic pressure acting on the control valve provides a force back through the brake pedal to give the operator a "feel" of the braking action.

The booster output piston rod operates a conventional dual master cylinder as previously described which supplies hydraulic pressure to operate the front and rear service brakes. The master cylinder operates with hydraulic brake fluid.

Normal fluid flow from the booster outlet through a flow switch will cause the switch to be electrically open. When there is no fluid flow past the switch, the switch will close and the "BRAKE PRESSURE" light at the instrument panel will illuminate warning the driver of loss of flow. The loss of either side of the split hydraulic brake system will also cause the "BRAKE PRESSURE" warning light to come on through the pressure differential switch (brake warning light switch).

HYDRAULIC PUMP FLUID PLOW INTERRUPTION RESERVE POWER MOD (Fig. 13)

Should the flow of fluid from the power steering fluid pump be interrupted due to engine shutdown or system malfunction, this condition will be sensed by the flow switch and the electric controlled circuit will then activate the electric hydraulic (EH) pump mounted on the Hy-Power booster (Fig. 13) only when the brake pedal is depressed. This condition is termed "Reserve Power Mode".

During this reserve power mode the EH pump draws fluid from the low pressure side of the booster piston and delivers it to the high pressure side. The EH pump is capable of providing boost pressure that is approximately one-half of the primary system pressure. A stop light switch activates EH pump when the brake pedal is depressed with the ignition on or off.

Remember that the EH pump furnishes auxiliary hydraulic pressure to operate the Hy-Power unit only and will not provide pressure for power steering.

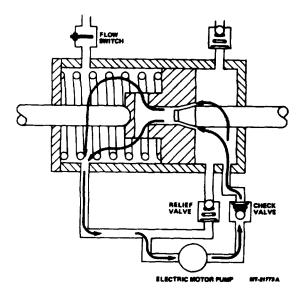


Fig. 13 Electric Hydraulic Pump Motor Operation During Reserve Power Mode.

Hy-Power Pressure Values						
Booster Input Master Cylinder Output*						
6,205 kPa (900 psi)	13,780 kPa (2,000 psi)					
EH Pump Output Master Cylinder Output						
2,068 kPa (350 psi)min.	5,515 kPa (800 psi)					

^{*} Brake Line Pressure

RESIDUAL CHECK VALVE

A residual check valve (Fig. 14) is located in each hydraulic fluid outlet of the master cylinder.

The residual check valve maintains 34 to 172 kPa (5-25 psi) hydraulic pressure in hydraulic system beyond master cylinder to provide

sealing of wheel cylinder piston cups with released brakes. The valve isolates a momentary vacuum which may occur in master cylinder. This pressure will not cause brake shoes to drag as the shoe return springs overcome residual pressure in hydraulic system.

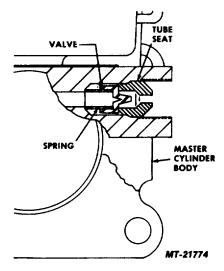


Fig. 14 Residual Check Valve

During manual bleeding the valve assists pumping fluid through the system by closing every time brake pedal is released. If valve should fail to hold residual pressure, a very small leak or even road shock over a period of time could cause increased pedal stroke and a spongy pedal feel.

The residual check valve action can be inspected by cracking a bleeder screw open. A spurt of fluid will indicate residual pressure.

BRAKE LINES, FITTINGS AND HOSES

Hydraulic lines (tubing and flexible hose), Fig. 15, transmit fluid under pressure between master cylinder and wheel cylinders.

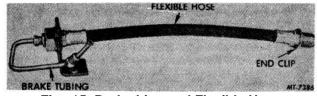


Fig. 15 Brake Line and Flexible Hose

Hoses are the flexible links between wheels or axles and the frame or body. They must withstand fluid pressure without expansion and must be free to flex during spring deflection and wheel turns without damaging the hose.

CAUTION

Hydraulic lines are subject to damage and deterioration; therefore, they should be inspected periodically, to avoid personal injury or property damage.

WHEEL CYLINDERS

The wheel cylinders are attached to brake backing plate. Their purpose is to convert hydraulic pressure from master cylinder to mechanical force required to expand brake shoes against the brake drum.

The wheel cylinder consists of a body, piston spring, piston(s), rubber cup(s), boots(s) and bleeder valve. Fig. 16 illustrates a double piston wheel cylinder and Fig. 17 illustrates a single piston type wheel cylinder.

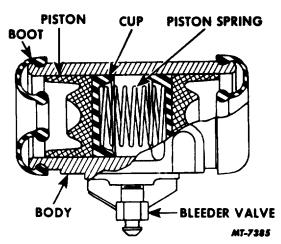


Fig. 16 Typical Double Piston Wheel Cylinder (Cross Sectional View)

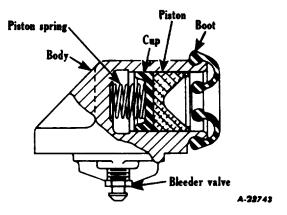


Fig. 17 Typical Single Piston Wheel Cylinder (Cross Sectional View)

PRESSURE DIFFERENTIAL VALVE (Brake Warning Light Switch)

GENERAL

The pressure differential valve (Fig. 18) is positioned in split brake system to sense a loss of hydraulic pressure in either side of the split hydraulic system and illuminate a warning light (Brake Pressure) at the instrument panel.

The switch consists of two pistons, O-ring seals, piston stops, springs and a pin.

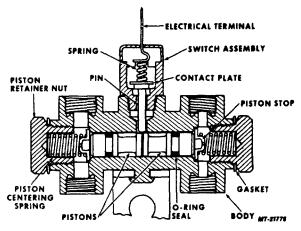


Fig. 18 Warning Light Switch (Cross Sectional View)

OPERATION

The warning light is connected to a warning light switch (Fig. 19). The end of one piston is subjected to line pressure from one side of the split brake system while opposite end of piston is subjected to line pressure from other side of the split brake system. If line pressure of one side of the split system differs by more than 586 to 1034 kPa (85-150 psi) from that of other, pistons are moved off center and electrical circuit closes (Fig. 20), thus illuminating warning light at instrument panel. This is a positive warning to vehicle operator that a system failure has occurred.

The warning light will remain illuminated even after repairs have been performed. To return light to proper functioning cycle again, the switch <u>must be removed</u> from body and reinstalled (see RESETTING BRAKE WARNING LIGHT SWITCH).

To test warning light circuit and prevent possible operation of vehicle with one brake system in a failed condition, the ignition switch is wired into the circuit. If light fails to illuminate when ignition switch is turned to ON position, it would indicate that a bulb is defective or

there is an open circuit, such as a broken wire or loose connection. The light will go out when the engine starts only if the power booster system is functioning properly and there is no pressure difference greater than 586 to 1034 kPa (85-150 psi) in the split system.

CAUTION

To avoid personal injury or property damage, the vehicle should not be operated other than to the nearest safety facility, and then only with extreme caution if the warning light is inoperative or one brake system is in a failed condition; since addition stopping distance may be required.

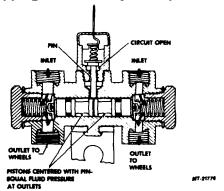


Fig. 19 Warning Light Switch

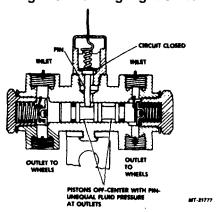


Fig. 20 Warning Light Switch

RESETTING BRAKE WARNING LIGHT SWITCH

After a pressure difference of more than 586 to 1034 kPa (85-150 psi) has occurred within the brake system, "BRAKE PRESSURE" warning light on instrument panel will remain illuminated with engine running. The light will not go out, even after needed service has been performed, until the switch has been reset.

To reset warning light switch, clean all foreign matter from switch and disconnect electrical wire from switch terminal. Unscrew and completely remove switch from body (Fig. 21). Reinstall and tighten switch. Do not over-tighten switch.

IMPORTANT

If hydraulic fluid appears at the opening in body when switch is removed, depress brake pedal and check for fluid leakage past piston Oring seals. If fluid is displaced (squirts from opening), replace warning light switch body assembly.

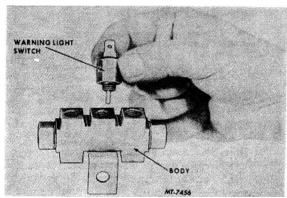


Fig. 21 Resetting Warning Light Switch

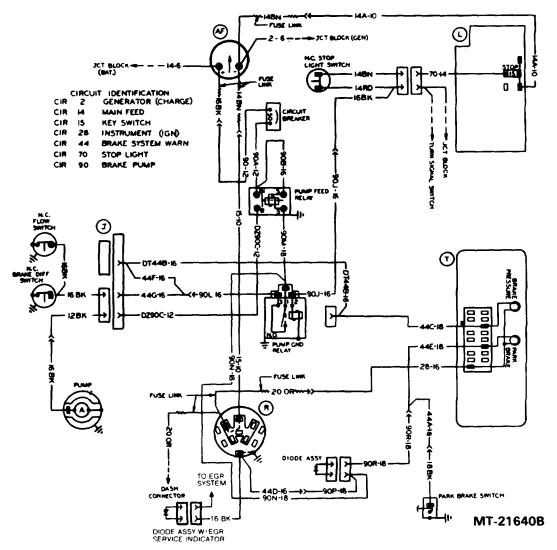


Fig. 22 Circuit Diagram of Bus, 1st Generation

It should be remembered that test circuit will illuminate light when ignition switch is turned to "ON" position.

Connect electrical wire to switch terminal. Warning light should not illuminate with engine running after switch is reset.

ELECTRIC CONTROLLED CIRCUIT

PARK BRAKE WARNING SYSTEM (Bus Only)

When the key switch is turned to "START", the park brake light will illuminate and EH pump will operate since the key switch is grounded in that mode. Upon release of key, switch the circuit is broken and the light should go off unless the parking brake is set and park brake circuit is closed thru the park brake switch.

The diode in the park brake circuit prevents EH pump operation when the park brake is set. This diode is located in a connector as shown on circuit diagrams and

looks like a jumper wire. (Some of these diodes may be covered with electrical tape.)

BRAKE PRESSURE CIRCUIT

When the key switch is in "ON" position and engine off, the flow switch will be closed, completing the circuit for the Brake Pressure light .

In the pump circuit you will note that there is a magnetic switch which is the pump feed and is activated thru the completed circuit in the pump ground relay upon application of the brake pedal. The pump ground relay obtains the ground source from either the flow switch or the brake pressure differential valve switch in the event of a failure in one of the split systems.

The pump feed relay is also grounded when the key switch is in the "START" position so that the EH pump will cycle momentarily.

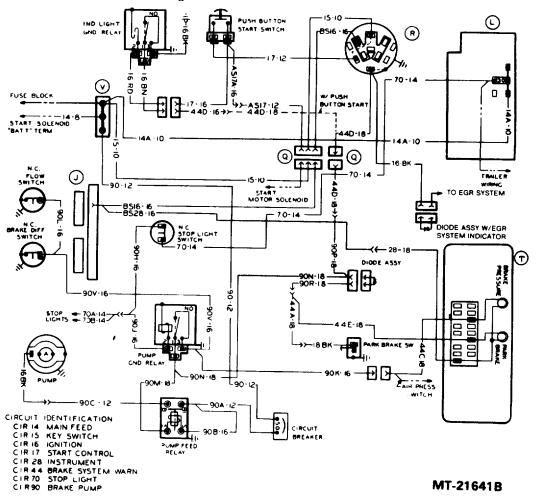


Fig. 23 Circuit Diagram of Cab and Chassis, 1st Generation

In addition to school bus chassis, a few trucks were equipped with the Park Brake Warning System. Because of these few vehicles, the circuit diagram (Fig. 23) was not changed.

The rectifier assembly used with EGR service indicators will only be on vehicles with V-345 and V-392 Engines.

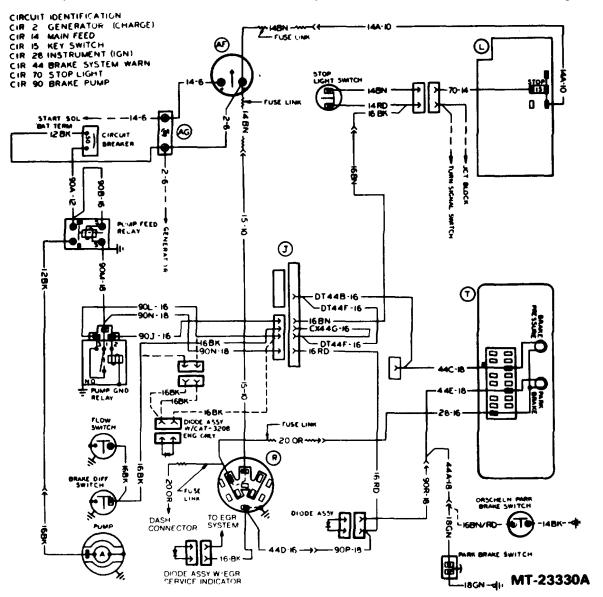


Fig. 24 Circuit Diagram of Bus, 2nd Generation

IDENTIFICATION OF CODE LETTERS IN CIRCLES ON CIRCUIT DIAGRAMS

AF - Ammeter

AG - Junction Block

J - Bulkhead Connector

L - Fuse Block

Q - Instrument Panel Connector

R - Key Switch

T - Instrument Cluster

V - Feed thru Stud

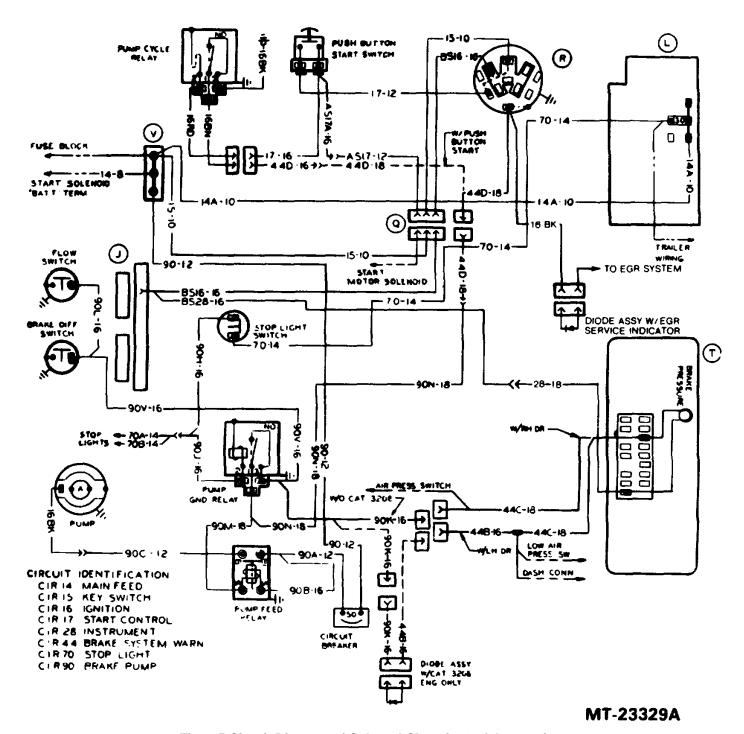


Fig. 25 Circuit Diagram of Cab and Chassis, 2nd Generation



CHAPTER III

REMOVE & REINSTALL, DISASSEMBLY, SERVICE AND REASSEMBLY

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GENERAL

The on vehicle repair of the Hy-Power booster assembly with master cylinder is limited to replacement of the electric hydraulic pump or flow switch. For all other repairs and overhaul, the. master cylinder and Hy-Power must be removed from the vehicle.

The master cylinder may be separated from the power booster for master cylinder repairs or to permit removing the power booster from the vehicle without removing the master cylinder or disconnecting the hydraulic brake fluid lines.

IMPORTANT

Before disassembling any brake component special attention must be given to work area and prevention of contamination by the two types of hydraulic fluids, used in the Hy-Power brake system. Refer to CHAPTER I, SPECIAL FLUID PRECAUTIONS.

Keep in mind that the Hy-Power system utilizes two separate hydraulic systems, operating with different incompatible fluids. Never attempt to reuse any fluid drained from the system or components.

Do not allow brake fluid to contact any HyPower components. Conversely, do not allow power steering fluid to come into contact with internal parts of the master cylinder or other components serviced with brake fluid.

REMOVE AND REINSTALL

MASTR CYLINDER

- 1. Block the vehicle wheels or set parking brake.
- Position a container under the master cylinder to catch fluid. Then disconnect hydraulic lines from master cylinder.

Observe hydraulic line location at master cylinder to prevent lines being switched at reassembly.

- 3. Plug or cap lines to keep out foreign matter.
- 4. Remove bolts securing master cylinder to power booster assembly (Fig. 1).



Fig. 1 Removing Master Cylinder Mounting Bolts

- 5. Reassemble the master cylinder on the power booster assembly and torque bolts to 41-52 Nm (30-38 ft. lbs.).
- 6. Remove plugs or caps from hydraulic lines.
- Connect hydraulic brake fluid lines to master cylinder. Be careful when connecting hydraulic brake line fittings to avoid damage from cross threading or over tightening.

Always check fittings that have been reinstalled for leaks by depressing the brake pedal to build up maximum pressure within the system after bleeding the system. If any leaks are noted or suspected, they should be corrected prior to operating the vehicle.

8. Bleed brake system to be assured that the hydraulic system is free of air. Refer to Chapter IV for bleeding procedure.

ELECTRIC HYDRAULIC PUMP

- 1. Block vehicle wheels or set parking brake.
- 2. Disconnect the EH pump electrical lead.
- Position a container under the pump to catch fluid.
- 4. Remove the motor support strap (Fig. 2).

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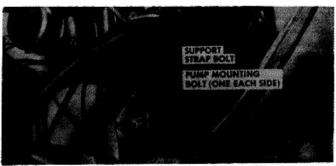


Fig. 2 Removing EH Pump

- 5. Remove the two pump mounting bolts (Fig. 2). Remove the pump. The relief valve spring and relief valve stem will come out of the Hy-Power body when the pump is removed. Use care not to lose these parts.
- 6. Remove two O-rings from the grooves in the pump mounting flange.
- 7. Install new O-rings in the pump flange grooves prior to installing new pump.
- 8. Install the relief valve, slotted end first into the body of the Hy-Power casting and engage small O.D. of the relief valve spring against flange on relief valve. Hold these parts in position until the EH pump is in place.
- 9. Position the pump on the Hy-Power unit and install the two mounting bolts. Torque bolts to 22-41 Nm (16-30 ft. lbs.).
- 10. Install pump motor support strap attaching bolt and torque to 11-15 Nm (99-135 in. lbs.).
- 11. Reconnect the EH pump electrical lead.
- 12. Bleed the Hy-Power system as directed in Chapter IV.

FLOW SWITCH

The Hy-Power booster operates on power steering fluid only. Do not allow contamination with brake fluid.

- Position a suitable container to catch fluid from the flow switch and hoses.
- 2. Disconnect the electrical lead to the flow switch.
- 3. Loosen the inner hose clamp at the flow switch and remove the hose.
- Remove the flow switch using a 25 mm (1") open-end wrench. Fig. 3 illustrates this operation with the Hy-Power removed from from the vehicle for overhaul.

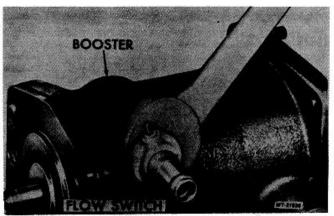


Fig. 3 Removing Flow Switch

- 5. Use new O-ring seal when installing the flow switch. Torque to 27-41 Nm (20-30 ft. lbs.).
- 6. Make electrical and fluid connections in reverse order of removal.
- 7. Bleed the Hy-Power system as directed in Chapter IV.

HY-POWER BOOSTER

The Hy-Power booster can be removed from the vehicle without removing the master cylinder.

This procedure involves removing the hardware attaching any brake line clips in the vicinity of the master cylinder.

- 1. Block the vehicle wheels, disconnect battery ground cable and disconnect the electrical leads from Hy-Power electric hydraulic pump and flow switch (if not previously removed).
- Position a suitable container under the HyPower unit to catch power steering fluid.
 Disconnect the hydraulic hoses from the Hy-Power unit and cover the hose ends to prevent

fluid contamination.

- Remove the four bolts attaching the master cylinder to the Hy-Power booster (Fig. 1), moving the master cylinder forward a sufficient distance to clear the end of the booster push rod and supporting the master cylinder in this position.
- 4. Disconnect the booster push rod from the brake pedal.
- Remove the hardware attaching the Hy-Power unit to the vehicle and remove the Hy-Power unit
- 6. If master cylinder was removed with Hy-Power booster, attach master cylinder to the booster. Torque bolts to 41-52 Nm (30-38 ft. lbs.).

- 7. Adjust the booster push rod clevis so that the clevis opening (center) is approximately 178 mm (7 in.) from mounting face of booster.
- Position Hy-Power unit on the vehicle and torque fasteners to 31-41 Nm (25-30 ft. lbs.). You will note that two studs and two bolts are utilized.
- 9. Connect push rod clevis to brake pedal. Refer to Brake Pedal Adjustment in this Chapter.
- 10. Reassemble any hardware attaching any brake line c: 'ps.
- 11. If the master cylinder was not removed with the booster, secure master cylinder to booster at this time. Torque bolts to 41-52 Nm (30-38 ft. lbs.).
- 12. Connect fluid hoses to the booster.
- 13. If master cylinder fluid lines were disconnected, they should be connected at this time.
- 14. Connect the EH pump and flow switch electrical leads, then reconnect the battery ground cable.
- 15. Bleed the Hy-Power system as directed in Chapter IV.
- If the master cylinder was removed, bleed the brake hydraulic system as directed in Chapter IV.

CAUTION

If the Hy-Power or brake hydralic system has been opened or any component removed or any line disconnected- do not attempt to move the vehicle until the affected system (or systems) has been properly bled, or the vehicle will not have braking capabilities.

PRESSURE DIFFERENTIAL VALVE (Brake Warning Light Switch)

- 1. Set parking brake.
- Clean area of warning switch and valve body free of dirt and foreign material.
- 3. Disconnect wire from warning switch terminal.
- Remove inlet and outlet fluid lines and plug or cap lines to avoid entrance of dirt. Be sure to note position of hydraulic lines for correct installation.

- 5. Remove valve mounting bolt.
- 6. Position assembly on vehicle and secure with mounting bolt.
- Install hydraulic lines to correct inlet and outlet openings in valve body. Refer to figures 4, 5 and 6 in Chapter I for typical split hydraulic system connections at pressure differential valve.
- 8. Adequately tighten all fittings. Remove switch assembly from body and bleed brakes. Refer to Chapter IV, BLEEDING BRAKE SYSTEM.
- After brakes are bled; with engine running apply steady foot pressure to brake pedal and check all fittings for leaks. Inspect opening where switch assembly attaches to body to be certain that O-ring seals are not leaking.
- Install and sufficiently tighten switch assembly in body. Do not overtighten since no seal other than to prevent the entrance of dirt or foreign material is required between switch assembly and body.
- 11. Connect warning light wire to switch terminal. Turn ignition switch to ON position. Warning light should illuminate. Start engine.

When ignition switch returns to ON position, warning light should "go out". If warning light fails to function properly, investigate system further to determine problem.

CAUTION

Remember that when testing warning light circuit, engine will start. Be certain that all personnel and equipment are free of engine.

MASTER CYLINDER

DISASSEMBLY

- Remove the reservoir cover and diaphragm, and drain the fluid from the reservoir.
- 2. Remove the four bolts that secure the body to the reservoir using an E 10 Torx head socket.
- 3. Remove the small "O" ring and the two compensating valve seals from the recessed areas on the bottom side of the reservoirs.

Do not remove the two small filters from the inside of the reservoir unless they are damaged and are to be replaced.

4. Since the spring load of the primary piston is approximately 267-311N (60-701bf) it will be difficult to depress the piston by hand. Therefore, it is suggested that a cross bar type puller similar to SE 1368 which has a 600 angle at the end of the center bolt be used or a puller with a ball swivel point to avoid damage to piston. Assemble the puller on the end of the master cylinder using two of the master cylinder mounting holes diagonally opposite each other (Fig. 4). Using two 3/8" x 5 1/2" bolts which permit threading the puller center bolt down, forcing the piston into the bore approximately 25.4mm (1").

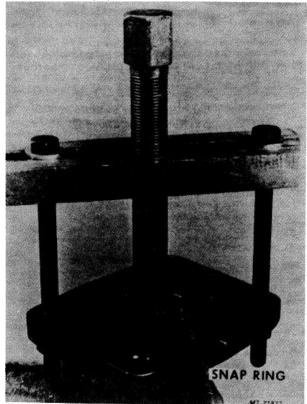


Fig. 4 Depressing Master Cylinder Primary Piston
Using a Cross Bar Type Puller

 After the piston has been depressed the compensating valve poppets and springs can be removed. Then remove the stop pin from master cylinder body.

- Before releasing the puller assembly, remove the snap ring from master cylinder bore using a snap ring pliers. Then release the piston and remove the puller assembly from end of the master cylinder.
- 7. Remove the primary and secondary pistons from cylinder bore. It may be necessary to plug the front outlet port and to apply low air pressure to the front compensating valve port to remove the secondary piston assembly. If air pressure is used to remove the secondary piston, place the open end of the cylinder bore approximately 25.4mm (1") from a padded workbench or other surface to catch the piston when it comes out of the bore. Apply low air pressure very carefully to ease the piston out of the bore.

CAUTION

Never point the open end of the bore at Never point the open end of the bore at anyone when applying air pressure. The piston may come out of the bore with considerable force and cause personal i injury.

- 8. Remove tube seats with screw extractor. If present remove residual valve and springs.
- No further disassembly of master cylinder components are required since these components are serviced with the repair kit as assembled components.

CLEANING AND INSPECTION

Cylinder castings may be degreased or cleaned with most commercial parts cleaners provided they are thoroughly rinsed with denatured alcohol or clean brake fluid to remove all traces of solvent. Use compressed air or a lint-free cloth to dry parts after removing them from the cleaning solvent. All hydraulic parts must be thoroughly cleaned and protected (after cleaning) from dust or other air-borne foreign material until reassembly. Do not use cotton waste for cleaning or drying parts, as particles of lint or thread fibres may block the compensating ports when cylinder is placed in service.

Be sure that all foreign matter is removed from the filters in the bottom of the master cylinder reservoir. If the filters do not clean !up) they must be replaced.

IMPORTANT

Do not use mineral-base cleaning solvents such as gasoline, kerosene, distillant, carbon tetrachloride, acetone, paint thinner, etc. to clean rubber parts. These solvents attach rubber parts, causing them to become soft, tacky and swollen in an extremely short time.

Inspect cylinder bore for scoring or corrosion. It is best to replace a corroded cylinder. Corrosion can be identified as pits or excessive roughness. Excessive blemishes such as pitting, scratches and visible wear patterns necessitate unit replacement.

Accumulations of dirt or gummy substances, not removed during the cleaning process, may be r-emoved with crocus cloth by revolving cylinder on cloth supported by finger.

If master or wheel cylinders were honed, remember that the cylinder diameter must not be materially increased. In other words, scratches and pits in cylinder walls render the unit useless as honing the bore sufficiently to remove them would increase bore diameter to the point that new piston cups will not seal properly. The possibility that cylinder may have been honed during a previous overhaul should not be overlooked.

Care must be exercised when cleaning the bore of the master cylinder since the bore has a step near the blind end. The configuration of the step must not be altered. Crocus cloth may be used to clean the 450 angle of the step and at the bottom of master cylinder bore.

Be certain that the cylinder has no burr at compensating or inlet ports, as it would damage new piston seal. If a burr or sharp edge is present anywhere in cylinder bore, it must be removed.

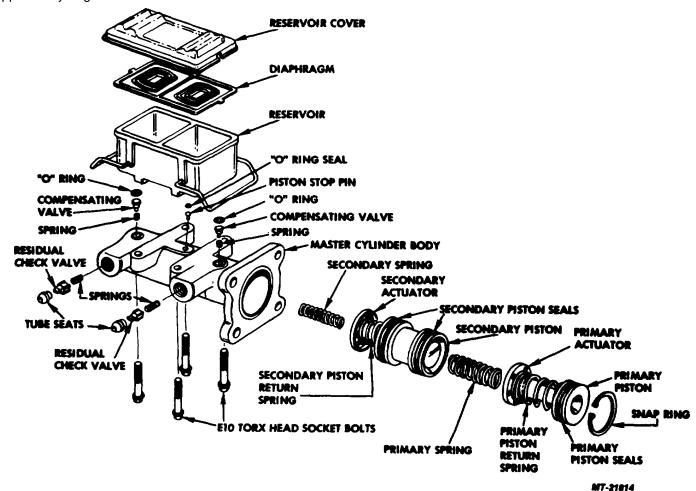


Fig. 5 Exploded View of Master Cylinder

At final inspection, be certain that master cylinder compensating ports are open. A soft copper wire may be used to probe compensating port. Do not use a steel wire.

REASSEMBLY

Refer to Fig. 5

- 1. Lubricate the secondary piston assembly and the master cylinder bore with clean brake fluid.
- Assemble the secondary spring (smaller of the two springs) in the open end of the secondary piston actuator and assemble the piston return spring (larger spring) in the open end of the secondary piston.
- 3. Insert the secondary piston assembly, actuator end first, into the master cylinder bore and press assembly to the bottom of the bore.

Lubricate the primary piston assembly with clean brake fluid. Insert the primary piston assembly, actuator end first, into the bore.

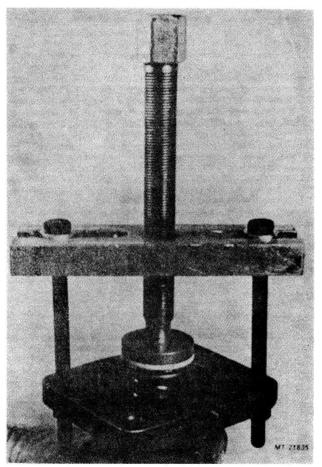


Fig. 6 Depressing Primary Piston With Puller

- 4. Lubricate the primary piston assembly with clean brake fluid. Insert the primary piston assembly, actuator end first, into the bore.
- 5. Assemble a cross bar type puller similar to SE 1368 on the end of the master cylinder using two 3/8" x 5 1/2" bolts. Position the piston retainer snap ring around the puller center bolt. Thread the center bolt down on piston forcing it into the master cylinder bore (Fig. 6).

Prior to installing the puller on the master cylinder be sure to check the center bolt end so that it will not damage the tapered sides in end of piston. Do not allow the piston to turn when compressing the piston into cylinder boie. Allowing the piston to rotate could result in damage to piston seals.

- 6. Install the retaining ring in the groove in the cylinder bore.
- Install the compensating valve seals and the small "O" ring seal in the recesses on the bottom of the reservoir. Be sure that all seals are fully seated.
- 8. Holding pistons depressed approximately 25.4mm (1") by using tool shown in Fig. 6, assemble the compensating valve springs and the compensating valve poppets and piston stop pin in the compensating valve ports and stop pin hole.
- Holding the pistons compressed, position the reservoir on the master cylinder body and secure with the four mounting bolts. Tighten the bolts to 22-41 Nm (16-30 ft. lbs.).
- 10. Remove the puller assembly from the master cylinder. Do not permit piston to rotate when removing puller.
- 11. Install residual valve assemblies and press tube seats into outlet ports with tube nut.

WHEEL CYLINDERS

Wheel cylinders should be reconditioned whenever brake lining is replaced because of the following:

- 1. As lining wear, wheel cylinder rubber cups move back and forth over a new, widened smooth area.
- Corrosion and foreign matter builds up on the part of the cylinder walls where cups do not work.

- 3. When new thick lining is installed, cups are pushed closer together and must function over the roughened surface.
- 4. Since cups no longer seat against smooth cylinder walls, they allow fluid to leak out.

DISASSEMBLY

Wheel cylinders are disassembled by removing the dust boot, then the piston or pistons, cup or cups, depending upon style of cylinder (refer to Chapter II, Figs. 16 and 17), then remove piston spring.

CLEANING AND INSPECTION

The instructions for cleaning and inspection are the same as that listed in the Master Cylinder portion of this text.

REASSEMBLY

These instructions pertain to a double piston type wheel cylinder. A single piston type wheel cylinder will be reassembled in a similar manner.

To reassemble wheel cylinder, wet cylinder bore and dip new pistons and cups in clean brake fluid.

Refer to Fig. 7 for key numbers in parenthesis.

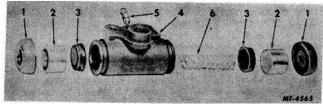


Fig. 7 Wheel Cylinder (Exploded View)

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Legend	ш	FIG.	,

Key	<u>Description</u>
1	BOOT
2	PISTON
3	CUP, Piston
4	CYLINDER, Wheel
5	VALVE, Bleeder
6	SPRING

IMPORTANT

Do not handle hydraulic system parts with greasy hands or permit parts to come in contact with mineral oil or grease.

Install spring (6) into wheel cylinder bore (4). Install a new cup (3) in each end of cylinder bore with cup lips toward spring.

Insert a piston (2) in each end with piston flat side against cup. Install new rubber boot (1) on each end of cylinder being certain that boot is positioned in groove on ends of cylinder (4).

Install bleeder screw (5) in cylinder body. Plug hydraulic fluid inlet to prevent the entrance of foreign material until installation.

ELECTRIC HYDRAULIC PUMP, FLOW SWITCH AND PRESSURE DIFFERENTIAL VALVE

The electric hydraulic pump, flow switch and pressure differential valve assemblies are serviced only as assemblies, therefore disassembly and reassembly of these components are not required. However, pay special attention to the instructions for cleaning and inspection of these components as outlined.

The brake warning light switch on the pressure differential valve is a serviced item and may be replaced.

Clean these components by wiping with cloth moistened with alcohol. Do not immerse in denatured alcohol, power steering fluid or brake fluid. Be sure to cap or plug all openings to avoid contamination.

HY-POWER BOOSTER

DISASSEMBLY (Fig. 8)

- Holding the unit over a suitable container, pull out the piston rod using a twisting motion (by hand, not pliers). Turn the end of the Hy-Power unit down to drain any fluid from the piston rod opening.
- Remove the flow switch (if not previously removed) using a 25mm (1") open end wrench (Fig. 3). Remove the O-ring seal from the flow switch.
- 3. Pull off the rubber boot.
- Support the unit in a vise, with electric hydraulic (EH) pump up, by clamping on the body flange at the push rod end.
- Remove the bolt and lock washer attaching the EH pump motor support strap to the Hy-Power body (Fig. 2).
- Remove the two bolts and washer attaching the EH pump to the Hy-Power body (Fig. 2) and lift off the pump. Remove the two

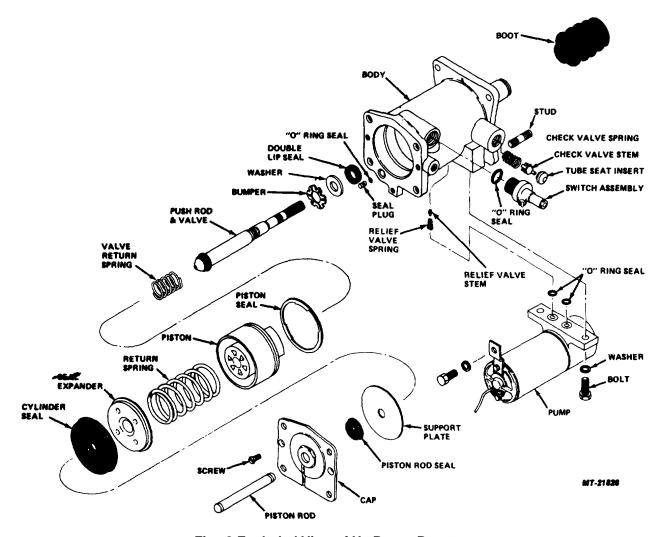


Fig. 8 Exploded View of Hy-Power Booster

O-ring seals. Do not attempt to disassemble the EH pump. It is serviced only as an assembly.

- 7. Remove the relief valve spring and the relief valve from the Hy-Power body at the pump mounting boss.
- 8. Reposition the booster in the vise with the cap end up. Install two 3/8 UNC x 5" bolts as shown in Fig. 9. Thread the bolts into diagonally opposite master cylinder mounting holes in the body until the ends of the bolts appear at the bottom of the body flange.

CAUTION

Make sure that bolts are securely in place before removing the screws attaching the cap as directed in the next step. The piston return spring is under a 134N (30 lbf) load and injury could result if the cap screws are removed without retaining the cap. The cap will in turn retain the spring (spring (Fig.10).

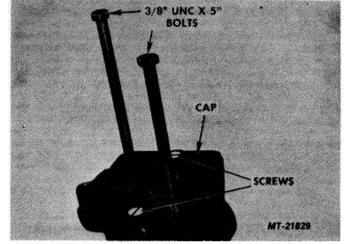


Fig. 9 Install Cap Retaining Bolts

9. Remove the two flat head screws attaching the cap to the body, allowing the cap to rise and the return spring to expand. If

support plate, cylinder seal and seal expander do not free themselves under the spring pressure, lift the cap with 5" bolts in place; with both hands over support plate and seal push down on one side of seal. Then allow the spring to free seal and expander (Fig. 10). After spring is completely relaxed, the two 5" long bolts retaining the cap may be removed (Fig. 11).

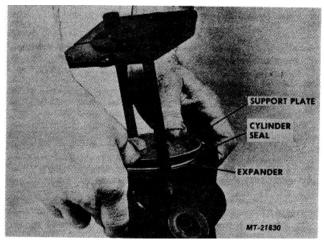


Fig. 10 Removal of Support Plate, Cylinder Seal and Expander

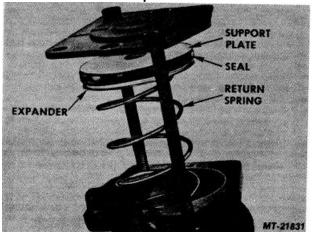


Fig. 11 Return Spring Relaxed

- 10. Remove the cap, support plate, cylinder seal, seal expander and return spring from the body. Remove the piston rod seal from the cap.
- 11. Reach into the body and remove the piston assembly. Remove the piston seal from the piston assembly. The piston assembly will be disassembled later.
- 12. Reach in the Hy-Power body and withdraw the valve return spring.

- 13. Press on the threaded end of the push rod and valve and remove from the body with a slight twisting motion. Remove the bumper from the push rod and valve.
- 14. Remove the double lip seal from body using seal removing tool SE2769 (Fig. 12).

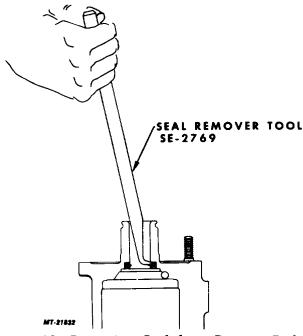


Fig. 12 Removing Seal from Booster Body

15. Form a remover tool from stiff wire or rod, similar to that shown in Fig. 13, and insert it into the by-pass port inside booster body and pull by-pass plug from booster body.

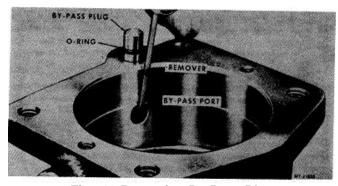
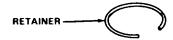


Fig. 13 Removing By-Pass Plug

16. Use a screw extractor to remove the tube seat insert. Then, remove the check valve stem and check valve spring.

17. Disassemble power piston by positioning piston on a bench (Fig. 14). Then remove the valve seat retainer and valve seat.





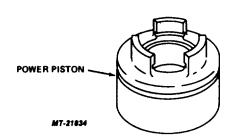


Fig. 14 Exploded View of Power Piston

CLEAN AND INSPECTION

Do not immerse the electric-hydraulic pump or flow switch in denatured alcohol or power steering fluid. Clean only by wiping with a clean cloth moistened with alcohol.

Clean metal parts (except flow switch and EH pump) in denatured alcohol or clean power steering fluid. Do not use brake fluid or any other solvent to clean Hy-Power booster parts. Use dry, filtered compressed air (NOT lubricated shop air) to dry parts and blow out all passages in the body.

A repair kit which contains all rubber parts is available for service requirements and these shall be replaced at overhaul.

Visually inspect parts for excessive wear or damage that would affect serviceability or cause leakage. Pay particular attention to the following:

- Check all parts for cracks, distortion or any other evidence of structural damage. Check threaded parts for stripped, crossed, or otherwise damaged threads.
- Check the piston OD and the mating bore in the body for scoring, nicks, burrs or corrosion. If power piston and/or body are damaged,

- complete replacement of Hy-Power unit will be required since they are not serviced separately. Likewise, inspect the cylindrical section of the push rod and valve and the piston rod and their mating bores in the body and cap.
- Check the conical seating surface on the push rod and valve for nicks, burrs or corrosion. Inspect the mating seat in the valve seat in the same manner.
- 4. Check that the ball joint in the push rod and valve is free to swivel within its limits but that there is not perceptible evidence or wear when the two sections of this assembly are pushed together or pulled apart. Also make sure that the stop staked to the valve near the conical end is not loose.
- 5. Check the mating surfaces of the body and the EH pump for nicks, burrs, or other damage that would cause leakage.

Repair shall be limited to the replacement of damaged or excessively worn parts. Do not attempt to rework or use abrasives in any form to remove surface defects from internal parts or surfaces.

- Replace the flow switch or EH pump if either part leaks or fails to operate properly. No repairs are authorized for these units.
- 2. Replace all rubber parts and other parts included in the repair kit at each overhaul.
- 3. Replace damaged studs. in body.

IMPORTANT

The Hy-Power booster operates on power steering fluid only. Before beginning assembly, make sure that all parts are clean and free from contamination from any other fluids. Use only new rubber parts from the repair kit. Lubricate parts at assembly with fresh, clean power steering fluid only.

REASSEMBLY

Refer to Fig. 8, exploded view of power booster.

 Assemble power piston assembly. Refer to Fig. 14 and position piston on a clean work area. Place the valve seat in the power piston. Work the retainer down into the piston groove using a suitable punch (Fig. 15).

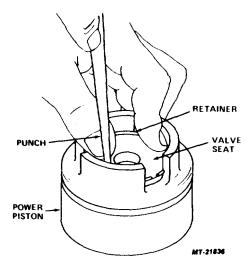


Fig. 15. Installing Power Piston Retainer.

- 2. Place the check valve spring and check valve stem in the body and install the tube seat insert. Be sure that the check valve stem is positioned as shown on the exploded view. Use a spare tube nut to press in the tube seat insert, tightening down the nut until the insert bottoms out in the body. Remove the nut and check the body port for any burrs that might have turned up.
- 3. Lubricate the O-ring with clean power steering fluid and install it in the groove in the seal plug. Press the seal plug into the bottom opening.
- Lubricate the double lip seal with clean power steering fluid. Install seal in machined area in the valve bore in the body using seal installer tool SE2770 (Fig. 16).
- Install a new bumper on the push rod and valve (Fig. 17). Start the bumper over the threaded end and slide it up against the retainer at the valve end.
- 6. Install the push rod and valve, threaded end first, through the large piston bore and into the valve bore in the body. After the valve portion of this assembly enters the valve bore, use a twisting motion to work the valve through the seal. Make sure the valve moves freely back and forth in the bore and then press into position.
- 7. Install the valve return spring over the nose of the valve.
- Lubricate a new piston seal with clean power steering fluid and fit it into the groove in the power piston assembly.

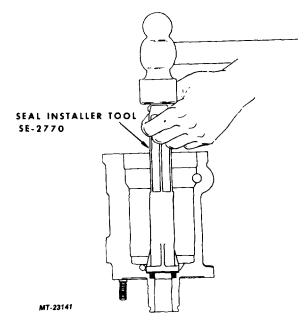


Fig. 16. Installing Double Lip Seal.

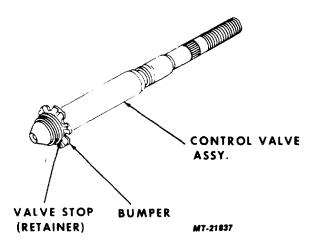


Fig. 17. Bumper Installation on Push Rod.

- Install the power piston assembly in the body bore. Make sure the piston goes into the body in the direction shown on the exploded view (Fig. 8). Press the piston in to bottom of the bore.
- 10. Position the body in a vise with the large bore up and install the return spring.
- 11. Lubricate the piston rod seal with clean power steering fluid and install in the groove in the cap. The lips of the seal must point to the inside of the cap (as it will be installed on the body).

- 12. Lubricate the cylinder seal inside and outside diameters with clean power steering fluid. Position the support plate, cylinder seal and seal expander against the cap as these parts will be installed in the body. Position these components over the body on the return spring. Make sure the cap is positioned relative to the body, drain groove to bottom of unit as mounted on vehicle.
- 13. Thread two 3/8" UNC x 5" bolts through the cap into diagonally opposite master cylinder body mounting holes in the body until the ends of the bolts appear at the bottom of the body flange. Push support plate cylinder seal and seal expander into body bore with cap, compressing the spring. As the seal expander, cylinder seal and cap are about to enter the body, make sure they do so without binding on the side of the body bore. If any restriction is felt, back off, realign parts and try again. (Refer to Figs. 9, 10 and 11).

(Sometimes, gently shaking the cap as it enters the body will help to align parts so that they will enter the body bore without binding).

- 14. Force parts into the body far enough to permit metal-to-metal contact between the cap and the body. Install and tighten the two flat head screws and remove the two 5/8" bolts.
- 15. Install O-rings in the two pump flange grooves.
- 16. Reposition the Hy-Power unit in the vise so that the EH pump mounting flange is facing up. Install the relief valve into the body bore, notched end first. Make sure relief valve is seated in bore. Position the small O.D. of the relief valve spring into the body over the relief valve. Then position the EH pump on the body. Install attaching bolts and tag. Torque to 22-41 Nm (16-30 lb. ft.).
- 17. Install the pump m6tor bracket attaching bolt and torque to 11.2-15.3 Nm (99-135 lb. in.).
- 18. Install the boot with the large ID head directly in the groove in the body nose.
- Place new O-ring over threaded end of flow switch. Install the flow switch. Torque to 27-41 Nm (20-30 lb. ft.).
- 20. Lubricate the piston rod with clean power steering fluid and install it through the hole in

the cap using a twisting motion, Push the piston rod in until it seats in the piston.

GAUGING POWER PISTON ROD

After the Hy-Power booster is reassembled, check the piston rod extension with the go/no-go gauge (SE2768 tool) (Fig. 18) as follows:

- 1. Support the Hy-Power unit in a vise, piston rod end up. Press down firmly on the end of the piston rod to make sure that the rod and other internal parts are bottomed out. Release slowly.
- 2. Position the gauge over the piston rod. Extension of rod is to be within limits.
- If piston rod is not within limits, you may have improperly reassembled the booster. Be sure piston rod is pressed down firmly to be sure it is seated. If rod is not within limits, the booster must be disassembled and rechecked for proper assembly.

BRAKE PEDAL ADJUSTMENT

The brake pedal adjustment is at the booster control valve (push rod) and clevis. Proper pedal height (travel) will be obtained when the clevis is adjusted to 177.8 mm (7") between booster mounting surface and clevis center opening.

STOP LIGHT SWITCH ADJUSTMENT

The stop light switch should be adjusted (Fig. 19) so that the clearance between the switch body (not plunger) and pedal lever is 3.048 mm (0.12"), when the brake pedal has been properly adjusted.

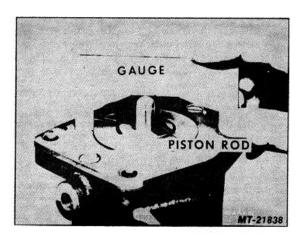


Fig. 18. Gaging Power Piston Rod.

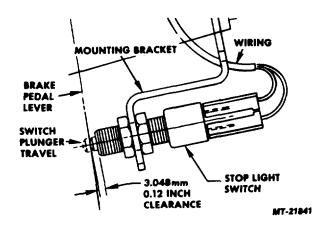


Fig. 19. Stop Light Switch Adjustment.

PARK BRAKE SWITCH ADJUSTMENT

The park brake switch is located at the park brake control lever mechanism (Fig. 20)and should be adjusted (Fig. 21) so that the clearance between the switch mounting bracket and end of switch body is 6.35 mm (.25"). Do not include plunger travel.

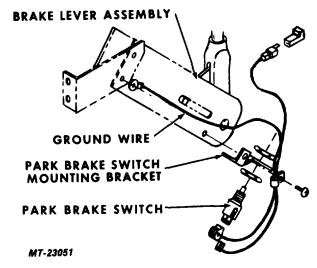


Fig. 20. Park Brake Switch Installation.

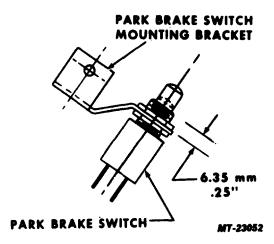


Fig. 21 Park Brake Switch Adjustment.



CHAPTER IV BLEEDING BRAKE SYSTEM AND ROAD TEST

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GENERAL

The Hy-Power brake installation consists of two separate and distinct hydraulic systems, one serviced with power steering fluid and the other with hydraulic brake fluid. Either or both of these systems shall be bled:

- 1. If trouble-shooting indicates the cause to be air in either or both systems.
- 2. If any component in either or both systems is removed for repair or replacement.
 - (If the Hy-Power booster and master cylinder are removed together as a unit, then both the power steering fluid and brake fluid systems must be bled).
- 3. If any hose, tube line or fitting in the system is disconnected for any reason.

CAUTION

When bleeding, take care to identity fluids power steering fluid or brake fluid and use only in the proper operating system. Discard all fluid bled or drained from either system. Do not use for refill, cleaning or any other purpose. Failure to observe these precautions could result in failure of the brake system. with resultant personal injury or property damage.

The hydraulic brake system must be free of air to function properly. If air becomes mixed with brake fluid, loss of pedal reserve will result since air in the hydraulic system compresses. On most brakes, a bleeder valve (screw) is provided at each wheel cylinder for removal of any air in the hydraulic brake system. If air should become mixed within the booster system.

If air should become mixed within the booster system, sluggish brake response will result.

Bleeding the brake system consists of forcing brake fluid and any air in the brake fluid out of the hydraulic system at one or more bleed points. There are two methods of bleeding the hydraulic brake system; manual bleeding and pressure bleeding. For either method of bleeding, a supply of clean hydraulic brake

fluid is necessary. Do not reuse brake fluid that has been drained from the hydraulic brake system, as the fluid may be contaminated or contain dirt.

It is recommended that hydraulic system be thoroughly flushed whenever repairs are performed to be assured that hydraulic fluid is not contaminated.

Before bleeding the brake system, the brake light warning switch must be removed to prevent shearing end of pin. Unequal pressure between the split sections of brake system during bleeding could cause warning light switch pistons to shift from side to side and shear switch pin. If pin is sheared off, the body must be disassembled, end of pin removed and a new switch installed.

Prior to removing warning light switch, be sure to remove any dirt accumulation around warning switch to avoid entrance of dirt. Refer to RESETTING BRAKE WARNING LIGHT SWITCH INSTRUCTIONS found in Chapter II.

To flush the system, use bleeding procedures outlined herein and flush new brake fluid through system until it appears clean.

The order in which wheel cylinders are bled normally does not affect the quality of the bleeding operation. The following sequence is recommended however, to reduce the possibility of missing a wheel cylinder: right rear, left rear, right front, left front.

BLEEDING THE HY-POWER SYSTEM

Required Procedures

The following procedures, done in the order given, are required to bleed the Hy-Power system.

Before bleeding the system, be sure that all hose clamps, line connectors and fittings are tight enough to prevent the entry of air into the system or fluid leaks. Have enough power steering fluid to maintain fluid in the reservoir at all times during the bleeding procedure.

- 1. Set parking brakes.
- 2. Remove the drag link, at pitman arm, on vehicles with power steering.

Use only power steering fluid recommended in LUBRICATION Section (CTS-2412) of Service Manual.

3. Fill the reservoir to within 12.7mm (1/2") of the top.

(On models using a remote mounted reservoir, fill the reservoir as described above and then squeeze the hose starting at the pump and working up to the reservoir. This will help eliminate air trapped in the hose).

DO NOT INSTALL THE RESERVOIR CAP DURING THE BLEEDING PROCEDURE

If the engine is stopped during the bleeding operation, power steering fluid will be forced out the top of the reservoir.

A modified reservoir cap can be placed on the reservoir just prior to stopping the engine to direct any overflow into a container.

- 4. To prevent the entry of air into the system, have a person ready to pour power steering fluid into the reservoir the moment the engine starts. Start the engine and add as much fluid as necessary to keep the level in the reservoir above the pump intake passage.
- 5. When the engine idle and reservoir fluid level has stabilized, pump the brake three or more times to eliminate air from brake booster. Add as much fluid as necessary to keep the level in the reservoir above the pump intake passage.

IMPORTANT (Vehicles With Power Steering)

Do not turn steering gear hard or fast against gear stops. Excessive force or speed can cause high hydraulic pressure or fluid overheating. This may damage the steering gear and/or power steering fluid pump.

6. With the engine at idle speed, on vehicles with power steering, slowly turn the steering wheel as far as it will go in one direction lightly against gear stop. Reverse steering wheel direction 1/2 turn and then back again lightly against gear stop. Repeat this five times and then turn the steering wheel as far as it will go the opposite direction and lightly bump the gear stop five times.

Maintain oil level in reservoir above the pump intake passage. Turn the steering wheel to the center position and let the engine idle for a few seconds while installing the overflow cap. Turn off the engine for at least one minute to allow air to bubble out through the improvised overflow cap.

- Remove overflow cap, restart engine and add oil as necessary to maintain oil level above the pump intake passage.
- 8. Repeat the procedures given in steps 3, 4, 5 and 6 as needed (four to five times) until there is not more than one inch rise in reservoir fluid level with engine stopped and reservoir cap off. Steps 9, 10 and 11 pertain to vehicles with power steering.
- Start engine and center steering by turning the wheel from one gear stop to the opposite counting the number of turns. Turn steering wheel half the turns back to center and shut off engine.
- 10. Connect drag link to pitman arm.
- 11. Start engine and idle at 1500 rpm and turn wheels right and left lightly against wheel stops continuing for two minutes. This should eliminate any air left in the system. Shut off engine, check for leaks and fill reservoir to final fill as marked on integral reservoir or on remote reservoir and install reservoir cap.

PRESSURE BLEEDING BRAKE SYSTEM

If both the brake fluid system and booster system require bleeding, bleed the booster system first using instructions provided in this Chapter.

A pressure bleeder and master cylinder adapter for connecting the bleeder to master cylinder reservoir is necessary. An adapter plate is required to maintain fluid level during brake bleeding.

Hydraulic brake fluid level should be 6.4 to 12.7 mm (1/4" to 1/2") from top of master cylinder reservoirs. If when pressure bleeder adapter plate is removed, fluid level is too high to too low, add or remove sufficient fluid to bring to correct level.

Be sure there is enough brake fluid in

bleeder tank to complete bleeding operation and tank is charged with air pressure of 69 to 207 kPa (10-30 psi).

Remove reservoir cover and attach pressure bleeder hose to master cylinder using proper adapter. Open valve in pressure bleeder hose and bleed all air out of the hose before connecting it to the adapter. Close valve after making this connection. Then open the valve when ready to begin bleeding to pressurize master cylinder and hydraulic system.

CAUTION

Do not lift, move or shake the tank after air pressure is applied. This may cause sediment at the bottom of the tank to go in suspension in the brake fluid, which may result in early failure of tile brake system.

Bleeding Sequence Be sure to remove the brake warning light switch.

Always begin with the master cylinder, bleeding at both service line nuts. Then, bleed the wheel units, longest line first, beginning with the right-rear. Next bleed the left-rear, and so on working through all of the units and concluding with the left-front service brake.

Attach a bleeder tube (hose) to right rear wheel cylinder bleeder valve (screw). Submerge the free end of the hose in a glass jar partially filled with brake fluid. Loosen bleeder valve approximately three-quarter turn.

When fluid coming from the submerged end of the hose is free of air bubbles, close bleeder valve and remove drain hose. Repeat this procedure at each wheel cylinder.

When bleeding operation is completed, close valve in pressure bleeder #hose. Enclose connection with shop towel and disconnect pressure bleeder and adapter from master cylinder.

Check hydraulic fluid level to see that both reservoirs are filled to 6.4 to 12.7 mm (1/4" to 1/2") from top edge.

Install master cylinder reservoir cover and diaphragm; secure cover to master cylinder.

MANUAL BLEEDING BRAKE SYSTEM

Fill the nester cylinder fluid reservoirs with clean brake fluid.

Bleeding Sequence

Be sure to remove the brake warning light switch. It is suggested tat the electrical leads to the electric hydraulic pump be disconnected during the manual bleeding to avoid needless pump operation. Begin with the master cylinder by loosening the service brake line nuts with steady pressure applied to brake pedal. When all air has been bled from master cylinder move to wheel units, longest line first, beginning with right rear brake group. Next bleed left rear and so on completing the bleeding of all units and concluding with the left front service brake.

Attach a bleeder tube (hose) to right rear wheel cylinder bleeder valve (screw). Submerge free end of hose in brake fluid in a partially filled glass jar.

Apply steady pressure to brake pedal and open bleeder valve. When fluid coming from submerged end of hose is free of air bubbles, close bleeder valve and release brake pedal. If pedal goes to toe board while bleeding a wheel cylinder without removing all air bubbles, close bleeder valve and release pedal slowly. Repeat bleeding operation at this same wheel cylinder until clean fluid, free of air bubbles, flows from the submerged end of drain hose. Repeat same procedure at each wheel cylinder until all air is expelled from system. Check level of brake fluid in master cylinder frequently during bleeding operations and keep master cylinder reservoirs at least half full.

Be sure to check the brake fluid level frequently during bleeding procedure. Always use clean, fresh specified fluid.

After completing the bleeding operation be sure that master cylinder reservoirs are filled to 6.4 to 12.7 mm (1/4" to 1/2").



ROAD TEST

IMPORTANT

Before road testing a vehicle, depress brake pedal to be sure there is adequate reserve pedal. Make a series of low speed stops to be sure brakes are functioning.

Road test vehicle and check general operation for the following:

- 1. Low Pedal
- 2. Vibrating Pedal
- 3. Spongy or Springy Pedal
- 4. Hard Pedal
- 5. Drag
- 6. Fade
- 7. Pull
- 8. Grab
- 9. Squeal or Other Abnormal Noise
- 10. Lock
- 11. Sluggish Response

If any of the above conditions are noted, refer to TROUBLE SHOOTING CHART (Chapter V) and perform required service to correct problem.

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CHAPTER V TROUBLE SHOOTING

The following trouble shooting guide may be used as an aid for determining the type of brake service required. This guide also lists the possible conditions and corrections.

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CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
PARK BRAKE LIGHT			
Key switch in	Light ON	Normal function of system (Bulb Check)	None.
START position	Light OFF	Defective bulb, diode or ignition switch	Replace bulb, diode or ignition switch.
		Defective indicator light ground relay (push button start only)	Replace defective indicator light ground relay.
Key switch ON engine	Light ON	Normal function (Bus only)	None.
OFF w/Brake Application	Light ON (12000 miles)	Faulty EGR rectifier	Replace EGR rectifier assembly.
BRAKE PRESSURE L	лент		
Key switch OFF	Light OFF, electric hydraulic pump operates when service brakes are applied	Normal function of system	None.
	Light ON and EGR Service Light ON	Faulty EGR rectifier	Replace EGR rectifier assembly.
	Electric hydraulic pump operates all	Magnetic switch stuck in closed position	Replace magnetic switch.
	the time	Faulty EGR rectifier assembly	Replace EGR rectifier assembly
Key switch in	Light ON	Normal function of system (Bulb Check)	None.
ON position engine not operating	Light ON hydraulic pump operates when service brakes are applied	Normal function of system	None.
Key switch in ON position,	Light OFF	Normal function of system	None.
engine operating service brakes applied	Light ON	 Loss of hydraulic boost assist Flow switch not operating 	 Hydraulic pump belts loose or broken; Adjust or Replace. Check for shorted flow switch with engine operating.
			Check for contaminated flow switch. Replace flow switch.
Key switch in START position	Light ON momentarily and electric hydraulic pump operates	Normal function of system	None.



CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
BRAKE PRESSURE L	JGHT		
Key switch in ON	Light OFF	Normal function of system.	None.
position and engine operating with service brakes applied	Light ON (electric hydraulic pump will be actuated w/light ON)	 Loss of hydraulic boost assist Flow switch not operating 	 Hydraulic pump belts or hoses broken or loose; adjust or replace. Air in boost system; refill and bleed system. Check for short or contamination or
аррпец	ON)	·	replace switch.
		Brake pressure differential valve (switch) closed	3. Faulty warning switch or loss of one side of split brake system (Refer to Hydraulic Brake portion of guide).
ELECTRIC HYDRAUL Inoperative	IC (EH) PUMP Will not operate when brakes are applied w/engine	Battery condition low	Try to start engine. If engine will not crank, check condition of battery/ies and terminals. Correct abnormally low battery and/or clean terminals.
	not operating	Low or no voltage at EH pump motor connection	Check voltage at EH pump (11-14V), If voltage is within specs proceed to Non Functioning Motor.
		3. Loose feed stud connections	3. Clean and tighten feed stud connections.
		4. Faulty circuit breaker	4. Replace.
		5. Stop light switch	5. Check stoplight switch adjustment and continuity.
		6. Flow switch	6. Check continuity through flow switch.
		7. Low voltage at pump ground relay	7. Check voltage at stoplight side (cir. 90J) of pump ground relay with brakes applied. (Spec. 11-14V).
		8. Low voltage at magnetic switch	8. Check voltage at both "S" terminals (Spec. 11-14V).
		No voltage supply to electric hydraulic pump	9. Check voltage (Spec. 11-14V) of EH pump terminal (B) at magnetic switch.
		10. Faulty component	10. Replace faulty component.
		11. Non functioning motor	11. Check electrical connection between motor lead wire and harness. If loose, corroded, or disconnected, clean and secure connection. Check grounding of pump housing to booster. Housing
			must be bolted securely to booster to provide a ground. Replace EH pump assembly.



CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
ELECTRIC HYDRAULIC (EH) PUMP (Cont'd.)			
Operates	In start mode	Normal function	None
·	Little or no boost	1. Faulty pump	Replace EH pump.
		Relief valve not assembled (properly)	Assemble relief valve properly.
Operates	Key switch ON or	Improper adjusted stop light switch	Adjust stop light switch or replace.
Continuously	OFF	Stuck pump ground relay	2. Replace pump ground relay.
		3. Faulty EGR rectifier (12,000 miles)	Replace EGR rectifier assembly.
Pump noise	Excessive gurgle,	Trapped air in pump	Depress brake pedal lightly with the engine off for
	chatter, etc.		thirty seconds and re- lease. Recheck and should
			the problem persist, repeat above procedure
			after a three minute waiting period. This noise will
			diminish upon continued use of the brakes
0:11			under normal driving conditions.
Oil leakage	At booster and EH	Damaged or missing O-rings at pressure	Replace two O-rings.
	pump mating surface	and/or return port	Barlana Ellanona acceptata
	At pump end plate	Damaged or missing end plate seal	Replace EH pump assembly.
BOOSTER	From EH pump motor	Damaged shaft seal	Replace EH pump assembly.
Sluggish	Sluggish operation	Air in booster hydraulic system	Bleed hydraulic system.
Siuggisii	Siuggisii operation	Restricted hose or line	2. Check for pinched or kinked hose or line.
		3. Faulty booster	3. Remove and disassemble booster.
		3. Tadity booster	Examine and replace all worn parts
		4. Contaminated power steering fluid	4. Replace power steering fluid.
HYDRAULIC (POW	/ER STEERING) PUMP	4. Contaminated power steering hald	4. Replace power steering raid.
Noise	Pump noise	1. Loose belt	1. Tighten belt.
	p	Lines touching other parts of chassis	2. Adjust line position.
		3. Low oil level	3. Fill reservoir.
		4. Aerated fluid	Check fluid level. Locate source of air leak
			and correct. Bleed hydraulic system.
		5. Contaminated hydraulic fluid	5. Replace fluid and bleed system.
		6. Excessive back pressure caused by	Locate restriction and correct.
		lines or booster head	Bleed system.
		7. Internal damage to pump	7. Overhaul or replace pump.
Leakage	Leaks at the reservoir	Ring seal cut	1. Replace "O" ring seal.
		2. "0" ring improperly installed	Install seal properly.



CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
HYDRAULIC (Power	Steering) PUMP (Cont'd.)		
Leakage	Leaks at top of the Reservoir	 Reservoir too full Air in the oil 	 Fill to proper level. Locate source of air leak and correct. Bleed system.
	Leaks at the pressure fitting or mounting stud Leaks at the shaft seal Leaks in metal parts	 Not tightened sufficiently Cross threaded or damaged seat Defective seat on hose end Damaged seals Defective seal Damaged shaft Poor casting 	1. Torque to 41-54 Nm (30-40 ft. lbs., 2. Replace damaged part. 3. Replace hose. Bleed system. 4. Replace seals. 1. Replace seal. 2. Replace shaft. 1. Replace defective parts.
Poor or loss of assist (sluggish)	Pump inoperative or poor to no assist	 Loose drive belt Low oil level Air in the oil Defective lines or booster Internal damage to pump 	 Tighten belt. Fill reservoir to proper level. Bleed system. Locate source of air leak and correct. Bleed system. Overhaul or replace. Overhaul or replace pump.
	Relief valve leaking	Relief valve not assembled properly Relief valve spring failed	Reassemble relief valve properly. Replace relief valve spring.
BOOSTER AND/OR Leakage	MASTER CYLINDER At master cylinder mounting	Booster or master cylinder leaking	Determine if leakage is hydraulic brake fluid or hydraulic booster fluid. If brake fluid; repair or replace master cylinder. If booster fluid; repair or replace booster.
	At-booster to dash panel mounting	Booster leaking	Repair or replace booster.
	At flow switch	Damaged "O" ring Faulty flow switch	Replace "O" ring. Replace "O" ring and flow switch.



CONDITION	DESCRIPTION	POSSIBLE CAUSE		CORRECTION
Low Pedal	Pedal may go to floor under steady pressure	Leak in hydraulic brake system	1.	Check master cylinder, wheel cylinders, calipers, tubes and hoses for leakagerepair or replace faulty parts.
	process	2. Air in hydraulic brake system	2.	Bleed hydraulic system.
		3. Poor quality brake fluid (low	3.	Drain hydraulic system and fill
		boiling point).		with approved brake fluid.
		4. Low brake fluid level.	4.	Fill master cylinder and bleed hydraulic system.
		Weak brake hoses that expand under pressure.	5.	Replace defective hoses.
		6. Improperly adjusted pedal push rod.	6.	Adjust push rod.
		7. Excessive clearance between drums and linings.	7.	Adjust brakes.
		8. Automatic adjusters not working	8.	Make several forward and reverse brake stops; if pedal does not come up, repair automatic adjusters.
		Bent or distorted brake shoes	9.	Replace shoes and linings in axle sets.
	Pedal may go to floor on first application only	Residual pressure check valves not holding pressure in lines	1.	Repair or replace master cylinder.
Springy or	Pedal has a soft,	Poor quality brake fluid (low	1.	Drain hydraulic system and fill
Spongy Pedal	springy or spongy	(boiling point).		with approved brake fluid.
	feel when depressed	Weak brake hoses that expand under pressure	2.	Replace defective hoses.
		3. Air in hydraulic system	3.	Bleed hydraulic system.
		4. Bent or distorted brake shoes	4.	Replace shoes and linings in axle sets.
		5. Cracked or thin drums	5.	Replace drums in axle sets.
Hard Pedal	Excessive pedal	Poor quality brake linings and brake	1.	Replace with approved shoes and
	pressure is	fade. **		linings in axle sets.
	required to stop	2. Grease or brake fluid soaked linings	2.	Repair grease seal, wheel cylinder
	vehicle			as necessary and replace shoes,
				linings in axle sets.
		3. Glazed linings	3.	Sand lining surface or replace
				shoes and linings in axle sets.
		Damaged or distorted shoes	4.	Replace shoes and linings in axle sets.

^{** -} Fade is a temporary reduction of brake effectiveness resulting from heat.



CONDITION	DESCRIPTION		POSSIBLE CAUSE		CORRECTION
Hard Pedal (Cont'd.)	Excessive pedal pressure is required to stop vehicle (Cont'd.)				
		5.	Scored, barrel-shaped or bell-mouthed	5.	Refinish or replace drums in
			drums		axle sets.
		6.	Faulty power brake system	6.	Check power steering fluid pump belt. Check output pressure of power steering fluid pump. Install gage in inlet line to Hy-Power unit. Gage should read at least 6,175 kPa (750 psi) before pedal becomes hard to push. Check to insure pedal travel is not being interfered with under dash or in linkage. Disassemble Hy-Power unit and examine all internal parts.
		7.	Clogged master cylinder tubes	7.	Replace tubes or hoses, as
			or hoses		necessary.
		8.	Frozen master cylinder piston(s)	8.	Repair or replace master cylinder.
<u>Grabby Brakes</u>	Severe reaction to pedal pressure	1.	Rough or corroded master cylinder bore	1.	Repair or replace master cylinder.
		2.	Binding brake pedal linkage	2.	Free up and lubricate.
		3.	Faulty power brake	3.	Replace power section of power brake.
		4.	Incorrect or distorted shoes	4.	Replace with correct shoes and linings in axle sets.
		5.	Incorrect linings or linings loose on shoes	5.	Replace with correct shoes and linings in axle sets.
		6.	Grease on brake fluid on linings	6.	Repair grease seal or wheel cylinder as required. Replace shoes or lining in axle sets.
		7.	Loose or distorted brake backing plate.	7.	Tighten or replace backing plate.
		8.	Scored, hard spotted or out-of-round drums	8.	Refinish or replace drums in axle sets.



CONDITION	DESCRIPTION		POSSIBLE CAUSE		CORRECTION
Vehicle Pulls to		1.	Faulty suspension parts	1.	Repair suspension system.
One Side		2.	Incorrect or distorted shoes	2.	Replace with correct shoes and lining in axle sets.
		3.	Incorrect lining or loose lining on shoes	3.	Replace with correct shoes and in axle sets.
		4.	Grease or brake fluid on linings	4.	Repair grease seal or wheel cylinder as required. Replace shoes and lining in axle sets.
		5.	Shoes not centered in drums	5.	Adjust anchor pins (if equipped with adjustable anchor pins).
		6.	Loose or distorted brake backing plate	6.	Tighten or replace backing plate.
		7.	Scored, hard spotted or out-of-round drums, or different sized drums on same axle	7.	Refinish or replace drums in axle sets.
		8.	Water on linings	8.	Apply brakes a few times to dry linings.
		9.	Sticking wheel cylinder piston	9.	Repair or replace wheel cylinder.
Pulsating		1.	Worn or damaged front wheel bearings	1.	Replace bearings.
Brake Pedal		2.	Out-of-round drums	2.	Refinish or replace drums in axle sets.
Noise and Chatter	Squealing, clicking or scraping sound upon brake	1.	Bent, damaged or incorrect shoes	1.	Replace with correct shoes and lining. Always replace in axle sets.
	application	2.	Worn out lining	2.	Replace shoes and lining in axle sets.
		3.	Foreign material imbedded in linings	3.	Replace shoes and lining in axle sets.
		4.	Broken shoe return springs, shoe holddown pins or shoe holddown springs	4.	Replace defective parts.
		5.	Rough, grooved or dry shoe ledges or pads on backing plate	5.	Smooth shoe ledges and pads and apply high temperature lubricant.
		6.	Cracked or threaded drums(lathe marks).	6.	Replace drums in axle sets.
Decreasing Brake		1.	Plugged master cylinder compensating port(s)	1.	Repair or replace master cylinder.
Pedal Travel		2.	Swollen master cylinder seals	2.	Repair or replace master cylinder, flush hydraulic system and fill with approved brake fluid.
		3. 4.	Weak. or broken shoe return springs Sticking wheel cylinder piston	3. 4.	Replace return springs. Repair or replace wheel cylinder.



CONDITION	DESCRIPTION	POSSIBLE CAUSE CORRECTION
All Brakes Drag	But brake adjustment is correct	 Binding brake pedal Soft or swollen rubber parts caused by incorrect or contaminated brake fluid Free up and lubricate. Replace all rubber parts, flush hydraulic system and fill with approved brake fluid.
		Plugged master cylinder compensating port(s). Repair or replace master cylinder.
Rear Brakes Drag		Improper brake shoe adjustment
One Brake Drags		 Loose or worn front wheel bearings Defective brake hose or hydraulic tube (preventing return of brake fluid). Adjust to specifications, or replace. Replace defective hose or tube, as necessary.
		 Weak or broken shoe return springs Improper brake shoe adjustment Adjust shoes and repair automatic adjusters, if necessary.
		5. Sticking wheel cylinder pistons 5. Repair or replace wheel cylinders.
		6. Swollen wheel cylinder cups 6. Repair or replace wheel cylinder Flush hydraulic brake system and fill with approved fluid.
		7. Bent or distorted brake shoes 7. Replace shoes and linings in axle sets.

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CHAPTER VI TORQUE CHART

BRAKE GROUP MOUNTING BOLT-NUT

Tighten the brake group mounting bolts to the torque values listed from the nut side. Since some of the mounting holes in the steering knuckles are of conical design, the knuckle bolts must utilize conical mounting nuts to coincide with the mounting holes in the knuckle. These conical nuts have a smooth cone surface and the torque values are considerably higher than the torque values for regular nuts or prevailing type lock nuts.

FRONT AXLE BRAKE GROUP MOUNTING BOLTS WITH CONICAL TYPE NUTS

TORQUE

Bolt Size	Newton-Meters (N.m)	Foot Pounds (ft.lbs.)
1/2"	135.6-162.7	100-120
5/8"	298.3-325.4	220-240

FRONT AND REAR AXLE BRAKE GROUP MOUNTING BOLTS WITH REGULAR NUTS OR PREVAILING TORQUE TYPE LOCK NUTS

TORQUE

Newton-Meters (N.m)	Foot Pounds (ft.lbs.)
74.6-81.4	55-60
115-129	85-95
155.9-169.5	115-125
216.7-237.3	160-175
373.0-406.7	275-300
	74.6-81.4 115-129 155.9-169.5 216.7-237.3

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BRAKES HYDRAULIC DUAL POWER BRAKE BOOSTER WITH SPLIT HYDRAULIC BRAKE SYSTEM

CODE 04055

For service information regarding the hydraulic pump not covered in this section, refer to the specific power steering pump section in the CTS-2001 Service Manual.

Service information pertaining to inspection and refinishing brake drums can be found in RECONDITIONING BRAKE DRUMS, SHOES, ROTORS AND PADS, Section CTS-2779.

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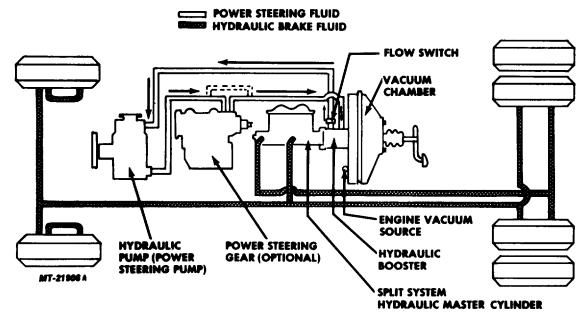


Fig. 1. Typical Schematic of Dual Power Brake System.

DESCRIPTION (BRAKE SYSTEM)

The dual power brake (DPB) system (Fig. 1) features a split hydraulic brake system and master cylinder assembly, which is in turn mounted on the dual power brake booster assembly. The dual power booster is termed "dual power" since it uses vacuum and hydraulic boosted power sources in combination.

Normal power braking is accomplished by brake pedal force activating the vacuum cylinder booster. Additional stopping force is made available when overtravel of vacuum, valving within the vacuum booster activates the hydraulic booster.

The vacuum chamber receives its power source from the engine, while the hydraulic booster power source is from a separate hydraulic pump (power steering).

The vacuum and hydraulic systems work together in the DPB system under normal conditions. If a malfunction should occur such as broken vacuum hose or hydraulic pump drive belt or ruptured pump hose, either vacuum or hydraulic brake system alone

has backup capabilities in providing braking.

The DPB booster assembly is a combination of two boosters, vacuum and hydraulic, which is connected in tandem to the master cylinder.

The vacuum booster uses engine intake manifold vacuum and atmospheric pressure in the booster to provide power assist through the hydraulic booster to the master cylinder (Fig. 3).

Hydraulic booster assist is generated by hydraulic fluid supplied by a hydraulic (power steering) pump when additional power assist is received. The hydraulic booster is mechanically activated by the vacuum booster in the event the vacuum booster becomes inoperative.

The purpose of the split hydraulic brake system is to safeguard against complete loss of brakes if a failure should occur in either of the partial sections of the hydraulic system.

Essentially the hydraulic brake system has been divided into two independent brake systems utilizing a tandem or two section integral master cylinder.

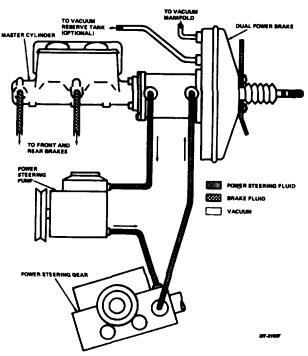


Fig. 2. Two Hydraulic Systems.

The tandem master cylinder design provides controlled brake application since one section of the master cylinder will continue to operate should a failure occur in the other section.

The system utilizes two types of fluid as shown in Fig. 2.

- 1. Hydraulic brake fluid in the master cylinder and hydraulic brake system to wheel brakes and is filled at the master cylinder.
- 2. Power steering fluid in the hydraulic pump, steering (if equipped with power steering gear) and hydraulic booster. The hydraulic booster system is filled at the hydraulic pump reservoir.

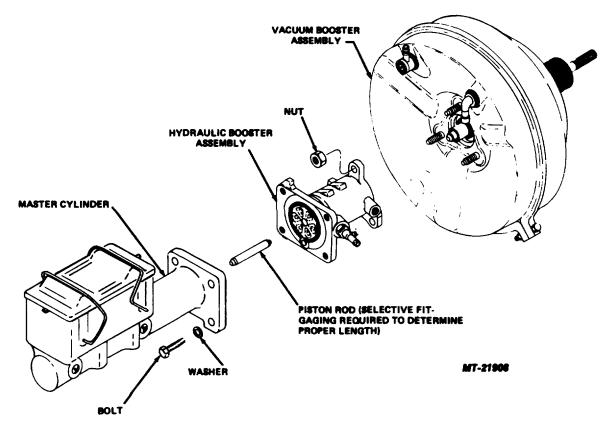


Fig. 3. Dual Power Brake Booster With Master Cylinder.

The split system is designed so that each partial braking system is individual. During normal brake applications both sections function as a single system. The split brake system provides ability to stop if failure occurs in one of the partial systems. However, stopping ability is reduced and pedal travel is increased by such failure.

The complete loss of vehicle brakes with the split system is considered unlikely during normal operation. However, accidental major damage to the vehicle could result in complete brake failure as could negligent continued operation with one failed system or failure to provide periodic brake maintenance based upon type and severity of vehicle service.

Figure 4 illustrates code 04055 split hydraulic system used with the dual power booster.

You will note that both wheel cylinders at both front axle brake groups and one wheel cylinder at each rear axle brake group makes up part of the split brake system. The remaining portion of the split system is one wheel cylinder at each rear axle brake group. This split system may be referred to as a (1 axle + 1/2 axle) x (1/2 axle) split.

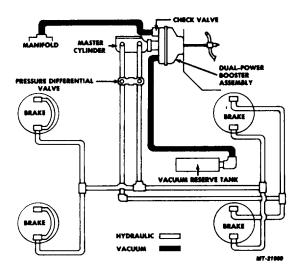


Fig. 4. Brake Code 04055 4x2 Vehicle Split System (1 axle + 1/2 axle) x (1/2 axle).

MAINTENANCE CHECKS

The brake system should be checked periodically for evidence of needed repairs. Before starting to check out the brake system itself, the following related components on the vehicle should be examined and serviced if found defective.

1. Tires.

- 2. Shock absorbers.
- 3. Wheel bearings.
- 4. Suspension.
- 5. Wheel alignment.

The following procedure is given as an aid in checking out the brake system.

BRAKE INDICATOR LIGHTS

Both trucks and busses will have a "BRAKE PRESSURE" indicator light. All busses and some trucks will have a "PARK BRAKE" indicator. (Refer to Electric Controlled Circuit in Chapter II).

PARK BRAKE INDICATOR (All Busses and Some Trucks)

The "PARK BRAKE" indicator is operated in conjunction with the parking brake. During engine cranking period the "PARK BRAKE" indicator should illuminate. This light will go out after engine is started providing the parking brake is not applied. If parking brake is applied this light will stay on after engine has started. If light does not illuminate during starting period, the light bulb may be defective.

BRAKE PRESSURE INDICATOR (All Chassis)

When the ignition switch is turned to "ON" position with engine off, the "BRAKE PRESSURE" light should illuminate indicating that the light bulb is functioning. After the engine has started the "BRAKE PRESSURE" light should go off indicating that the hydraulic brake system is functioning properly. Continued illumination of the "BRAKE PRESSURE" indicator could be caused by either a loss of power booster assist, low vacuum or a faulty condition in one side of the split hydraulic system.

Should the "BRAKE PRESSURE" light come on during vehicle operation when the brakes are not applied, the problem is in the hydraulic booster system. If the light should come on during brake application, the problem could be either in one of the split hydraulic systems, or booster system.

Should the "BRAKE PRESSURE" light illuminate, the vehicle should be operated only with the extreme caution to a repair facility due to reduced braking capability.

If a failure should occur in both the primary and backup boosters, the foot pedal force alone will provide a very limited means of stopping the vehicle.

CAUTION

Braking capabilities will be greatly reduced without engine assist. DO NOT MOVE VEHICLE WITH DEAD ENGINE.

If a failure is experienced in one side of the split hydraulic system, the vehicle will still have the remaining portion of the split system to allow stopping the vehicle; however, the vehicle should be operated only with extreme caution to reach a repair facility since the braking capabilities will be reduced.

BRAKE PEDAL

- Pedal return should be unrestricted when pedal is fully released (see BRAKE PEDAL ADJUSTMENT in Chapter III).
- 2. Excessive side movement indicates worn pedal mounting.
- 3. Interference should not occur when pedal is depressed.
- 4. There should be ample clearance between pedal and toe board when pedal is fully depressed (brakes applied).

MASTER CYLINDER

- 1. Fluid level should be 6.4 to 12.7 mm (1/4" to 1/2") from top of reservoir.
- 2. Check for external leaks at hydraulic line connections or at master cylinder mounting flange.
- 3. Check compensating valve by watching for surge of fluid in reservoir when pedal is depressed.
- Internal wear or leaks are indicated by pedal fading away under steady foot pressure (also sign of leak elsewhere in hydraulic brake system).
- To check residual check valve operation, depress and release brake pedal. Open bleeder valve and check for spurt of fluid indicating pressure in lines.

STOP LIGHT SWITCH

If stop lights are inoperative, it would indicate either defective bulbs, defective switch, loose or broken connections, or switch improperly positioned.

BRAKE LINES, FITTINGS AND HOSES

- 1. Check lines for kinks, dents or rupture.
- Check hoses for abrasion, kinks, soft spots, rupture, collapse, cracks, twists or loose frame supports.
- 3. Examine all connections for leaks.
- 4. Carefully check for incomplete ruptures indicated by a bubble between the plys of the flexible hose or a torn inner line (Fig. 5).

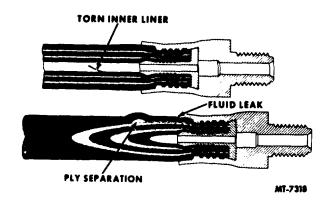


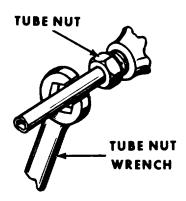
Fig. 5 Flexible Hose Damage.

- 5. Brake line fittings will sometimes become rusted or corroded to the wheel cylinder and/or brake line. Be careful not to twist the line causing a line fracture during removal or installation. Brake line open ends should be capped to prevent the entrance of foreign material.
 - Always use correct type and size of wrench on fittings (Fig. 6).
 - Avoid damage to female fittings by supporting fitting with a spare tube nut during removal and installation (Fig. 7).
- 6. Use only steel tubing when replacement of tubing is required. Use old tubing as a pattern for forming and routing the new.
 - Avoid kinks and sharp bends when forming tube. Use tubing cutter to cut tubing to required length making allowance for flare at each end of tube.

Assemble tube nuts on tubing before flaring.

After flaring tube, blow out with air pressure to remove any particles of dirt or chips.

Do not discard old tube nuts until you are certain that new ones are available.



MT-7450

Fig. 6. Use of Tube Nut Wrench.



MT-7451

FITTING

Fig. 7. Protecting Fitting Against Damage.

WHEEL CYLINDERS

Pull back rubber boots and check for leaks. If cylinders are disassembled, look for dirt, corrosion or pitting. If leakage is evident, the hydraulic cylinder should be repaired or replaced as required.

HYDRAULIC BRAKE FLUID

As a result of use, brake fluid becomes contaminated and loses some of its original qualities. It is good practice to bleed brake system until all old fluid is removed when performing major brake work. Also, old fluid should be bled from the system and replaced with clean brake fluid if any hydraulic system parts are corroded, fluid is discolored, contains water or is dirty.

If any rubber parts of the hydraulic brake system are soft or swollen, old fluid should be removed and hydraulic system should be flushed and refilled with brake fluid. All cups and seals must also be replaced.

<u>Do not</u> reuse old brake fluid. For type of fluid, refer to CTS-2412 in your Service Manual under LUBRICATION.

It is recommended that the brake hydraulic system be flushed when hydraulic cylinders are repaired or replaced to assure that hydraulic brake fluid is not contaminated. To flush hydraulic system, utilize normal bleeding procedures (refer to BLEEDING BRAKE SYSTEM in Chapter IV) and flush system thoroughly until it appears clean.

BRAKE GROUPS

 Check linings for being too thin, uneven wear, damaged, soiled with grease or brake fluid, or for being loose on shoes. Whenever brake lining or blocks are worn to within 1.6 mm (1/16") on medium and heavy duty trucks of rivets, brake shoes must be removed and relined.

It is recommended that all brakes be relined at the same time since this will maintain balanced braking of the vehicle. If complete replacement is not desirable or necessary, be sure that all lining on one axle (both sides) is replaced at the same time.

IMPORTANT

Intermixing of various types of lining material other than that specified is not recommended.

- Examine brake shoes for worn anchor ends, damaged rims or webs, or cracked or broken welds.
- Mechanical parts should be checked for heat damage, broken ends or loss of tension in shoe return springs, wear or corrosion of shoe holddown pins, springs and cups, wear on adjusting screw, looseness of mounting or anchors and worn shoe ledges on backing plate.

DRUMS

- 1. Check brake drums for scores, heat checks, outof-roundness and oversize.
- Wheel bearings should be checked for wear.
 Also, check grease seals for evidence of grease leaks. Refer to WHEEL Service Manual section.

CAUTION

An accident could result if the vehicle is operated while any of the foregoing items need attention, or if any other brake system service requirements are suspected.

SPECIAL FLUID PRECAUTIONS

CAUTION

The DPB System consists of two completely separate hydraulic systems operating on two different and incompatible fluids; power steering fluid and hydraulic brake Failure to observe all fluid. preventing precautions contamination of either system wit fluid from the other will result in the swelling and deterioration of rubber parts leading to reduced brake performance and eventual failure of the brake system and could result in a vehicle accident.

The DPB installation consists of two separate hydraulic systems operating with different and incompatible fluids. To avoid fluid contamination, the following should be observed:

1. Use only fluids specified (or equivalent).

- Refer to CTS 2412 LUBRICATION manual section.
- Make sure that fluids are properly identified. Store only in original containers and carefully check the label before using.
- 3. Add fluids only to the following locations:
 - a. Power steering fluid to the hydraulic pump reservoir.
 - b. Brake fluid to the brake master cylinder.
- 4. Discard do not attempt to reuse any fluid drained from either system.
- 5. Anytime a fluid hose or line is disconnected for maintenance, cover the open fittings and/or ports to prevent contamination of fluid.
- Overhaul components in a clean work area, with clean tools and hands.
 - Hands or tools exposed to one fluid could contaminate parts which operate in the other fluid.
- 7. Denatured alcohol may be used to clean parts. However, do not clean parts operating in one fluid with alcohol previously used to clean parts operating in the other fluid.

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CHAPTER II OPERATION

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GENERAL

The Dual Power Brake (DPB) booster is a combination of two boosters, vacuum and hydraulic, connected in tandem to a master cylinder. The vacuum booster uses engine intake manifold vacuum and atmospheric pressure in the booster to provide power assist through the hydraulic booster to the master cylinder (Fig. 1). The hydraulic booster assist is generated by power steering fluid supplied by a hydraulic (power steering) pump when additional power assist is required. The hydraulic booster is mechanically activated by the vacuum booster or directly by the brake pedal through the vacuum booster in the event the vacuum booster becomes inoperative.

The master cylinder is essentially a hydraulic pump which converts mechanical force to hydraulic pressure. The master cylinder used with the DPB booster is known as a tandem type, which can be identified by the two hydraulic fluid outlets on the side of the cylinder bore.

MASTER CYLINDER

The basic component parts of the master cylinder used with the Dual Power Brake booster system differ from those used in other master cylinders, however, the function is basically the same.

An exploded view of the master cylinder can be found in Chapter III of this section.

When the master cylinder is in the released position (Fig. 2), the actuator of the primary and secondary pistons are in contact with the compensating valve stems, which project into the cylinder bore, keeping the valves off their seats, allowing hydraulic fluid in the reservoirs to enter the cylinder bore.

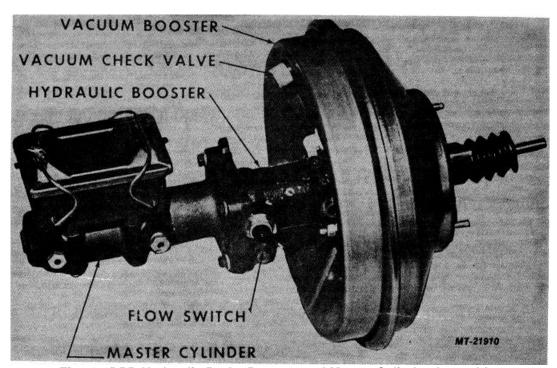


Fig. 1. DPB Hydraulic Brake Booster and Master Cylinder Assembly.

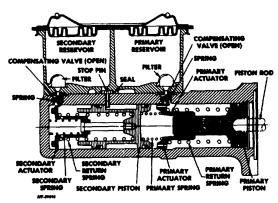


Fig. 2. Released Position.

The initial forward movement of the primary piston moves the primary actuator, permitting the compensating valve to seat, closing off the passage between the pressure chamber in the cylinder bore (Fig. 3). Further movement of the piston rod causes the hydraulic pressure within the cylinder to move the secondary actuator allowing the secondary compensating valve to close (Fig. 4) and secondary piston is no longer resting on the stop pin.

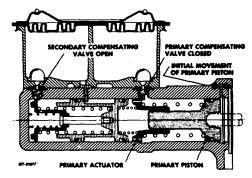


Fig. 3. Primary Compensating Valve Closed.

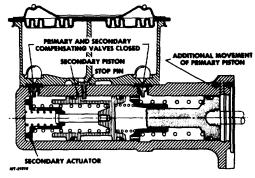


Fig. 4. Primary and Secondary Compensating Valves Closed.

When the primary and secondary systems are at midstroke position (Fig. 5), the primary piston and primary return spring has moved the primary actuator to the point where the actuator has contacted the secondary piston and secondary return spring force has bottomed the secondary actuator in the master cylinder bore.

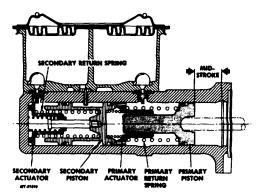


Fig. 5. Primary and Secondary Systems at Mid-Stroke.

When the master cylinder has obtained the full stroke mode in both primary and secondary systems (Fig. 6), both the primary and secondary pistons have traveled their maximum travel and the primary and secondary actuators have bottomed out. The full stroke mode condition would only exist if both primary and secondary systems should fail or if a very poor brake adjustment condition should occur.

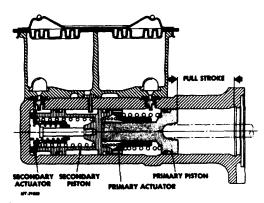


Fig. 6. Primary and Secondary Systems at Full Stroke.

If the primary system should fail (Fig. 7), there will be no fluid pressure in that portion of the brake system, therefore, the primary piston will bottom out the primary actuator.

However, the secondary piston will develop fluid pressure in that system thus stopping capabilities are still available in that portion of the brake system.

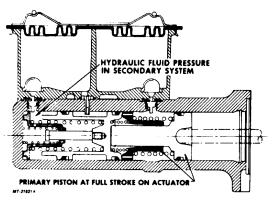


Fig. 7. Secondary System at Mid-Stroke with Primary System Failed.

If a failure should occur in the secondary system (Fig. 8), the secondary piston will bottom out in that side of the master cylinder, while the primary section will maintain the capabilities to enable stopping the vehicle.

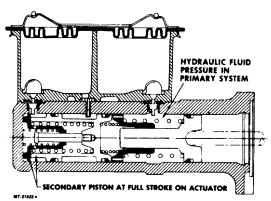


Fig. 8. Primary System at Mid-Stroke with Secondary System Failed.

It must be remembered that increased stopping distance will be required if a failure should occur in one of the two systems.

DUAL POWER BRAKE BOOSTER

VACUUM BOOSTER

Released Position (Fig. 9)

A vacuum line from the engine intake-manifold is connected to the vacuum check valve (1) in the front housing (2) of the power brake. This check valve is designed to prevent loss of vacuum when manifold

vacuum falls below that in the vacuum booster. It also permits several applications of the vacuum booster after the engine is stopped or the vacuum source is lost.

In the released position the air valve (3) is seated on the floating control valve (4). The air at atmospheric pressure, enters through the filter elements (5) in the tube extension of the vacuum power piston and is shut off at the air valve (3). The floating control valve is held away from the valve seat (6) in the power piston (7). The vacuum, which is present at all times in the space (8) to the left of the power piston is free to evacuate any existing air on the right side (9) of the power piston.

This air is drawn through two small passages (10) in the power piston, over the valve seat (6) in the power piston, and then through the power piston into the space at the left of the power piston (8). It is then drawn through the check valve to the vacuum source.

In the released position there is vacuum on both sides of the vacuum power piston, and the power piston (7) is held against the rear housing by the power piston return spring (11).

At rest, the reaction plate (12) is held against the reaction retainer (13). The reaction levers (14) are held back against the reaction plate (12) by the air valve springs (15). The air valve spring holds the air valve (3) back, so that its retaining ring (16) rests against the vacuum power piston (7).

The floating control valve assembly (4) is held against the air valve seat by the floating control valve spring (17).

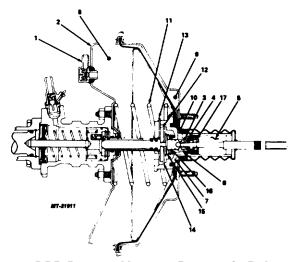


Fig. 9. DPB Booster Vacuum Booster in Released Position.

Applying Position (Fig. 10)

As the brake pedal is depressed the air valve push rod assembly (18) carries the air valve (3) away from the floating control valve (4). The floating control valve will follow until it is in contact with the raised seat (6) in the power piston (7). When this occurs, the vacuum is shut off in the space (9) to the right of the power piston. Air, under atmospheric pressure, rushes through the air filters (5) and travels past the seat of the air valve (3) and through two passage ways (10) into the space (9) to the right of the power piston and diaphragm. Since there is vacuum on the left side of the power piston (8), the force of the air at the atmospheric pressure on the right of the piston will force the power piston and diaphragm (7) to travel to the left.

As the vacuum power piston (7) travels to the left the control valve sleeve (19) carries the hydraulic power piston (20) and piston rod (21) forward. This moves the primary and secondary piston into the bore of the master cylinder and the hydraulic brake fluid pressure will build up in the service brake system (master cylinder and service brakes). Pressure builds in the service brake system to approximately 4136 kPa (600 PSI) as the vacuum booster reaches maximum output.

As the pressure builds up in the master cylinder, force is transmitted back through the hydraulic booster to the reaction plate (12) which moves off its seat on the reaction retainer (13) and presses against the reaction levers (14). The levers, in turn, swing about their pivots and bear against the end of the air valve (3) and air valve push rod assembly (18). In this manner a portion of the load is transferred back through the reaction system to the brake pedal. This gives the operator a feel, which is proportional to the degree of brake application.

Holding Position (Fig. 11)

When the desired pedal pressure is reached, the power piston (7) moves to the left until the floating control valve (4), which is still seated on seat (6) of the power piston (7), again seats on the air valve (3). Then both air and vacuum are shut off to the space (9) to the right of the diaphragm. The vacuum booster will now remain stationary until either more pressure is applied or pressure is released at the brake pedal. Reaction force is transmitted through the levers (14) back to the brake pedal as previously described in Vacuum Booster Applying Position text.

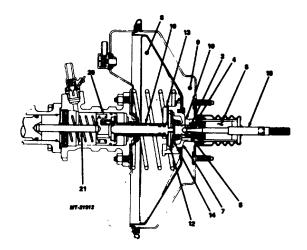


Fig. 10. DPB Booster Vacuum Booster in Applied Position.

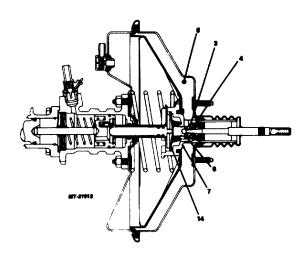


Fig. 11. DPB Booster Vacuum Booster in Holding Position.

Releasing Position (Fig. 12)

As the pressure at the pedal is released the air valve spring (15) forces the air valve (3) back until its retaining ring (16) rests against the vacuum power piston (7). As it returns, the air valve (3) pushes the floating control valve (4) off its seat (6) on the power piston (7). The air valve (3) seating on the floating control valve (4) shuts off the outside air source. When the air valve (3) lifts the floating control valve (4) from its seat (6) on the power piston, it opens the space (9) to the right of the power piston to the vacuum source. Since both sides of the power piston (7) are now under vacuum, the power piston return spring (11) will return

the piston (7) to its released position against the rear housing. as the power piston (7) is returned, the master cylinder pistons move back to their released position when brake pedal is in released position.

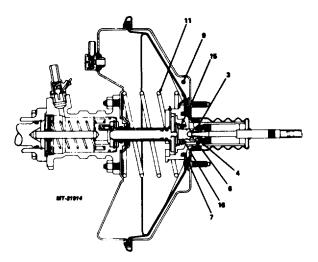


Fig. 12. DPB Booster Vacuum Booster in Releasing Position.

HYDRAULIC BOOSTER (Fig. 13)

The hydraulic booster operates on hydraulic fluid provided by a hydraulic (power steering) fluid pump. The fluid enters the booster at the rear and is directed between the control valve and control valve seat through the power piston to exit at the flow switch and return to the hydraulic pump reservoir.

The hydraulic booster is activated as the vacuum booster approaches maximum output or directly through the vacuum booster when the vacuum booster becomes inoperative. As maximum output of the vacuum booster is approached the air valve (3) moves forward to contact the control valve (26). Increased brake pedal force moves the control valve (26) forward restricting the flow of fluid between the control valve and the control valve seat (27). Restriction builds up pressure (force) behind the hydraulic power piston (20). This force is added to the force from the vacuum booster and is transmitted to the master cylinder to build up pressure in the service brake system.

Pressure (force) continues to build behind the power piston (20) as the control valve (26) moves closer

to the valve seat (27). To prevent excessive pressure build up, a relief valve (28) is installed in the hydraulic power piston (20). Pressure is relieved at 6204 kPa (900psi) behind the power piston, transulating to a pressure of approximately 2758 kPa (1400 psi) in the service brake system. Combining the service brake pressure of approximately 4i36 kPa (600 psi) created by the action of the vacuum booster with the pressure of approximately 2758 kPa (1400 psi) created by the action of the hydraulic booster, we have a total of about 13,788 kPa (2000 psi) to apply the service brake.

If the vacuum booster becomes inoperative, the air valve (3) immediately moves forward to contact the control valve (26) when force is applied to the brake pedal. The hydraulic booster is activated directly and in the same manner described. The hydraulic booster operating by itself, through the master cylinder, creates about 2758 kPa (1400 psi) brake fluid pressure.

If the hydraulic booster becomes inoperative, the vacuum booster will operate as described in preceding paragraphs and will create, through the master cylinder, approximately 4136 kPa (600 psi) brake fluid pressure.

If both boosters become inoperative, brake pedal force is transmitted through the air valve assembly, through the control valve, through the hydraulic power piston and through the piston rod to move the master cylinder pistons to build pressure in the service brake systems.

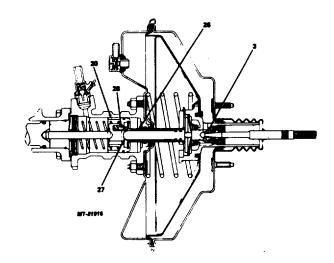


Fig. 13. DPB Booser Hydraulic Booster Operation.

RESIDUAL CHECK VALVE

A residual check valve (Fig. 14) is located in each hydraulic fluid outlet of the master cylinder.

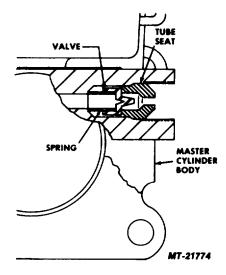


Fig 14. Residual Check Valve.

The residual check valve maintains 34 to 172 kPa (5-25 psi) hydraulic pressure in hydraulic system beyond master cylinder to provide sealing of wheel cylinder piston cups with released brakes. This pressure will not cause brake shoes to drag since the shoe return springs counteract residual pressure.

During manual bleeding the valve assists pumping fluid through the system by closing every time brake pedal is released. If valve should fail to hold residual pressure, a very small leak or even road shock over a period of time could cause increased pedal stroke and a spongy pedal feel.

The residual check valve action can be inspected by cracking a bleeder screw open. A spurt of fluid will indicate residual pressure.

BRAKE LINES, FITTINGS AND HOSES

Hydraulic lines (tubing and flexible hose), Fig. 15, transmit fluid under pressure between master cylinder and wheel cylinders.

Hoses are the flexible links between wheels or axles and the frame or body. They must withstand fluid pressure without expansion and must be free to flex during spring deflection and wheel turns without damaging the hose.

CAUTION

Hydraulic lines are subject to damage and deterioration; therefore, they should be inspected periodically to avoid personal injury or property damage.

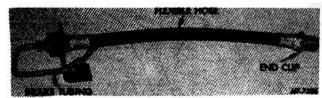


Fig. 15. Brake Line and Flexible Hose.

WHEEL CYLINDERS.

The wheel cylinders are attached to brake backing plate. Their purpose is to convert hydraulic pressure from master cylinder to mechanical force required to expand brake shoes against the brake drum.

The wheel cylinder consists of a body, piston spring, piston(s), rubber cup(s), boots(s) and bleeder valve. Fig. 16 illustrates a double piston wheel cylinder and Fig. 17 illustrates a single piston type wheel cylinder.

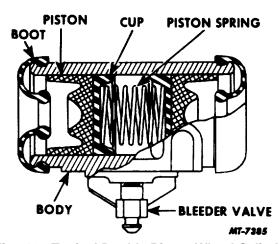


Fig. 16. Typical Double Piston Wheel Cylinder (Cross Sectional View).

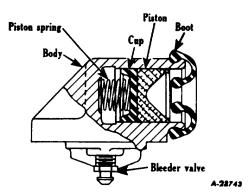


Fig. 17. Typical Single Piston Wheel Cylinder (Cross Sectional View).

PRESSURE DIFFERENTIAL VALVE (Brake Warning Light Switch)

GENERAL

The pressure differential valve (Fig. 18) is positioned in split brake system to sense a loss of hydraulic pressure in either side of the split hydraulic system and illuminate a warning light (Brake Pressure) at the instrument panel.

The switch consists of two pistons, O-ring seals, piston stops, springs and a pin.

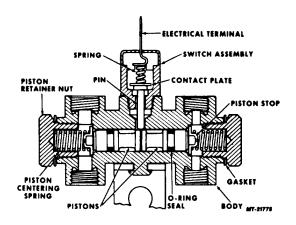


Fig. 18. Cross Sectional View of Pressure Differential Valve.

OPERATION

The warning light is connected to a warning light switch (Fig. 19). The end of one piston is subjected to line pressure from one side of the split brake system while opposite end of piston is subjected to line pressure from other side of the split brake system. If line pressure of one side of the split system differs by more than 586 to 1034 kPa (85-150 psi) from that of other, pistons are moved off center and electrical circuit closes (Fig. 20), thus illuminating warning light at instrument panel. This is a positive warning to vehicle operator that a system failure has occurred.

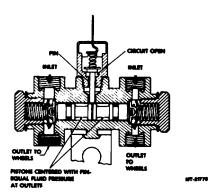


Fig. 19. Pressure Differential Valve With No. System Failure.

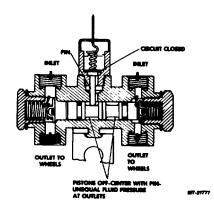


Fig. 20. Pressure Differential Valve With System Failure.

The warning light will remain illuminated even after repairs have been performed. To return light to proper functioning cycle again, the switch must beremoved from body and reinstalled (see RESETTING BRAKE WARNING LIGHT SWITCH).

To test warning light circuit and prevent possible operation of vehicle with one brake system in a failed condition, the ignition switch is wired into the circuit. If light fails to illuminate when ignition switch is turned to ON position, it would indicate that a bulb is defective or there is an open circuit, such as a broken wire or loose connection. The light will go out when the engine starts only if the power booster system is functioning properly

and there is no pressure difference greater than 586 to 1034 kPa (85-150 psi) in the split system.

CAUTION

To avoid personal injury or property damage, the vehicle should not be operated other than to the nearest service facility, and then only with extreme caution if the warning light is inoperative or one brake system is in a failed condition since additional stopping distance may be required.

RESETTING BRAKE WARNING LIGHT SWITCH

After a pressure difference of more than 586 to 1034 kPa (85-150 psi) has occurred within the brake system, "BRAKE PRESSURE" warning light on instrument panel will remain illuminated with engine running. The light will not go out, even after needed service has been performed, until the switch has been reset.

To reset warning light switch, clean all foreign matter from switch and disconnect electrical wire from switch terminal. Unscrew and completely remove switch from body (Fig. 21). Reinstall and tighten switch. Do not over-tighten switch.

Connect electrical wire to switch terminal. Warning light should not illuminate with engine running after switch is reset.

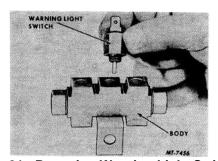


Fig. 21. Resetting Warning Light Switch.

IMPORTANT

If hydraulic fluid appears at the opening in body when switch is removed, depress brake pedal and check for fluid leakage past piston O-ring seals. If fluid is displaced (squirts from opening), replace warning light switch body assembly.

It should be remembered that test circuit will illuminate light when ignition switch is turned to ON position.

WARNING LIGHT ELECTRIC CIRCUIT

Figures 22, 23, 24 and 25 illustrate circuit diagrams used with the Dual Power Brake system. They have been identified by first and second generation due to changes in the circuits.

The main difference in the two circuits is that a push button start switch system has been added to the circuit.

PARK BRAKE WARNING LIGHT SYSTEM (Bus Only)

When the key switch is turned to "START" position, the park brake light will illuminate since the key switch is grounded in that mode. Upon release of the key switch the ground circuit is broken and the light should go off providing the parking brake is not set. If the park brake is set, circuit is closed through the park brake switch and the park brake light will remain on.

If a vehicle has a push button start system, a ground relay will be used in the system to provide a ground in order to obtain the park brake light illumination in the START mode. In addition to the school bus chassis, a few trucks were equipped with the Park Brake Warning System. Because of these few vehicles, the circuit diagram (Fig. 23) was not changed.

Fig. 25 illustrates the electrical circuit on a truck without the park brake warning system.

Vehicles with EGR Service Warning Indicator will have a diode type rectifier in the park brake circuit and EGR service indicator circuit. These diodes prevent the EGR service indicator being activated when the Park Brake switch functions and the park brake indicator illuminating when the EGR switch is closed. These diodes are used on bus chassis only and will be located near the Key Switch.

BRAKE PRESSURE WARNING LIGHT

Three switches in the circuit will cause illumination of the Brake Pressure Warning Light. They are Low Vacuum Switch, Flow Switch and the Brake Pressure Differential Switch. Closing of any one of the switches will cause the light to illuminate.

Examples are: When the key switch is turned to "ON" and the engine is not operating the flow switch will be closed since there is no flow of hydraulic fluid through the booster. The low vacuum switch will cause the light to illuminate if there is no vacuum reserve. After the engine has started, the system should have flow of hydraulic fluid and vacuum supply. If you apply the brakes and the light goes on, one side of the split system could be faulty.

Vehicles which do not have the Park Brake Warning System will not have the following: (1) Park brake switch (2) Indicator light ground relay, if vehicle is equipped with push button start.

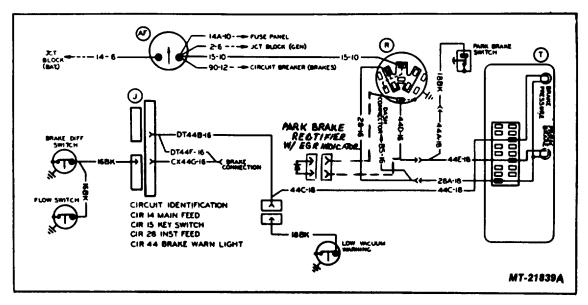


Fig. 22. Circuit Diagram of Bus (First Generation).

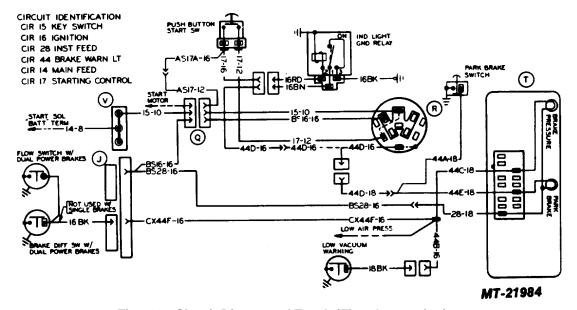


Fig. 23. Circuit Diagram of Truck (First Generation).

IDENTIFICATION OF CODE LETTERS IN CIRCLES (Fig. 22 and 23)

AF - Ammeter

J - Bulkhead Connector

L - Fuse Block

Q - Instrument Panel Connector

R - Key Switch

T - Instrument Cluster

V - Feed Thru Stud

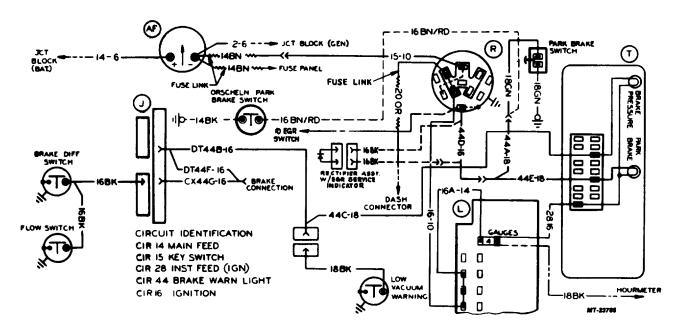


Fig. 24. Circuit Diagram of Bus (Second Generation).

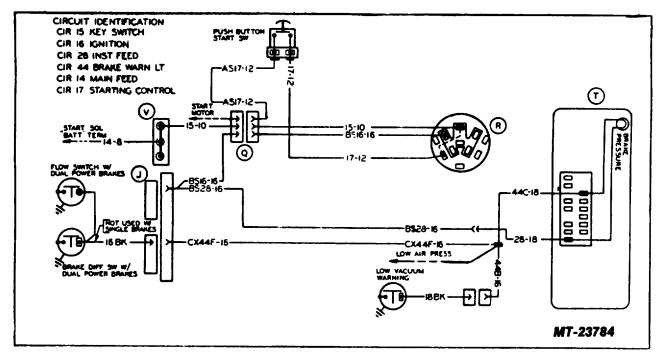


Fig. 25. Circuit Diagram of Truck (Second Generation).



CHAPTER III REMOVE & REINSTALL, DISASSEMBLY, SERVICE AND REASSEMBLY

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GENERAL

The on vehicle repair of the DPB booster assembly with master cylinder is limited to replacement of the flow switch, vacuum check valve, elbow or grommets. For all other repairs and overhaul, the master cylinder or booster assembly must be removed from the vehicle.

Either one of the three units (master cylinder, hydraulic or vacuum booster) may be separated from each other for unit repairs without removing the master cylinder and complete DPB booster as an assembly.

IMPORTANT

Before disassembling any brake component special attention must be given to work area and prevention of contamination by the two types of hydraulic fluids, used in the DPB system. Refer to CHAPTER I, SPECIAL FLUID PRECAUTIONS.

Keep in mind that the DPB system utilizes two separate hydraulic systems, operating with different incompatible fluids. Never attempt to reuse any fluid drained from the system or components.

Do not allow brake fluid to contact any DPB components. Conversely, do not allow power steering fluid to come into contact with internal parts of the master cylinder or other components serviced with brake fluid.

REMOVE AND REINSTALL

MASTER CYLINDER

- 1. Block the vehicle wheels or set parking brake.
- Position a container under the master cylinder to catch fluid. Then disconnect hydraulic lines from master cylinder.
 - Observe hydraulic line location at master cylinder to prevent lines being switched at reassembly.
- 3. Plug or cap lines to keep out foreign matter.

4. Remove bolts securing master cylinder to power booster assembly (Fig. 1).

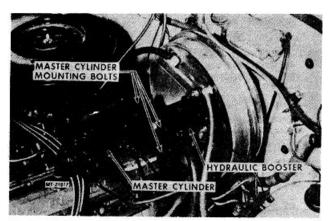


Fig. 1. Removing Master Cylinder Mounting Bolts.

- 5. Reassemble the master cylinder on the power booster assembly and torque bolts to 41-52 Nm (30-38 ft. lbs.).
- 6. Remove plugs or caps from hydraulic lines.
- 7. Connect hydraulic brake fluid lines to master cylinder. Be careful when connecting hydraulic brake line fittings to avoid damage from cross threading or over tightening. Always check fittings that have been reinstalled for leaks by depressing the brake pedal to build up maximum pressure within the system after bleeding the system. If any leaks are noted or suspected, they should be corrected prior to operating the vehicle.
- 8. Bleed brake system to be assured that the hydraulic system is free of air. Refer to Chapter IV for bleeding procedure.

FLOW SWITCH

The DPB booster operates on power steering fluid only. Do not allow contamination with brake fluid.

- 1. Position a suitable container to catch fluid from the flow switch and hoses.
- 2. Disconnect the electrical lead to the flow switch.

- 3. Loosen the inner hose clamp at the flow switch and remove the hose.
- 4. Remove the flow switch using a 25 mm (1") open-end wrench.
- 5. Use new O-ring seal when installing the flow switch. Torque to 27-41 Nm (20-30 ft. lbs.).
- Make electrical and fluid connections in reverse order of removal.
- Bleed the DPB system as directed in Chapter IV

DUAL POWER SRAKE BOOSTER

The Dual Power Brake Assembly may be removed as a complete assembly, as individual booster units (master cylinder, hydraulic power booster, and vacuum power booster or combinations of units such as master cylinder and hydraulic power booster or hydraulic power booster and vacuum power booster.

Dual Power Brake Assembly With Master Cylinder

- Set parking brake. Position a suitable container under the hydraulic booster and master cylinder assemblies to catch power steering and brake fluid which will be discharged when lines and hoses are disconnected.
- Disconnect the brake lines from the master cylinder hydraulic outlets and from the hydraulic power booster. Cover these lines to prevent entrance of contaminates. Move lines only enough to permit removal of the DPB assembly. This minimum movement will assist in establishing proper and quicker connection when the unit is replaced.
- Remove the electrical connection from the flow switch.
- 4. Disconnect the vacuum hose from the vacuum check valve and disconnect the reserve tank vacuum hose from the elbow if the vehicle is so equipped. Cover the vacuum line(s) to prevent the entrance of contaminates.
- 5. Disconnect the push rod from the brake pedal.
- Remove the four attaching nuts from inside the cab. Move the unit forward to free the studs from the cowl.

IMPORTANT

If the master cylinder and hydraulic power booster are removed together, the units should be separated and repaired at different locations to avoid contamination of the two systems. Refer to Chapter I, SPECIAL FLUID PRECAUTIONS.

- 7. If master cylinder and hydraulic booster were separated from the vacuum power booster, assemble these units. Attach master cylinder to hydraulic booster and torque bolts to 41-52 Nm (30-38 ft. lbs.). Then secure the hydraulic booster and master cylinder assembly to the vacuum power booster with new lock nuts and torque nuts to 22-40 Nm (16-30 ft.lbs.).
- Adjust the booster push rod clevis so that the clevis opening (center) is approximately 178 mm (7 in.) from mounting face of vacuum booster.
- 9. Position complete booster assembly with master cylinder on the vehicle and torque fasteners to 31-41 Nm (25-30 ft. lbs.).
- 10. Connect push rod clevis to brake pedal. Refer to Brake Pedal Adjustment in this Chapter.
- 11. Connect engine vacuum hose to vacuum check valve and connect auxiliary vacuum reserve tank to elbow.
- 12. Connect fluid hoses to the booster.
- 13. Connect master cylinder fluid lines.
- 14. Connect the flow switch electrical lead.
- 15. Bleed the hydraulic booster and hydraulic brake systems as directed in Chapter IV.

CAUTION

If the DPB booster or brake hydraulic system has been opened -any component removed or any line disconnected -do not attempt to move the vehicle until the affected system (or systems) has been properly bled as vehicle will not have braking capabilities.

Hydraulic Booster or Hydraulic Booster and Master Cylinder Assembly

The hydraulic booster may be removed from the vehicle without removing the master cylinder or vacuum booster or both master cylinder and hydraulic booster may

be removed as an assembly. This procedure involves removing the attaching hardware such as brake line clips of master cylinder.

- 1. Set parking brake.
- 2. Disconnect flow switch electrical lead.
- Remove the four bolts which secure master cylinder to the hydraulic booster when removing only the hydraulic booster. Then move the master cylinder forward sufficiently to clear the end of the booster assembly. Support the master cylinder in this position.
- Position a suitable container to catch fluid from the hydraulic booster lines and brake fluid lines if master cylinder is being removed with the hydraulic booster.
- Disconnect the hydraulic lines from the hydraulic booster and master cylinder if it is being removed. Then cover the lines to prevent entrance of contaminants.
- 6. Remove the three locknuts attaching the hydraulic booster to the vacuum booster (Fig. 2).

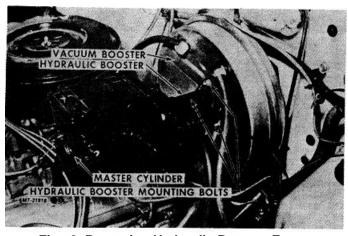


Fig. 2 Removing Hydraulic Booster From Vacuum Booster

- 7. Move the hydraulic booster off the vacuum booster studs and remove from the vehicle.
- 8. If master cylinder was removed with hydraulic booster, attach master cylinder to the hydraulic booster. Torque bolts to 41-52 Nm (30-38 ft. lbs.).
- 9. Move the assembly into position on the vacuum power booster. Attach new lock- nuts and torque to 22-40Nm (16-30ft.lbs.).

- 10. If the master cylinder was not removed with the hydraulic power head, attach at this time. Torque bolts to 41-52 Nm (30-38 ft. lbs.).
- 11. Connect power steering fluid lines to hydraulic booster inner and outer clamps must secure return line from flow switch.
- 12. Connect brake fluid lines if disconnected.
- 13. Connect flow switch electrical lead.
- 14. Bleed the hydraulic booster systems and hydraulic brake system as directed in Chapter IV.

CAUTION

If the hydraulic booster or brake hydraulic system has been opened -- any component removed or any line disconnected, <u>do not</u> attempt to move the vehicle until affected system (or systems) have been properly bled as the vehicle will not have braking capabilities.

Vacuum Power Booster or Vacuum Power Booster With Hydraulic Power Booster

- Position a suitable container under the hydraulic power booster to catch power steering fluid which will be discharged if the hoses are removed.
- 2. Remove the hardware attaching any brake line clips in the vicinity of the master cylinder.
- 3. Disconnect hydraulic lines from the hydraulic booster if being removed.
- 4. Remove the four bolts attaching the master cylinder to the hydraulic power head if power booster is to be removed with vacuum booster. If not, remove the three lock nuts securing hydraulic booster to vacuum power booster.
- Move the master cylinder and booster forward a sufficient distance to clear the hydraulic and vacuum power booster for removal and then support the master cylinder and booster in this position.
- 6. Disconnect the electrical connection from flow switch if hydraulic booster is to be removed.
- 7. Disconnect the vacuum hose from vacuum check valve. Also disconnect the vacuum reserve tank hose. Cover vacuum lines to prevent entrance of contaminates.
- 8. Disconnect push rod from brake pedal.
- 9. Remove the four attaching nuts securing vacuum unit to dash panel. Move unit

forward to free studs from dash panel.

IMPORTANT

If vacuum and hydraulic booster are removed as an assembly, the units should be separated and repaired at different locations to avoid contamination of the two systems.

- 10. Assemble the hydraulic power booster to the vacuum power booster using new lock nuts. Torque nuts to 22-40 Nm (16-30 ft. lbs.).
- 11. Adjust booster push rod clevis so that the clevis opening (center) is approximately 178 mm (7") from mounting face of vacuum booster.
- 12. Mount the vacuum unit to dash panel and install the four nuts. Torque the attaching nuts to 31-41 Nm (25-30 ft. lbs.).
- Connect booster push rod clevis to brake pedal lever.
- 14. Connect vacuum hoses to vacuum booster unit.
- 15. If hydraulic power booster was not removed with vacuum power booster, attach at this time using new lock nuts. Torque nuts to 22-40 Nm (16-30 ft. lbs.).
- 16. If the vacuum power cylinder was replaced and after the vacuum and hydraulic boosters are assembled, the piston rod height must be checked. To do so, separate the master cylinder from the booster.
- 17. Press down firmly on the piston rod to make sure the rod and other internal parts are bottomed out in the hydraulic power booster.
- 18. Check the piston rod extension to be within limits using the Push Rod Height Gauge SE-2773 (Fig. 8).
- 19. If piston rod is not within limits, select a new piston rod to bring the extension within limits. A total of six piston rods are available with lengths as indicated and identified in the following charts.

PISTON ROD IDENTIFICATION			
Part No.	Letter ID	Part No.	Letter ID
501834-C1	С	501837-C1	J
501835-C1	Ε	501838-C1	L
501836-C1	G	501839-C1	N

Letter ID is located near taper at three places on rod.

REPLACEMENT PISTON RODS			
Part No.	Length		
	Millimeters Inches		
501834-C1	102.05 - 102.21	4.018- 4.024	
501835-C1	102.63- 102.79	4.041 - 4.047	
501836-C1	103.21- 103.37	4.063 - 4.070	
501837-C1	103.79- 103.95	4.086 - 4.093	
501838-C1	104.37- 104.53	4.109 - 4.115	
501839-C1	104.96- 105.12	4.132 - 4.139	

If substitution is necessary, pull out the piston rod using a slight twisting motion. Lubricate the substitute rod with clean power steering fluid and press into the hydraulic power head using a slight twisting motion. Press down firmly to make sure the rod is seated.

After substitution, recheck the piston rod extension using gauge SE-2773. Repeat the substitution, if necessary, to bring the piston rod extension within specifications.

- 20. Assemble the master cylinder to the hydraulic power booster and torque to 41-52 Nm (30-38 ft. lbs.).
- 21. If hydraulic booster system was opened, the system will have to be bled as outlined in Chapter IV.

CAUTION

If the hydraulic booster or hydraulic brake system has been opened -- any component removed or any line disconnected -- do not attempt to move the vehicle until affected system or systems have been properly bled as the vehicle will not have braking capabilities.

PRESSURE DIFFERENTIAL VALVE (Broke Warning Light Switch)

- 1. Set parking brake.
- 2. Clean area of warning switch and valve body free of dirt and foreign material.
- 3. Disconnect wire from warning switch terminal.
- Remove inlet and outlet fluid lines and plug or cap lines to avoid entrance of dirt. Be sure to note position of hydraulic lines for correct installation.
- 5. Remove valve mounting bolt.
- 6. Position assembly on vehicle and secure with mounting bolt.

- 7. Install hydraulic lines to correct inlet and outlet openings in valve body. Refer to figure 4, Chapter I, for typical split hydraulic system connections at pressure differential valve.
- 8. Adequately tighten all fittings. Remove switch assembly from body and bleed brakes. Refer to Chapter IV, BLEEDING BRAKE SYSTEM.
- 9. After brakes are bled; with engine running apply steady foot pressure to brake pedal and check all fittings for leaks. Inspect opening where switch assembly attaches to body to be certain that O-ring seals are not leaking.
- 10. Install and sufficiently tighten switch assembly in body. Do not overtighten since no seal other than to prevent the entrance of dirt or foreign material is required between switch assembly and body.
- 11. Connect warning light wire to switch terminal. Turn ignition switch to ON position. Warning light should illuminate. Start engine.

When ignition switch returns to ON position, warning light should, "go out". If warning light fails to function properly, investigate system further to determine problem.

CAUTION

Remember that when testing warning light circuit, engine will start. Be certain that all personnel and equipment are free of engine.

MASTER CYLINDER DISASSEMBLY

- 1. Remove the reservoir cover and diaphragm, and drain the fluid from the reservoir.
- 2. Remove the four bolts that secure the body to the reservoir using an E 10 Torx head socket.
- Remove the small "O" ring and the two compensating valve seals from the recessed areas on the bottom side of the reservoirs. Do not remove the two small filters from the inside of the reservoir unless they are damaged and are to be replaced.
- 4. Since the spring load of the primary piston is approximately 267-311Nm (60-70 ft. lbs.) it will be difficult to depress the piston by hand. Therefore, it is suggested that a cross bar type puller similar to SE 1368 which has a 600 angle at the end of the center bolt be used or a puller

with a ball swivel point to avoid damage to piston. Assemble the puller on the end of the master cylinder using two of the master cylinder mounting holes diagonally opposite each other (Fig. 3). Using two 3/8" x 5 1/2" bolts which permit threading the puller center bolt down, forcing the piston into the bore approximately 25.4 mm (1") .

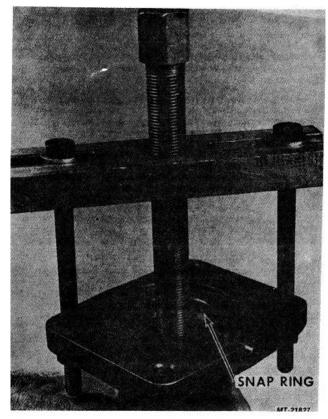


Fig. 3 Depressing Master Cylinder Primary Piston Using a Cross Bar Type Puller

- After the piston has been depressed the compensating valve poppets and springs can be removed. Then remove the stop pin from master cylinder body.
- Before releasing the puller assembly, remove the snap ring from master cylinder bore using a snap ring pliers. Then release the piston and remove the puller assembly from end of the master cylinder.
- 7. Remove the primary and secondary pistons from cylinder bore. It may be necessary to plug the front outlet port and to apply low air pressure to the front compensating

valve port to remove the secondary piston assembly. If air pressure is used to remove the secondary piston, place the open end of the cylinder bore approximately 25.4 mm (1") from a padded workbench or other surface to catch the piston when it comes out of the bore. Apply low air pressure very carefully to ease the piston out of the bore.

CAUTION

Never point the open end of the bore at anyone when applying air pressure. The piston may come out of the bore with considerable force and cause personal injury.

- 8. Remove tube seats with screw extractor. If present, remove residual valve and springs.
- 9. No further disassembly of master cylinder components are required since these components are serviced with the repair kit as assembled components.

CLEAN AND INSPECTION

Cylinder castings may be degreased or cleaned with most commercial parts cleaners provided they are thoroughly rinsed with denatured alcohol or clean brake fluid to remove all traces of solvent. Use compressed air or a lint-free cloth to dry parts after removing them from the cleaning solvent. All hydraulic parts must be thoroughly cleaned and protected (after cleaning) from dust or other air-borne foreign material until reassembly. Do not use cotton waste for cleaning or drying parts, as particles of lint or thread fibres may block the compensating ports when cylinder is placed in service.

Be sure that all foreign matter is removed from the filters in the bottom of the master cylinder reservoir. If the filters do not clean up they must be replaced.

IMPORTANT

Do not use mineral-base cleaning solvents such as gasoline, kerosene, distillant, carbon tetrachloride, acetone, paint thinner, etc. to clean rubber parts. These solvents attack rubber parts, causing them to become soft, tacky and swollen in an extremely short time.

Inspect cylinder bore for scoring or corrosion. It is best to replace a corroded cylinder. Corrosion can be identified as pits or excessive roughness. Excessive blemishes such as pitting, scratches and visible wear patterns necessitate unit replacement.

Accumulations of dirt or gummy substances, not removed during the cleaning process, may be removed with crocus cloth by revolving cylinder on cloth supported by finger.

If master or wheel cylinders were honed, remember that the cylinder diameter must not be materially increased. In other words, scratches and pits in cylinder walls render the unit useless as honing the bore sufficiently to remove them would increase bore diameter to the point that new piston cups will not seal properly. The possibility that cylinder may have been honed during a previous overhaul should not be overlooked.

Care must be exercised when cleaning the bore of the master cylinder since the bore has a step near the blind end. The configuration of the step must not be altered. Crocus cloth may be used to clean the 450 angle of the step and at the bottom of master cylinder bore.

Be certain that the cylinder has no burr at compensating or inlet ports, as it would damage new piston seal. If a burr or sharp edge is present anywhere in cylinder bore, it must be removed.

At final inspection be certain that master cylinder compensating ports are open. A soft copper wire may be used to probe compensating port. Do not use a steel wire.

REASSEMBLY Refer to Fig. 4

- 1. Lubricate the secondary piston assembly and the master cylinder bore with clean brake fluid.
- Assemble the secondary spring (smaller of the two springs) in the open end of the secondary piston actuator and assemble the piston return spring (larger spring) in the open end of the secondary piston.
- 3. Insert the secondary piston assembly, actuator end first, into the master cylinder bore and press assembly to the bottom of the bore.
- 4. Lubricate the primary piston assembly with clean brake fluid. Insert the primary piston assembly, actuator end first, into the bore.
- 5. Assemble a cross bar type puller similar to SE 1368 on the end of the master cylinder using two 3/8" x 5 1/2" bolts. Position the

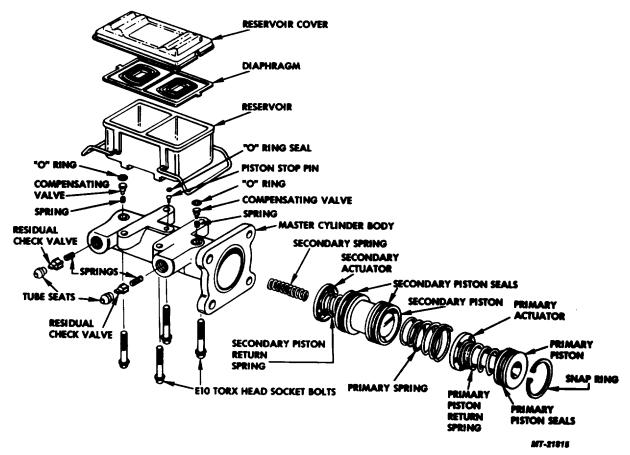


Fig. 4 Exploded View of Master Cylinder

piston retainer snap ring around the puller center bolt. Thread the center bolt down on piston forcing it into the master cylinder bore (Fig. 5).

Prior to installing the puller on the master cylinder be sure to check the center bolt end so that it will not damage the tapered sides in end of piston. <u>Do not</u> allow the piston to turn when compressing the piston into cylinder bore. Allowing the piston to rotate could result in damage to piston seals.

- 6. Install the retaining ring in the groove in the cylinder bore.
- Install the compensating valve seals and the small "O" ring seal in the recesses on the bottom of the reservoir. Be sure that all seals are fully seated.
- 8. Holding pistons depressed approximately 25.4 mm (1") by using tool shown in Fig. 5, assemble the compensating valve springs and the compensating valve poppets and piston stop pin in the compensating valve ports and stop pin hole.

- 9. Holding the pistons compressed, position the reservoir on the master cylinder body and secure with the four mounting bolts. Tighten the bolts to 22-41 Nm (16-30 ft. lbs.).
- Remove the puller assembly from the master cylinder. <u>Do not</u> permit piston to rotate when removing puller.
- 11. Install residual valve assemblies and press tube seats into outlet ports with tube nut.

WHEEL CYLINDERS

Wheel cylinders should be reconditioned whenever brake lining is replaced because of the following:

- 1. As lining wear, wheel cylinder rubber cups move back and forth over a new, widened smooth area.
- Corrosion and foreign matter builds up on the part of the cylinder walls where cups do not work.

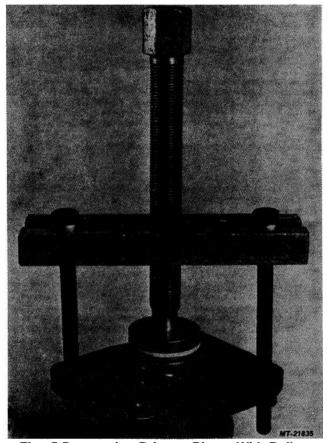


Fig. 5 Depressing Primary Piston With Puller

- 3. When new thick lining is installed, cups are pushed closer together and must function over the roughened surface.
- 4. Since cups no longer seat against smooth cylinder walls, they allow fluid to leak out.

DISASSEMBLY

Wheel cylinders are disassembled by removing the dust boot, then the piston or pistons, cup or cups, depending upon style of cylinder (refer to Chapter II, figs. 16 and 17), then remove piston spring.

CLEAN AND INSPECTION

The instructions for cleaning and inspection are the same as that listed in the Master Cylinder portion of this text.

REASSEMBLY

These instructions pertain to a double piston type wheel cylinder. A single piston type wheel cylinder will

be reassembled in a similar manner.

To reassemble wheel cylinder, wet cylinder bore and dip new pistons and cups in clean brake fluid.

Refer to Fig. 6 for key numbers in parenthesis.

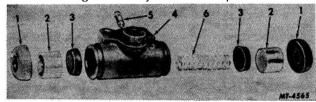


Fig. 6 Wheel Cylinder (Exploded View)

	Legend for Fig. 6
<u>Key</u>	Description
1	BOOT
2	PISTON
3	CUP, Piston
4	CYLINDER, Wheel
5	VALVE, Bleeder
6	SPRING

IMPORTANT

Do not handle hydraulic system parts with greasy hands or permit parts to come in contact with mineral oil or grease.

Install spring (6) into wheel cylinder bore (4). Install a new cup (3) in each end of cylinder bore with cup lips toward spring.

Insert a piston (2) in each end with piston flat side against cup. Install new rubber boot (1) on each end of cylinder being certain that boot is positioned in groove on ends of cylinder (4).

Install bleeder screw (5) in cylinder body. Plug hydraulic fluid inlet to prevent the entrance of foreign material until installation.

FLOW SWITCH AND PRESSURE DIFFERENTIAL VALVE

The flow switch and pressure differential valve assemblies are serviced only as assemblies, therefore disassembly and reassembly of these components are not required. However, pay special attention to the instructions for cleaning and inspection of these components as outlined.

The brake warning light switch on the

pressure differential valve is a serviced item and may be replaced.

Clean these components by wiping with cloth moistened with alcohol. Do not immerse in denatured alcohol, power steering fluid or brake fluid. Be sure to cap or plug all openings to avoid contamination.

HYDRAULIC BOOSTER

DISASSEMBLY

Refer to Fig. 7 and proceed as follows:

- Hold the unit over a suitable container to catch fluid and pull out the piston rod using a twisting motion. Turn the end of the unit down to drain any fluid from the piston rod opening.
- 2. Support the unit in a vise, flow switch up, by clamping on the body flange.
- Remove the flow switch (if not previously removed for service) using a 25 mm (1") openend wrench. Remove the O-ring seal from the flow switch.

 Remove the cap by inserting a thin blade screw driver or other suitable tool under the lip of the cap and prying up. Use care not to distort or bend cap.

CAUTION

The piston return spring is under load and care should be used to prevent the spring from forcing the support plate, seal and expander out too rapidly and cause personal injury,

Remove the remaining parts from the cylinder bore. Also remove double lip seal from small diameter at the opposite end of unit.

CLEAN AND INSPICTION

- Clean metal parts (except flow switch) in denatured alcohol or clean power steering fluid. Do not use brake fluid or any other solvent to clean the hydraulic power head parts. Use dry, filtered compressed air (NOT lubricated shop air) to dry parts and blow out all passages in the body.
- 2. Visually inspect parts for excessive wear

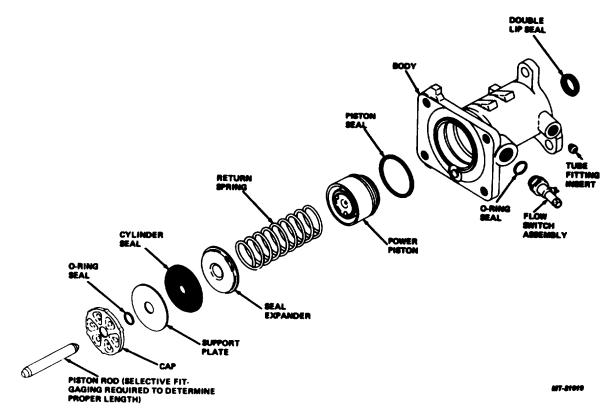


Fig. 7 Exploded View Hydraulic Booster

or damage that would affect serviceability or cause leakage. Pay particular attention to the following:

- a. Check all parts for cracks, distortion or any other evidence of structural damage. Check threaded parts for stripped, crossed, or otherwise damaged threads.
- b. Check the piston outside diameter and the mating bore in the body for scoring, nicks, burrs or corrosion.
- Inspect the control valve seat in the power piston for nicks, burrs, corrosion or excessive wear.
- Repair shall be limited to the replacement of damaged or excessively worn parts. Do not attempt to rework or use abrasives in any form to remove surface defects from internal parts or surfaces.
 - Replace the flow switch if it leaks or fails to operate properly. No repairs are authorized for this unit.
 - b. Replace all parts included in the repair kit at each overhaul.
 - c. Replace damaged studs in body.

IMPORTANT

The hydraulic booster operates in power steering fluid only. Prior to beginning reassembly be sure all parts are clean and free of contamination from other fluids. Use only new rubber parts from repair kit. Lubricate all parts at reassembly with fresh clean power steering fluid only.

REASSEMBLY (Refer to Fig. 7)

- 1. Support the hydraulic power booster casting in a vise with the large bore up.
- 2. Lubricate a new piston seal with clean power steering fluid and fit it into the groove in the power piston assembly.
- Install the power piston assembly in the body bore.' Make sure the piston goes into the body in the direction shown on the exploded view (Fig. 7). Press the piston to bottom in the bore. Use care that seal is not rolled.
- 4. Install the return spring.
- Lubricate the cylinder seal inside diameter and outside diameter with clean power steering fluid. Position the O-ring, support plate, cylinder seal

- and seal expander against the cap as these parts will be installed in the body. Position this assembly over the body on the return spring and push down. When the cap extensions contact the casting, tap into position using a plastic or rubber mallet.
- 6. Install the piston rod and gauge the length of the piston rod after the vacuum booster and hydraulic booster are secured together. The piston rod must be gauged anytime any hard parts are replaced in the hydraulic booster or new vacuum power booster is installed, for proper selection of piston rod. It is suggested that the piston rod be gauged when soft parts are replaced in the booster also, since it provides a check on proper reassembly.

To gauge the piston rod, press down firmly on the piston rod to be sure that the rod and all internal parts are bottomed in the booster.

Check the piston rod extension to be within limits using the Push Rod Height Gauge, SE-2773 (Fig. 8).

If piston rod is not within limits, select a new piston rod to bring the extension within limits. A total of six piston rods are available with lengths as indicated and identified in following charts

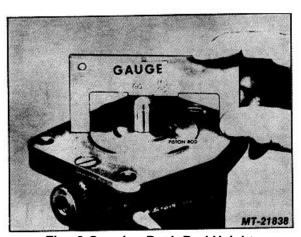


Fig. 8 Gauging Push Rod Height

PISTON ROD IDENTIFICATION

Part No.	Letter ID	Part No.	Letter ID
501834-C1	С	501837-C1	J
501835-C1	Е	501838-C1	L
501836-C1	G	501839-C1	N
Letter ID is lo	cated near ta	per on Rod.	

REPLACEMENT PISTON RODS				
Part No.	L	Length		
	Millimeters	Inches		
501834-C1	102.05 - 102.21	4.018 - 4.024		
501835-C1	102.63 - 102.79	4.041 - 4.047		
501836-C1	103.21 - 103.37	4.063 - 4.070		
501837-C1	103.79 - 103.95	4.086 - 4.093		
501838-C1	104.37 - 104.53	4.109 - 4.115		
501839-C1	104.96 - 105.12	4.132 - 4.139		

If substitution is necessary, pull out the piston rod using a slight twisting motion. Lubricate the substitute roc with clean power steering fluid and press into the hydraulic power head using a slight twisting motion. Press down firmly to make sure the rod is seated.

After substitution, recheck the piston rod extension using gauge SE-2773. Repeat the substitution, if necessary, to bring the piston rod extension within specifications.

VACUUM BOOSTER DISASSEMBLY (Refer to Fig. 9)

- 1. Scribe alignment marks on front and rear housings to facilitate reassembly.
- 2. Remove housing clamp. Use care when removing clamp since the booster assembly is spring loaded.
- 3. Separate the rear housing, power piston assembly and return spring from front housing.
- 4. Remove vacuum check valve elbow and grommets from front housing.
- 5. Remove clevis from push rod.
- 6. Remove the boot and filter from push rod.
- 7. Remove the power piston assembly from the rear housing.

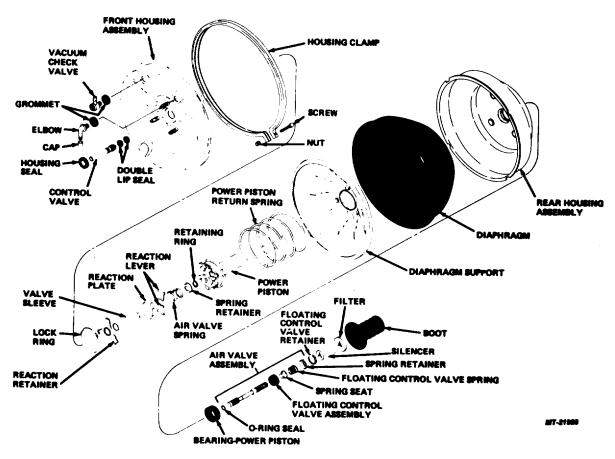


Fig. 9 Exploded View of Vacuum Power Booster

- 8. Remove the power piston bearing from the center opening of the rear housing.
- 9. Remove the lock ring from the power piston by prying one of the ends out from under the large divided locking lug, and then proceeding to pull it from under the other two small locking lugs on the power piston (Fig. 10).

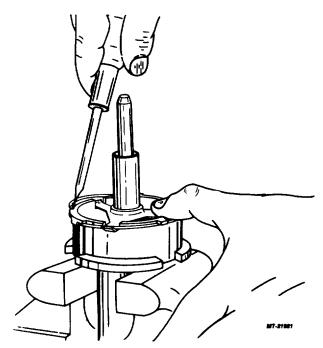


Fig. 10 Removing Snap Ring From Power Piston

10. Remove the reaction retainer - control valve assembly (Fig. 11) reaction plate, two reaction levers and air valve spring.

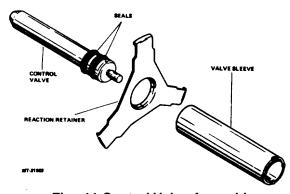


Fig. 11 Control Valve Assembly

11. Remove the air valve spring retainer from the end of the air valve in the power piston.

- 12. Place the square shank end of power piston wrench SE-2774 in a vise. Position the support plate and power piston over the wrench with the tube end of the power piston up (Fig. 12).
- 13. Pull the diaphragm ends away from the support plate so the hands can grip the steel support plate (Fig. 13).

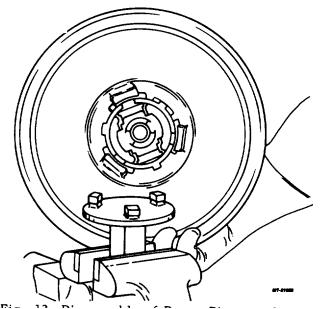


Fig. 12 Disassembly or Power Piston and Diaphragm

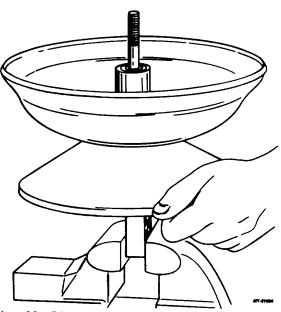


Fig. 13 Disassembling Power Piston and Diaphragm

- 14. Press down on the support plate and rotate (clockwise) until the support plate separates from the power piston. Remove the diaphragm and support plate.
- 15. Separate the diaphragm from the support plate and lay both parts aside.
- 16. Remove the silencer from the neck of the power piston tube.
- 17. Use a snap ring pliers to remove the snap ring from the air valve (Fig. 14).

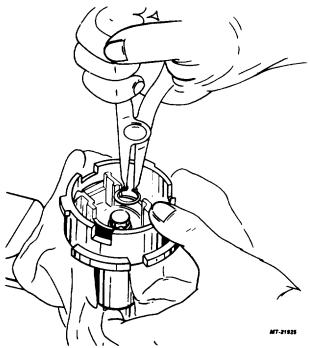


Fig. 14 Removing Snap Ring From Air Valve

- 18. Reassemble pedal clevis on push rod. Insert a screw driver through the clevis (Fig. 15) and use the screw driver as a puller to remove the air valve assembly from the power piston tube.
- 19. Remove the O-ring, floating control valve, retainer, spring retainer, spring, spring seat, and floating control valve assembly from the air valve assembly.
- 20. Push the control valve from the center of the valve sleeve. Remove the two double lip seals from the grooves in the control valve.

CLEAN AND INSPECTION

Clean parts in denatured alcohol. Use dry filtered compressed air (not lubricated shop air) to dry parts and blow out all passages.

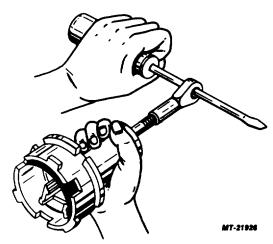


Fig. 15 Using a Screwdriver as a Puller

Visually inspect parts for excessive wear or damage that would affect serviceability or cause leakage. Check all parts for cracks, distortion or any other evidence of structural damage.

Repair shall be limited to the replacement of damaged or excessively worn parts. Do not attempt to rework or use abrasives in any form to remove surface defects from internal parts or surfaces.

Replace all rubber parts and other parts included in repair kits at each overhaul.

Use care during the reassembly of power booster so that no grease or mineral oil comes into contact with rubber parts.

Only approved lubricant supplied in vacuum booster repair kits should be used to lubricate rubber parts.

REASSEMBLY

- 1. Place power piston wrench No. SE-2774 in a vise. Position the power piston on the wrench with the three lugs fitting into the notches in the power piston. (Fig. 12)
- 2. Wipe a thin film of lubricant on the O-ring and cylindrical surface of the air valve. In- stall O-ring in second groove of air valve.
- 3. Press the air valve push rod assembly, air valve first, to its seat in the tube of the power piston.
- 4. Lubricate the outside diameter of a new floating control valve assembly.

- 5. Assemble the spring seat, spring and spring retainer to the floating control valve assembly. (Refer to Fig. 9).
- 6. Place the assembled group in the tube of the power piston with the floating control valve assembly end first.
- Using the floating control valve retainer installer No. SE-2771, manually seat floating control valve assembly and retainer in the tube of the power piston (Fig. 16).

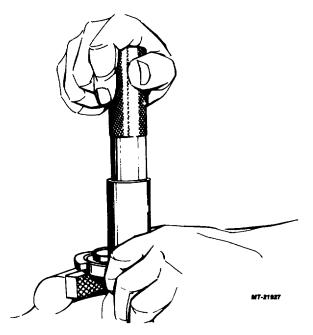


Fig. 16 Seating Floating Control Valve Retainer

If power piston has been replaced, it will be necessary to gauge power piston clearance to air valve assembly for proper selection of control valve (Fig. 17).

To determine which control valve to use, place the power piston gauge assembly SE-2772 on the three cutout lands on large diameter of power piston. Insert feeler gauge/s to determine clearance between body of gauge and floating pin. (Fig. 17) Then select a control valve from chart to come closest to clearance determined by feeler gauge/s.

Control valves are identified by grooves midway on outside diameter.

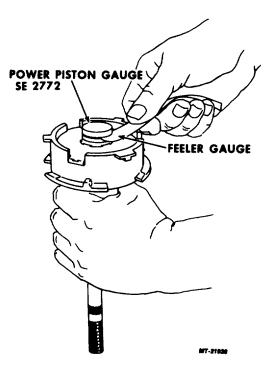


Fig. 17 Gauging Power Piston Assembly

IMPORTANT

If a new control valve is installed it will also be necessary to regauge piston rod (output rod) of hydraulic booster when the two units are reassembled. Refer to HYDRAULIC BOOSTER - REASSEMBLY (item 6) located in this chapter.

CONTROL VALVE CHART			
Clearance Determined		ID Grooves	Part No.
By Feeler Gauge			
Millimeters	Inches		
1.016 - 1.295	.040051	1	501825-C1
.711991	.028039	2	501826-CI
.381686	.015027	3	501827-CI

- 8. Press the silencer over the end of the push rod and into the power piston tube.
- 9. Assemble the diaphragm to the diaphragm support plate. Press the raised flange of the diaphragm through the hole in the center of the support plate. Be sure the edge of the center hole fits into the groove in the flange of the diaphragm.

- 10. Pull the diaphragm away from the outside diameter of the support plate so the metal of the support plate can be gripped with the hands. Wipe the diameter on the diaphragm that contacts the power piston with lubricant supplied in repair kit.
- Place support plate and diaphragm down over the tube on the power piston. Press down and turn the support plate counterclockwise until the locking lugs on the power piston come against the stops on the support plate (Figs. 12 and 13).
- Turn the piston and diaphragm assembly over and place it with tube down in a padded vise. Do not clamp assembly in the vise.
- With a pair of snap ring pliers, assemble the snap ring into the groove in the air valve (Fig. 14).
- 14. Place the air valve spring retainer to seat on the snap ring (Fig. 9).
- 15. Position the air valve return spring, small end down, on the spring retainer (Fig. 9).
- 16. Place the two reaction levers into position with the ears on the wide end in slots provided for them in the power piston. The narrow ends will rest on the top of the air valve return spring
- 17. Position the reaction plate on top of the reaction levers. Take note that the reaction plate is designed so that it will fit only one way in power piston (Fig. 18). Do not force plate as damage to power piston could result. Press down on the plate until the large ends of reaction levers pop up so the reaction plate rests flat on the levers. Be sure the reaction plate is centered.

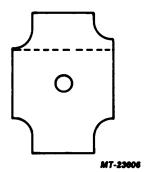


Fig. 18 Reaction Plate

- 18. Fit two new seals in the grooves on the control valve with the lips of the seals toward the tapered end (Fig. 11). Wipe a thin film of power brake lubricant on the seals. Assemble control valve, valve sleeve and reaction retainer as shown in Fig. 11.
- 19. Assemble the control valve sleeve and reaction retainer assembly to the power piston.

- 20. With the tapered end of the control valve up and with the reaction retainer held toward the top of the air valve assembly, place the small (pilot) end of the control valve in the hole in the center of the reaction plate. Align the ears on the reaction retainer with the notches in the power piston and push reaction retainer down until the ears seat in these notches.
- Maintain pressure on the reaction retainer and position the large lock ring down over the control valve assembly.

There is a lug on the power piston which has a raised divider in the center. One end of the lock ring goes under the lug and on one side of the divider (Fig. 10).

As you work your way around the power piston (either way) the lock ring goes over the ear of the reaction retainer, under a lug on the power piston and so forth, until the other end of the lock ring is seated under the lug with the raised divider. Be sure both ends of the lock ring are securely under the large lug and ends of lock ring are against divider.

- 22. Install two new grommets in the front housing and install a new vacuum check valve and the elbow that was removed earlier.
- 23. Place a new power piston bearing in the rear housing center hole so that the formed flange on the housing center hole fits into the groove in the bearing.

The flange and thin lip on the bearing must project out the stud side of the rear housing.

- 24. Coat the I.D. of the power piston bearing with a thin film of lubricant supplied in repair kit.
- 25. Position the front housing on flat clean surface.
- Center the power piston return spring on the front housing.
- 27. Wipe the tube on the power piston group with a thin film of lubricant. Assemble the power piston group to the rear housing by pressing the tube of the piston through the rear housing bearing. Press down until the power piston bottoms against the housing.
- 28. Hold the rear housing and power piston assembly (mounting studs up) over the front housing so that the scribe marks made before disassembly will line up.

A vacuum source may be applied to the vacuum check valve to assist in the final assembly of the booster. Be sure to plug one of the vacuum tubes

- 29. Lower the rear housing into the front housing checking the following:
 - a. Make sure the return spring seats around the power piston.

- b. Be sure that the bead on the outside diameter of the diaphragm is properly seated.
- 30. Reinstall clamp and torque clamp bolt to 4 8 Nm (45 75 in. lbs.).
- 31. Disconnect the vacuum source if used and unplug other vacuum tube.
- 32. Turn over assembly and position on cylinder of sufficient diameter to clear studs and length to accommodate air valve/push rod assembly. Reassemble the hydraulic booster on the vacuum booster if the two units were removed as an assembly. Torque lock nuts to 22 40 Nm (16 30 ft. lbs.).

Remember to gauge the piston rod extension of the hydraulic booster as outlined in this Chapter. Refer to:

- a. REASSEMBLY OF HYDRAULIC BOOSTER (Item 6).
- REMOVE AND REINSTALL, Vacuum Power Booster or Vacuum Power Booster with Hydraulic Power Booster (Items 17, 18 & 19).
- Place the silencer on the tube of the power piston. Slide the silencer down to cover the small holes.
- 34. Install filter in boot and install boot assembly over air valve/push rod assembly and over power piston tube.
- 35. Reinstall pedal clevis on vacuum booster push rod. Adjust clevis so that the center of opening is 178 mm (7") from mounting surface of vacuum booster.

BRAKE PEDAL ADJUSTMENT

The brake pedal adjustment is at the booster control valve (push rod) and clevis. Proper pedal height (travel) will be obtained when the clevis is adjusted to 177.8 mm (7") between booster mounting surface and clevis center opening.

STOP LIGHT SWITCH ADJUSTMENT

The stoplight switch should be adjusted (Fig. 18) so that the clearance between the switch body (not plunger) and pedal lever is 3.048 mm (0.12") when the brake pedal has been properly adjusted.

PARK BRAKE SWITCH ADJUSTMENT

The park brake switch is located at the park brake control lever mechanism (Fig. 19) and should be adjusted (Fig. 20) so that the clearance between the switch mounting bracket and end of switch body is 6.35 mm (.25"). Do not include plunger travel.

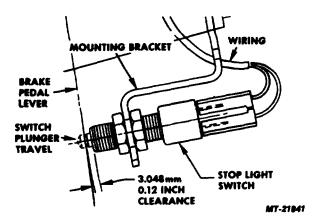


Fig. 19 Stoplight Switch Adjustment

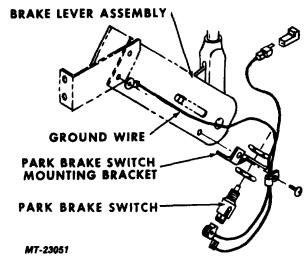


Fig. 20 Park Brake Switch Installation

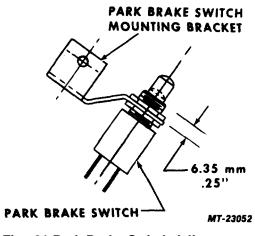


Fig. 21 Park Brake Switch Adjustment



CHAPTER IV

BLEEDING BRAKE SYSTEM AND ROAD TEST

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GENERAL

The DPB installation consists of two separate and distinct hydraulic systems, one serviced with power steering fluid and the other with hydraulic brake fluid. Either or both of these systems shall be bled:

- 1. If trouble-shooting indicates the cause to be air in either or both systems.
- 2. If any component in either or both systems is removed for repair or replacement.

(If the DPB booster and master cylinder are removed together as a unit, then both the power steering fluid and brake fluid systems must be bled).

3. If any hose, tube line or fitting in the system is disconnected for any reason.

CAUTION

When bleeding, take care to identify fluids -- power steering fluid or brake fluid and use only in the proper system. Discard all fluid bled or drained from either system. Do not use for refill, cleaning or any other purpose. Failure to observe these precautions could result in failure of the brake system with resultant personal injury or property damage.

The hydraulic brake system must be free of air to function properly. If air becomes mixed with brake fluid, loss of pedal reserve will result since air in the hydraulic system compresses. On most brakes, a bleeder valve (screw) is provided at each wheel cylinder for removal of any air in the hydraulic brake system. If air should become mixed within the booster system, sluggish brake response will result.

If both the brake fluid system and booster system require bleeding, bleed the booster system first using instructions provided in this Chapter.

BLEEDING THE DUAL POWER MRAKE SYSTEM

Required Procedures

The following procedures, done in the order given, are required to bleed the DPB system.

Before bleeding the system, be sure that all hose clamps, line connectors and fittings are tight enough to prevent the entry of air into the system or fluid leaks. Have enough power steering fluid to maintain fluid in the reservoir at all times during the bleeding procedure.

- 1. Set parking brakes.
- 2. Remove the drag link, at pitman arm, on vehicles with power steering.
 - Use only power steering fluid recommended in LUBRICATION Section (CTS-2412) of Service Manual.
- 3. Fill the reservoir to within 12.7mm (1/2") of the top.

(On models using a remote mounted reservoir, fill the reservoir as described above and then squeeze the hose starting at the pump and working up to the reservoir. This will help eliminate air trapped in the hose).

DO NOT INSTALL THE RESERVOIR CAP DURING THE BLEEDING PROCEDURE

If the engine is stopped during the bleeding operation, power steering fluid will be forced out the top of the reservoir.

A modified reservoir cap can be placed on the reservoir just prior to stopping the engine to direct any overflow into a container.

4. To prevent the entry of air into the system, have a person ready to pour power steering fluid into the reservoir the moment the engine starts. Start the engine and add as much fluid as necessary to keep the level in the reservoir above the pump intake passage. 5. When the engine idle and reservoir fluid level has stabilized, pump the brake three or more times to eliminate air from brake booster Add as much fluid as necessary to keep the level in the reservoir above the pump intake passage.

IMPORTANT

(Vehicles With Power Steering)

Do not turn steering gear hard or fast against gear stops. Excessive force or speed can cause high hydraulic pressure or fluid overheating. This may damage the steering gear and/or power steering fluid pump.

 With the engine at idle speed, on vehicles with power steering, slowly turn the steering wheel as far as it will go in one direction lightly against gear stop. Reverse steering wheel direction 1/2 turn and then back again lightly against gear stop.

Repeat this five times and then turn the <u>steering</u> wheel as far as it will go the opposite direction and lightly bump the gear stop five times.

Maintain oil level in reservoir above the pump intake passage. Turn the <u>steering wheel</u> to the center position and let the, engine idle for a few seconds while installing the overflow cap. Turn off the engine for at least one minute to allow air to bubble out through the improvised overflow cap.

- 7. Remove overflow cap, restart engine and add oil as necessary to maintain oil level above the pump intake passage.
- Repeat the procedures given in steps 3, 4, 5 and 6 as needed (four to five times) until there is not more than one inch rise in reservoir fluid level with engine stopped and reservoir cap off.
 Steps 9, 10 and 11 pertain to vehicles with power steering.
- Start engine and center steering by turning the wheel from one gear stop to the opposite counting the number of turns. Turn steering wheel half the turns back to center and shut off engine
- 10. Connect drag link to pitman arm.
- 11. Start engine and idle at 1500, rpm and turn wheels right and left lightly against wheel stops continuing for two minutes. This should eliminate any air left in the system. Shut off engine, check for leaks and fill reservoir to final fill as marked on integral reservoir or on remote

reservoir and install reservoir cap.

BLEEDING HYDRAULIC BRAKE SYSTEM

Bleeding the brake system consists of forcing brake fluid and any air in the brake fluid out of the hydraulic system at one or more bleed points. There, are two methods of bleeding the hydraulic brake system; manual bleeding and pressure bleeding. For either method of bleeding, a supply of clean hydraulic brake fluid is necessary. Do not reuse brake fluid that has been drained from the hydraulic brake system, as the fluid may be contaminated.

It is recommended that hydraulic system be thoroughly flushed whenever repairs are performed to be assured that hydraulic fluid is not contaminated.

Before bleeding the brake system, the brake light warning switch must be removed to prevent shearing end of pin. Unequal pressure between the split sections of brake system during bleeding could cause warning light switch pistons to shift from side to side and shear switch pin. If pin is sheared off, the body must be disassembled, end of pin re- moved and a new switch installed.

Prior to removing warning light switch, be sure to remove any dirt accumulation around warning switch to avoid entrance of dirt. Refer to RESETTING BRAKE WARNING LIGHT SWITCH INSTRUCTIONS found in Chapter II.

The hydraulic (power steering) pump should not be over filled since the pump could expel fluid when manual bleeding is being performed with a dead engine.

To flush the system, use bleeding procedures outlined herein and flush new brake fluid through system until it appears clean.

The order in which wheel cylinders are bled normally does not affect the quality of the bleeding operation. The following sequence is recommended however, to reduce the possibility of missing a wheel cylinder: right rear, left rear, right front, left front.

MANUAL BLEEDING

Fill the master cylinder fluid reservoirs with clean brake-fluid.

Bleeding Sequence

Be sure to remove the brake warning light switch.

Begin with the master cylinder by loosening the service brake line nuts with steady pressure applied to brake pedal. When all air has been bled from master cylinder move to wheel units, longest line first, beginning with right rear

brake group. Next bleed left rear and so on completing the bleeding of all units and concluding with the left front service brake.

Attach a bleeder tube (hose) to right rear wheel cylinder bleeder valve (screw). Submerge free end of hose in brake fluid in a partially filled glass jar.

Apply steady pressure to brake pedal and open bleeder valve. When fluid coming from submerged end of hose is free of air bubbles, close bleeder valve and release brake pedal. If pedal goes to toe board while bleeding. A wheel cylinder without removing all air bubbles, close bleeder valve and release pedal slowly. Repeat bleeding operation at this same wheel cylinder until clean fluid, free of air bubbles, flows from the submerged end of drain hose. Repeat same procedure at each wheel cylinder until all air is expelled from system. Check level of brake fluid in master cylinder frequently during bleeding operations and keep master cylinder reservoirs at least half full.

Be sure to check the brake fluid level frequently during bleeding procedure. Always use clean, fresh specified fluid.

After completing the bleeding operation be sure that master cylinder reservoirs are filled to 6.4 to 12.7 mm (1/4" to 1/2") from top edge.

PRESSURE BLEEDING

A pressure bleeder and master cylinder adapter for connecting the bleeder to master cylinder reservoir is necessary. An adapter plate is required to maintain fluid level during brake bleeding.

Hydraulic brake fluid level should be 6.4 to 12.7 mm (1/4" to 1/2") from top of master cylinder reservoirs. When pressure bleeder adapter plate is removed, fluid level is too high to too low, add or remove sufficient fluid to bring to correct level.

Be sure there is enough brake fluid in bleeder tank to complete bleeding operation and tank is charged with air pressure of 69 to 207 kPa (10- 30 psi).

Remove reservoir cover and attach pressure bleeder hose to master cylinder using proper adapter. Open valve in pressure bleeder hose and bleed all air out of the hose before connecting it to the adapter. Close valve after making this connection. Then open the valve when ready to begin bleeding to pressurize master cylinder and hydraulic system.

CAUTION

Do not lift, move or shake the tank after air pressure is applied. This may cause sediment at the bottom of the tank to go in suspension in the brake fluid which may result in early failure of the brake system.

Bleeding Sequence

Be sure to remove the brake warning light switch.

Always begin with the master cylinder, bleeding at both service line nuts. Then, bleed the wheel units, longest line first, beginning with the right-rear. Next bleed the left-rear, and so on working through all of the units and concluding with the left-front service brake.

Attach a bleeder tube (hose) to right rear wheel cylinder bleeder valve (screw). Submerge the free end of the hose in a glass jar partially filled with brake fluid. Loosen bleeder valve approximately three-quarter turn.

When fluid coming from the submerged end of the hose is free of air bubbles, close bleeder valve and remove drain hose. Repeat this procedure at each wheel cylinder.

When bleeding operation is completed, close valve in pressure bleeder hose. Enclose connection with shop towel and disconnect pressure bleeder and adapter from master cylinder.

Check hydraulic fluid level to see that both reservoirs are filled to 6.4 to 12.7 mm (1/4" to 1/2") from top edge.

Install master cylinder reservoir cover and diaphragm; secure cover to master cylinder.

ROAD TEST

IMPORTANT

Before road testing a vehicle, depress brake pedal to be sure there is adequate reserve pedal. Make a series of low speed stops to be sure brakes are functioning.



Road test vehicle and check general operation for the following:

- 1. Low Pedal
- 2. Vibrating Pedal
- 3. Spongy or Springy Pedal4. Hard Pedal
- 5. Drag
- 6. Fade
- 7. Pull
- 8. Grab
- 9. Squeal or Other Abnormal Noise
- 10. Lock
- 11. Sluggish Response

If any of the above conditions are noted, refer to TROUBLE SHOOTING CHART (Chapter V) and perform required service to correct problem.



CHAPTER V

TROUBLE SHOOTING	
The following trouble shooting guide may be used as an aid for determining the type of brake service required. guide also lists the possible conditions and corrections.	This



CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
PARK BRAKE LIGHT Key switch in START position Key switch in ON	Light ON Light OFF Light ON at	Normal function of system (Bulb Check) 1. Defective bulb or ignition switch 2. Defective indicator light ground relay (push button start only) 3. Defective park brake diode Faulty EGR diode assembly	None. 1. Replace bulb or ignition switch. 2. Replace defective indicator light ground relay. 3. Replace park brake diode. Replace EGR diode assembly.
position, engine OFF or ON w/Park Brake released *	12,000 miles	,	
BRAKE PRESSUR	<u>E LIGHT</u>		
Key switch OFF	Light OFF	Normal function of system	None.
Key switch in START position	Light ON momentarily	Normal function of system	None.
Key switch in ON position, engine	Light ON	Normal function of system (Bulb Check)	None.
not operating	Light OFF	Faulty bulb	Replace bulb.
Key switch in ON	Light OFF	Normal function of system	None.
position, engine operating	Light ON	 Loss of hydraulic boost Flow switch not operating 	 Hydraulic pump belts loose or broken; adjust or replace. Air in boost system; refill and bleed system. Check for shorted flow switch with engine operating. Check for contaminated flow switch. Replace flow switch.
		3. Low vacuum reserve	3. Check for damaged vacuum hoses or tubes. Repair or replace faulty hoses and tubing.
		4. Low vacuum switch not operating	Check for shorted low vacuum warning switch with engine operating; replace switch.

^{*} Faulty park brake diode could cause EGR indicator light to illuminate.



CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
BRAKE PRESSURI	l <u>E LIGHT (Cont'd.)</u>		
Key switch in ON	Light OFF	Normal function of system	None.
position, engine operating, service brakes applied	Light ON	Loss of hydraulic boost	Hydraulic pump belts loose or broken; adjust or replace. Air in boost system; refill and bleed
		2. Flow switch not operating	system. 2. Check for shorted flow switch with engine operating. Check for contaminated flow switch. Replace flow switch.
		3. Low vacuum reserve	3. Check for damaged vacuum hoses or tubes. Repair or replace faulty hoses or tubes.
		4. Low vacuum switch not operating	4. Check for shorted low vacuum warning switch with engine operating; replace switch.
		5. Brake pressure differential valve	 Faulty warning switch or loss of one side of split brake system. Replace warning switch or repair split brake systems.
BOOSTER Sluggish	Sluggish operation	Air in booster hydraulic system Restricted hose or line	Bleed hydraulic booster system. Check for pinched or kinked hose or line.
		3. Faulty booster	3. Remove and disassemble booster. Examine and replace all worn parts.
		Contaminated power steering fluid	4. Replace power steering fluid.
BOOSTER AND/OF	R MASTER CYLINDER		
Leakage	At -master cylinder mounting	Booster or master cylinder leaking	Determine if leakage is hydraulic brake fluid or hydraulic. booster fluid. If brake fluid; repair or replace master cylinder. If booster fluid; repair or replace booster.
	At hydraulic booster to vacuum booster mounting	Booster leaking	Repair or replace hydraulic booster.
	At flow switch	Damaged "O" ring Faulty flow switch	 Replace "O" ring. Replace "O" ring and flow switch.



CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
HYDRAULIC (Po	ower Steering) PUMP		
Noise	Pump noise	 Loose belt Lines touching other parts of chassis Low oil level Aerated fluid 	 Tighten belt. Adjust line position. Fill reservoir. Check fluid level. Locate source of air leak and correct. Bleed hydraulic system.
		5. Contaminated hydraulic fluid6. Excessive back pressure caused by lines or booster head7. Internal damage to pump	 5. Replace fluid and bleed system. 6. Locate restriction and correct. Bleed system. 7. Overhaul or replace pump.
Leakage	Leaks at top of the reservoir	Reservoir too full Air in the oil	 Fill to proper level. Locate source of air leak and correct. Bleed system.
	Leaks at the reservoir	 Ring seal cut O-ring improperly installed 	 Replace O-ring seal. Install seal properly.
	Leaks at the pressure fitting or mounting stud	 Not tightened sufficiently Cross threaded or damaged seat Defective seat on hose end Damaged seals 	 Torque to 41-54 Nm (30-40 ft. lbs.). Replace damaged part. Replace hose. Bleed system. Replace seals.
	Leaks at the shaft seal	Defective seal Damaged shaft	Replace seal. Replace shaft.
Poor or loss of assist	Leaks in metal parts Pump inoperative or poor to no assist	Poor casting Loose drive belt Low oil level	Replace defective parts Tighten belt. Fill reservoir to proper level. Bleed
		3. Air in the oil	system. 3. Locate source of air leak and correct. Bleed system.
		Defective lines or booster Internal damage to pump	4. Overhaul or replace.5. Overhaul or replace pump.
	Relief valve leaking	 Internal damage to pump Relief valve not assembled properly Relief valve spring failed 	 Neassemble relief valve properly. Replace relief valve spring.



CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
LOW PEDAL	Pedal may go to floor under steady pressure	Leak in hydraulic brake system tubes and hoses for leakage - repair or replace faulty parts.	Check master cylinder, wheel cylinders,
	pressure	 Air in hydraulic brake system Poor quality brake fluid (low boiling point). Low brake fluid level hydraulic system. Weak brake hoses that expand under pressure. Improperly adjusted pedal push rod Excessive clearance between drums and linings. Automatic adjusters not working 	 Bleed hydraulic system. Drain hydraulic system and fill with approved brake fluid. Fill master cylinder and bleed Replace defective hoses. Adjust push rod. Adjust drakes. Make several forward and reverse brake stops; if pedal does not come
	Pedal may go to floor on first application only	Bent or distorted brake shoes Residual pressure check valves not holding pressure in lines	up, repair automatic adjusters. 9. Replace shoes and linings in axle sets. 1. Repair or replace master cylinder.
SPRINGY OR SPONGY PEDAL	Pedal has a soft, springy or spongy feel when depressed	 Poor quality brake fluid (low boiling point) Weak brake hoses that expand under pressure. Air in hydraulic system Bent or distorted brake shoes Cracked or thin drums 	 Drain hydraulic brake system and fill with approved brake fluid. Replace defective hoses. Bleed hydraulic system. Replace shoes and linings in axle sets. Replace drums in axle sets.



CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
HARD PEDAL	Excessive pedal	Poor quality brake linings and	Replace with approved shoes and
	pressure is	brake fade.	linings in axle sets.
	required to stop vehicle	Grease or brake fluid soaked linings necessary and replace shoes, linings	2. Repair grease seal, wheel cylinder as
	1 3 3 3 3 3	The state of the s	in axle sets.
		3. Glazed linings	3. Sand lining surface or replace shoes and linings in axle sets.
		4. Damaged or distorted shoes	4. Replace shoes and linings in axle
		5. Scored, barrel-shaped or bell-	sets. 5. Refinish or replace drums in axle
		mouthed drums	sets.
		Faulty power brake system	6. Perform hydraulic & vacuum booster checks listed.
		Hydraulic Booster System	Check power steering fluid pump belt.
			Check output pressure of power
			steering fluid pump.
			Install gauge in inlet line to
			hydraulic booster unit. Gauge should
			read at least 6,175 kPa (750 psi)
			before pedal becomes hard to push.
			Check to insure pedal travel is not
			being interfered with under dash or
			in linkage.
			Disassemble hydraulic booster unit
			and examine all internal parts.
		Vacuum Booster System	Faulty vacuum check valve grommet
			or check valve. Replace as required.
			Collapsed, pinched or damaged
			vacuum hose; repair or replace as
			required.
			Plugged or loose vacuum fittings;
			clean or tighten as required.
			Faulty vacuum power unit; repair or
			replace vacuum power unit, repair of
		7. Clogged master cylinder tubes or	7. Replace tubes or hoses, as necessary,
		, 33	7. Replace tubes of floses, as flecessary,
		hoses 8. Frozen master cylinder piston(s)	8. Repair or replace master cylinder.
= 1. '	y reduction of brake effectiv	A STATE OF THE STA	

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CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
Grabby Brakes	Severe reaction to	Rough or corroded master cylinder bore	Repair or replace master cylinder.
	pedal pressure	2. Binding brake pedal linkage 3. Faulty vacuum booster	 Free up and lubricate. Power brake unit valve trouble. a. Sticking air valve. b. Restricted diaphragm passage. Reaction system. a. Dislodged reaction levers. b. Broken air valve spring. c. Worn or distorted levers or plates. Repair or replace vacuum power
		4. Incorrect or distorted shoes	booster. 4. Replace with correct shoes and linings
		Incorrect linings or linings loose on shoes	in axle sets. 5. Replace with correct shoes and linings in axle sets.
		6. Grease on brake fluid on linings	Repair grease seal or wheel cylinder as required. Replace shoes or lining in axle sets.
		7. Loose or distorted brake backing plate	7. Tighten or replace backing plate.
		Scored, hard spotted or out-of-round drums	8. Refinish or replace drums in axle sets.
<u>Vehicle Pulls</u> To One Side		Faulty suspension parts Incorrect or distorted shoes	Repair suspension system. Replace with correct shoes and lining
<u>10 0110 0140</u>		Incorrect lining or loose lining on	in axle sets. 3. Replace with correct shoes and lining
		shoes.	in axle sets.
		Grease or brake fluid on linings or pads	Repair grease seal or wheel cylinder as required. Replace shoes and lining in axle sets.
		5. Shoes not centered in drums	5. Adjust anchor pins (if equipped with adjustable anchor pins).
		Loose or distorted brake backing plate	6. Tighten or replace backing plate.
		7. Scored, hard spotted or out-of- round drums, or different sized drums on same axle.	7. Refinish or replace drums in axle sets.
		8. Water on linings 9. Sticking wheel cylinder piston	8. Apply brakes a few times to dry linings.9. Repair or replace wheel cylinder.



CONDITION	DESCRIPTION	POSSIBLE CAUSE	CORRECTION
Pulsating Brake Pedal		 Worn or damaged front wheel bearings. Out-of-round drums Bent rear axle 	 Replace bearings. Refinish or replace drums in axle sets. Replace axle.
Noise and Chatter	Squealing, clicking or scraping sound upon brake application	Bent, damaged or incorrect shoes Always replace in axle sets. Worn out lining Foreign material imbedded in linings Broken shoe return springs, shoe holddown pins or shoe holddown springs Rough, grooved or dry shoe ledges or pads on backing plate Cracked or threaded drums (lathe marks)	 Replace with correct shoes and lining. Replace shoes and lining in axle sets. Replace shoes and lining in axle sets. Replace defective parts. Smooth shoe ledges and pads and apply high temperature lubricant. Replace drums in axle sets.
Decreasing Brake Pedal Travel		Plugged master cylinder compensating port(s). Swollen master cylinder seals Weak or broken shoe return springs Sticking wheel cylinder piston	 Repair or replace master cylinder. Repair or replace master cylinder, flush hydraulic system and fill with approved brake fluid. Replace return springs. Repair or replace wheel cylinder,
All Brakes Drag	But brake adjustment is correct	Binding brake pedal Soft or swollen rubber parts caused by incorrect or contaminated brake fluid Plugged master cylinder compensating port(s).	Free up and lubricate, Replace all rubber parts, flush hydraulic system and fill with approved brake fluid. Repair or replace master cylinder.
Rear Brakes Drag		Improper brake shoe adjustment	Adjust shoes and repair automatic adjusters, if necessary.
One Brake Drags		 Loose or worn front wheel bearings Defective brake hose or hydraulic tube (preventing return of brake fluid) Weak or broken shoe return springs Improper brake shoe adjustment Sticking wheel cylinder pistons Swollen wheel cylinder cups Bent or distorted brake shoes 	 Adjust to specifications, or replace. Replace defective hose or tube, as necessary. Replace return springs. Adjust shoes and repair automatic adjusters, if necessary. Repair or replace wheel cylinders. Repair or replace wheel cylinder. Flush hydraulic brake system and fill with approved fluid. Replace shoes and linings in axle sets.



CHAPTER VI TORQUE CHARTS

BRAKE GROUP MOUNTING BOLT-NUT

Tighten the brake group mounting bolts to the torque values listed from the nut side. Since some of the mounting holes in the steering knuckles are of conical design, the knuckle bolts must utilize conical mounting nuts to coincide with the mounting holes in the knuckle. These conical nuts have a smooth cone surface and the torque values are considerably higher than the torque values for regular nuts or prevailing type lock nuts.

FRONT AXLE BRAKE GROUP MOUNTING BOLTS WITH CONICAL TYPE NUTS

TORQUE

Bolt Size	Newton-Meters (N.m)	Foot Pounds (ft. lbs.)
1/2"	135.6-162.7	100-120
5/8"	298.3-325.4	220-240

FRONT AND REAR AXLE BRAKE GROUP MOUNTING BOLTS WITH REGULAR NUTS OR PREVAILING TORQUE TYPE LOCK NUTS

TORQUE

Bolt Size	Newton-Meters (N.m)	Foot Pounds (ft. lbs.)
7/16"	74.6-81.4	55-60
1/2"	115-129	85-95
9/16"	155.9-169.5	115-125
5/8"	216.7-237.3	160-175
3/4"	373.0-406.7	275-300



BRAKES HYDRAULIC GENERAL

SINGLE SYSTEM BRAKE COMPONENTS

The text contained herein does not cover particular brake groups or reconditioning brake drums or shoes.

Refer to specific brake group manual sections for brake group service instructions.

Refer to CTS-2779 for instructions pertaining to reconditioning brake drums and shoes.

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CHAPTER V

TORQUE CHART



CHAPTER I

DESCRIPTION AND MAINTENANCE CHECKS

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DESCRIPTION

The hydraulic system used to actuate the brake mechanism consists of a compensating type master cylinder, in which the hydraulic pressure is originated; individual wheel cylinders, in which the hydraulic pressure is applied, which serve to actuate the brake shoes against the brake drum of each wheel; and the "line" consisting of steel tubing, flexible hose, brackets and unions, interconnecting the master cylinder and wheel cylinders. The master cylinder and wheel cylinders are fitted with pistons, all of which are provided with cup packings, which act as a seal to maintain pressure and prevent loss of brake fluid.

Depressing the brake pedal moves the piston within the master cylinder, thus displacing the brake fluid from the master cylinder through its outlet orifices, tubing and flexible hose connection into the wheel cylinders. The brake fluid, being noncompressible, enters each of the wheel cylinders, causing the cylinder pistons to move outward and actuate the brake shoes. As pressure on the pedal is increased, greater hydraulic pressure is built up within the wheel cylinders and, consequently, greater force is exerted against the shoes.

When the pressure on the pedal is released, the brake shoe retracting springs return the brake shoes to their normal or released position. The return movement of the brake shoes, in turn, causes movement of the wheel cylinder pistons toward their released position, thus forcing the fluid back through the tubing into the master cylinder.

MAINTENANCE CHECKS

The brake system should be checked periodically for evidence of needed repairs.

It is difficult to determine an exact maintenance interval (time or mileage) since vehicles will be used in wide varieties of operational applications and conditions.

Brake adjustment should be checked every 3,000 km (2,000 miles). Brake lining should be inspected every 19,000 km (12,000 miles) or every 12 months which ever occurs first.

Before starting to check out the brake system itself, the following related components on the vehicle should be examined and serviced if found defective.

- 1. Tires.
- 2. Shock absorbers.
- 3. Wheel bearings.
- 4. Suspension.
- 5. Wheel alignment.

The following procedure is given as an aid in checking out the brake system.

BRAKE PEDAL

- Pedal return should be unrestricted when pedal is fully released (see BRAKE PEDAL ADJUSTMENTS in Chapter III).
- Excessive side movement indicates worn pedal mounting.
- 3. Interference should not occur when pedal is depressed.
- 4. There should be ample clearance between pedal and toe board when pedal is fully depressed (brakes applied).
- 5. Pedal height should be corrected (see BRAKE PEDAL ADJUSTMENTS in Chapter III).

POWER CYLINDER

To check power cylinder for correct operation, refer to the respective "Power Cylinder" section of this Service Manual.

MASTER CYLINDER

- 1. Fluid level should be 6.4 to 12.7 mm (1/4 to 1/2") from top of reservoir.
- 2. Master cylinder vent must be clear and unrestricted.
- 3. Check for external leaks at hydraulic line connections or at push rod end.

- 4. Check cup clearance of compensating port by watching for surge of fluid in reservoir when pedal is depressed.
- 5. Internal wear or leaks are indicated by pedal fading away under steady foot pressure (also sign of leak elsewhere in system).
- 6. To check residual check valve operation, depress and release brake pedal. Open bleeder valve and check for spurt of fluid indicating pressure in lines.

STOP LIGHT SWITCH

If stop lights are inoperative, it would indicate either defective bulbs, defective switch, loose or broken connections or switch improperly positioned.

BRAKE LINES, FITTINGS AND HOSES

- 1. Check lines for kinks, dents or rupture.
- 2. Check hoses for abrasion, kinks, soft spots, rupture, collapse, cracks, twists or loose frame supports.
- 3. Examine all connections for leaks.
- 4. Carefully check for incomplete indicated by a bubble between the plys of the flexible hose or a torn inner line (Fig. 1).

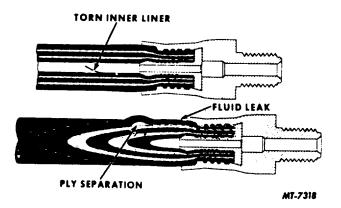


Fig. 1 Flexible Hose Damage

5. Brake line fittings will sometimes become rusted or corroded to the wheel cylinder and/or brake line. Be careful not to twist the line causing a line fracture during removal or installation. Brake line open ends should be capped to prevent the entrance of foreign material.

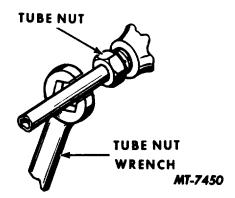


Fig. 2 Use of Tube Nut Wrench



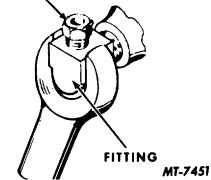


Fig. 3 Protecting Fitting Against Damage **During Removal or Installation**

Always use correct type and size of wrench on fittings (Fig. 2).

Avoid damage to female fittings by supporting fitting with a spare tube nut during removal or installation (Fig. 3).

6. Use only steel tubing when replacement is Use old tubing as a pattern for required. forming and routing the new. Avoid kinks and sharp bends when forming tube. Use tubing cutter to cut tubing to required length making allowance for flare at each end of the tube.

Assemble tube nuts on tubing before flaring. After flaring tube, blow out with air pressure to remove any particles of dirt or chips.

Do not discard old tube nuts until you are certain that new ones are available.

WHEEL CYLINDERS

Pull back rubber boots and check for leaks. cylinders are disassembled, look for dirt. corrosion or pitting.

HYDRAULIC BRAKE FLUID

As a result of use, brake fluid becomes contaminated and loses some of its original qualities. It is good practice to bleed the brake system until all old fluid is removed when performing major brake work. Also, the old fluid should be bled from the system and replaced with clean brake fluid if any of the hydraulic system parts are corroded, fluid is discolored, contains water or is dirty.

If any of the rubber parts of the hydraulic system are soft or swollen, old fluid should be removed; the hydraulic system should be flushed with alcohol or clean brake fluid and refilled with brake fluid. (All cups and seals should also be replaced.) Do not reuse old brake fluid. For type of fluid, refer to CTS-2412 in your Service Manual under LUBRICATION.

BRAKE GROUPS

1. Check linings for being too thin, uneven wear, damaged, soiled with grease or brake fluid, or for being loose on the shoes. Whenever brake linings or blocks are worn to within .79 mm (1/32") of rivets on light duty vehicles or 1.59 mm (1/16") of rivets on medium or heavy duty vehicles, the brake shoes must be removed and relined. It is recommended that all the brakes be relined at the same time since this will maintain balanced braking of the vehicle. If complete replacement is not desirable or necessary, be sure that all lining on one axle (both sides) is replaced at the same time.

IMPORTANT

Intermixing of various types of lining material other than that specified is not recommended.

- Examine brake shoes for worn anchor ends, damaged rims or webs, or cracked or broken welds.
- Mechanical parts should be checked for heat damage, broken ends or loss of tension in shoe return springs, wear or corrosion of shoe holddown pins, springs and cups, wear on adjusting screw, looseness of mounting or anchors and worn shoe ledges on backing plate.

DRUMS

1. Check brake drums for scores, heat checks, outof-roundness and oversize. Wheel bearings should be checked for wear. Also, check grease seals for evidence of grease leaks. Refer to WHEEL Service Manual sections.

VACUUM POWER CYLINDER (Hydrovac) AIR CLEANER

Vehicles with vacuum power cylinders, which do not have a direct air source to the engine air cleaner, will have a frame mounted air cleaner (Fig. 4 and 6). This air cleaner may be located either on the outside of the frame or to the inside of the frame.

If this air cleaner is mounted on the outside of the frame, it is suggested that it be relocated inside the frame away from direct road splash from the wheels.

The location of this air cleaner will be on the left frame rail under the cab in the area adjacent to the power cylinder.

Maintenance Interval Replaceable Element Type (Fig. 4)

19,000 km (12,000 miles)

Remove element and clean by tapping gently on a flat surface or use low air pressure. DO NOT WASH OR OIL DRY ELEMENT. 58,000 km (36,000 miles)

Replace element.

Vehicles operating under multi-stop or severe dust conditions will require cleaning or replacement of filter element more often.

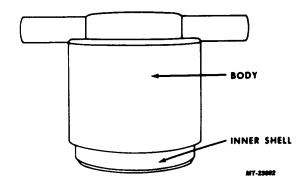


Fig. 4 Air Cleaner Assembly (Replaceable Element Type)

Removal and Installation Procedures of Element (Fig. 5)

- 1. Turn inner shell counter clockwise with hands or suitable size shop tool.
- 2. Remove element from shell.
- 3. Clean inside of air cleaner body and inner shell.
- 4. Clean or replace element.
- 5. Position element in inner shell and tighten shell snug. Then turn inner shell 1/8 additional turn.

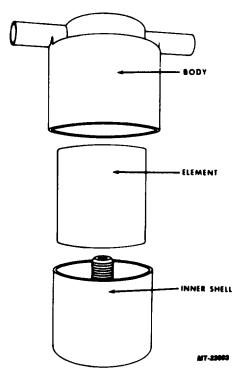


Fig. 5 Exploded View of Replaceable Element Type Air Cleaner

Maintenance Interval of Throw-Away Type (Fig. 6)

19,000 km (12,000 miles)

Remove complete air cleaner assembly and install new air cleaner.

Vehicles operating under multi-stop or severe dust conditions will require replacement more often.

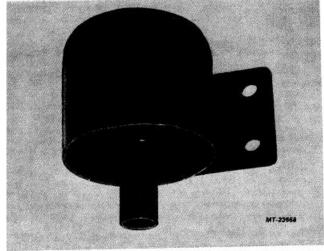


Fig. 6 Throw-Away Type Air Cleaner Assembly

CAUTION

A vehicle accident could result if the vehicle is operated while any of the foregoing items need attention or if any other brake system service requirements are "suspected.



CHAPTER II

OPERATION

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MASTER CYLINDER

The combination or compensating type master cylinder (Fig. 1) consists of a barrel and tank casting, residual check valve (L), piston cup return spring (I), piston cup (D), piston (B), piston stop (P), boot (G) and push rod (A).

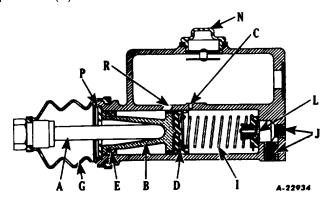


Fig. 1 Typical Master Cylinder

The fluid reservoir or supply tank is cast integrally over the master cylinder barrel. A combination filler and breather plug (N) permits atmospheric pressure on the reserve fluid at all times.

Depression of the pedal causes piston (B) and cup (D) to move forward in the cylinder barrel. A very small forward movement of cup (D) closes compensating port (C) and the pressure stroke commences.

Minimal pressure is built up until the fluid displaced has caused all shoes to go into contact with their drums. Additional pressure on the pedal produces higher hydraulic pressure within the brake system.

Removal of the operator's foot from the brake pedal after each brake application permits the brake pedal and push rod (A) to return independently to their off position.

The return of piston (B) and cup (D) is accomplished by the piston return spring (I).

The piston for this type of unit is designed to carry a primary cup (D) and a secondary cup (E). The construction of the piston is such that reserve fluid from the tank passes through vent (R) in a recessed area.

Thus, we have fluid on both sides of the primary cup. The secondary cup (E) is merely a seal to prevent loss of reserve fluid into boot (G).

The primary compensating function is to maintain a constant volume of fluid in the system at all times, regardless of expansion (heat) or contraction (cold). The secondary compensating function is the replacement of additional fluid into the system to counterbalance any loss due to gravity seepage.

The return of piston (B) and cup (D) can be faster in displaced volume than the return of the fluid through fitting (J) into the master cylinder. A momentary vacuum is created in the cylinder barrel and additional fluid is drawn into the system through the drilled holes in piston (B) and past the lip of cup (D). The operating fluid returns more slowly from the wheel cylinders and lines back into the master cylinder barrel. Any excess is bypassed by port (C) into the reservoir. Thus, we have a cylinder full of fluid for the next brake application.

Fig. 2 illustrates a master cylinder equipped with a bleeder valve located in the cylinder barrel. This bleeder valve is commonly used in the larger stroke master cylinders. Its purpose is for expelling any air that may be trapped in the upper head end of the cylinder barrel.

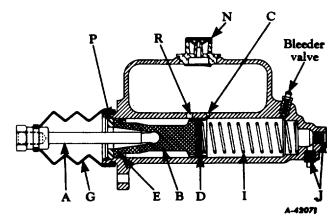


Fig. 2 Typical Master Cylinder with Bleeder Valve

The master cylinder (Fig. 2) is not equipped with a residual check valve. The valve is located in the power cylinder when this master cylinder is used.

Inspect the master cylinder at the time of making brake adjustment for correct fluid level.

Fluid should be within 6.4 to 12.7 mm (1/4 to 1/2") from the top of the filler neck. Do not fill the supply reservoir to the top of the filler neck.

When removing the supply reservoir filler cap, extreme care must be used to prevent dirt or moisture from entering the master cylinder.

POWER CYLINDER

The power cylinder assembly, whether it be a vacuum power booster or a compressed air booster, is designed to supplement the usual manual brake operation. The power brake units often appear different in shape and arrangement and internal components may also appear different; however, all function in the same manner. The operating force is controlled by a valve mechanism and exerted against a stroking device which converts it into pressure for braking.

Figures 3 and 4 illustrate two typical type vacuum power units. Complete detailed instructions pertaining to operation, description and overhaul for a particular unit may be found elsewhere in this service manual.

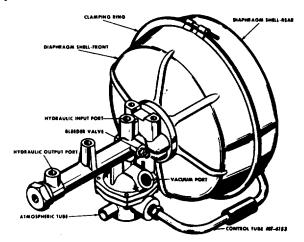


Fig. 3 Vacuum Power Cylinder

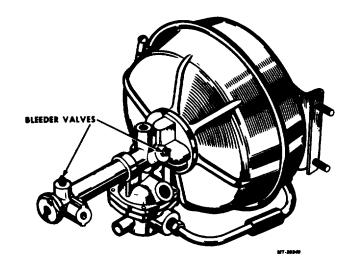


Fig. 4 Vacuum Power Cylinder

RESIDUAL CHECK VALVE

The residual check valve (Fig. 1), item L) maintains 41 to 124 kPa (6 to 18 psi) hydraulic pressure in the hydraulic system beyond the master cylinder to provide sealing of wheel cylinder piston cups with released brakes.

The valve isolates a momentary vacuum which may occur in the master cylinder. This pressure will not cause the brake shoes to drag, as the shoe return springs overcome the residual pressure in the hydraulic system.

During manual bleeding the valve assists pumping fluid through the system by closing every time the brake pedal is released. If the valve should fail to hold the residual pressure, a very small leak or even road shock over a period of time could cause increased pedal stroke and a spongy pedal feel.

The residual check valve action can be inspected by cracking a bleeder screw open. A small spurt of fluid will indicate residual pressure.

On vehicles equipped with certain type power cylinders, the check valve is located in the power cylinder slave cylinder tube; where this is the case. no check valve is used in the master cylinder. (Refer to power cylinder section specifications for the particular unit involved.)

WHEEL CYLINDERS

Two types of wheel cylinders are used in the hydraulic brake system. Different combinations of these two types of cylinders are used on different model trucks. Fig. 5 illustrates a single.

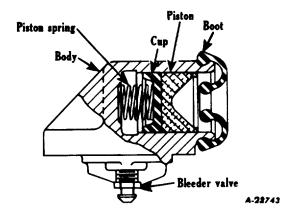


fig. 5 Typical Wheel Cylinder (Single-Piston Type)

piston wheel cylinder and Fig. 6 illustrates a doublepiston wheel cylinder. The wheel cylinder assembly is the unit that changes the applied hydraulic pressure into mechanical force to actuate the brake shoes.

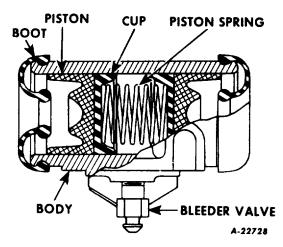


Fig. 6 Typical Wheel Cylinder(Double-Piston Type)



SUBTITLE HERE!!!

CHAPTER III CLEANING, INSPECTION AND SERVICE

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MASTER CYLINDER AND WHEEL CYLINDERS

It is possible to rehone most cylinders and place them in good working condition; however, this requires the use of up-to-date honing equipment. A cylinder hone kit is available under number SE-1679.

Cylinder castings may be degreased or cleaned with most commercial parts cleaners, provided they are thoroughly rinsed with denatured alcohol or clean brake fluid to remove all traces of solvent. Use compressed air or a lint-free cloth to dry parts after removing them from the cleaning solvent. All hydraulic parts must be thoroughly cleaned and protected (after cleaning) from dust or other air-borne foreign material until reassembly. Do not use cotton waste for cleaning or drying parts, as particles of lint or thread fibers may block the compensating ports when cylinder is placed in service. Clean rubber parts by washing them in clean denatured alcohol or hydraulic brake fluid.

IMPORTANT

Do not use minter-base cleaning solvents such as gasoline, kerosene, distillant, carbon tetrachloride. acetone, paint thinner, etc. to clean rubber parts. These solvents attack rubber parts, causing them to become soft, tacky and swollen in an extremely short time.

After cleaning, hold the cylinder casting toward a strong light and sight through the cylinder bore. Blemishes such as pitting, scratches and visible wear patterns necessitate unit replacement.

Accumulations of dirt or gummy substances, not removed during the cleaning process, may be removed with crocus cloth or jewelers rouge.

A hone (SE-1679) may be used to "clean-up" the cylinder provided its use does not materially increase the diameter of the cylinder bore.

If master or wheel cylinders must be honed, remember that the cylinder diameter must not be materially increased. In other words, scratches and pits in cylinder walls render the unit useless, as honing the bore sufficiently to remove them would increase the bore diameter to the point that new piston cups will not seal properly. The possibility that the cylinder may have been honed during a previous overhaul should not be overlooked.

IMPORTANT

After honing a cylinder and obtaining a blemish free bore, check the maximum piston clearance using a 6.35 mm (1/4") wide feeler gauge with a thickness as follows:

Cylinder Bore		Gauge Thick	ness
mm	Inch	mm	inch
19.050-30.163	3/4-1 3/16	.1524	.006
31.750-36.513	1 1/4-1 7/161	.1778	.007
38.100-Up	1 1/2-Up	.2038	.008

If the piston can be inserted with the feeler gauge in the cylinder bore, the unit should be replaced. If the piston cannot be inserted, the cylinder may be reused.

Be certain that the honed cylinder has no burr at the compensating or inlet ports, as it would damage the new piston cup lip. If a burr or sharp edge is present anywhere in the cylinder bore, it must be removed.

At final inspection, be certain that the master cylinder compensating ports are open. A soft copper wire may be used to probe the compensating port. Do not use a steel wire.

Wheel cylinders should be reconditioned whenever brake lining is replaced because of the following:

- 1. As lining wears, wheel cylinder rubber cups move back and forth over a new, widened smooth area.
- Corrosion and foreign matter builds up on the part of the cylinder walls where cups do not work.

- When new thick lining is installed, cups are pushed closer together and must function over the roughened surface.
- 4. Since cups no longer seat against smooth cylinder walls, they allow fluid to leak out.

BRAKE PEDAL ADJUSTMENT

When the brake control system is in the released position, the foot brake pedal should have 6.4 mm (1/4") free travel (Fig. 1) before the pressure stroke starts. This free travel is required to prevent blocking of the compensating port in the master cylinder. Brakes will drag if the compensating port becomes blocked due to pressure building up in the system. Shorten the pedal stop rod to allow the piston to uncover the compensating port allowing fluid to escape into the reservoir.

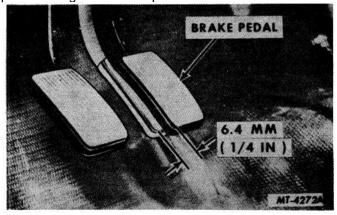


Fig. 1 Brake Pedal Free Travel

BLEEDING BRAKE SYSTEM

The hydraulic brake system must be free of air to function properly. If air becomes mixed with the brake fluid, loss of pedal reserve will result since the air in the hydraulic system compresses. A bleeder valve (screw) is provided at each wheel cylinder for removal of any air in the hydraulic brake system.

Bleeding the brake system consists of forcing brake fluid and any air in the brake fluid out of the hydraulic system at one or more bleed points. There are two methods of bleeding the hydraulic brake system; manual bleeding and pressure bleeding. For either method of bleeding, a supply of clean hydraulic brake fluid is necessary. Do not reuse brake fluid that has been drained from the hydraulic brake system, as the fluid may be contaminated or contain dirt.

The order in which wheel cylinders are bled normally does not affect the quality of the bleeding operation. The following sequence is recommended, however, to reduce the possibility of missing a wheel cylinder: right rear, left rear, right front, left front.

PRESSURE BLEEDING

A pressure bleeder with adapter plate for connection to the master cylinder reservoir is necessary to pressure bleed the brake system.

The adapter plate is designed to permit a transfer of fluid to maintain fluid level during brake bleeding.

Hydraulic brake fluid level should be approximately 12.7 mm (1/2") from top of master cylinder reservoir. If, when pressure bleeder adapter plate is removed, fluid level is too high or too low, add or remove sufficient fluid to bring to correct level.

Be sure there is enough brake fluid in the bleeder tank to complete the bleeding operation and the tank is charged with 69 207 kPa (10 30 psi) air pressure.

Remove reservoir cover and attach pressure bleeder hose to master cylinder using proper adapter. Open the valve in the pressure bleeder hose to pressurize the master cylinder and hydraulic system.

Attach a bleeder tube (hose) to right rear wheel cylinder bleeder valve (screw), Fig. 2.

Submerge the free end of the hose in a glass jar partially filled with brake fluid. Loosen bleeder valve approximately three-quarter's turn.

When fluid coming from the submerged end of the hose is free of air bubbles, close bleeder valve and remove drain hose. Repeat this procedure at each wheel cylinder.

When bleeding operation is completed, close the valve in the pressure bleeder hose. Enclose connection with shop towel and disconnect pressure bleeder and adapter from master cylinder.

Check hydraulic fluid level to see that reservoir is filled to within 12.7 mm (1/2") from top edge.

Install master cylinder reservoir cover.

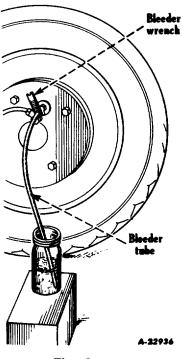
MANUAL BLEEDING

Fill the master cylinder fluid reservoir with clean brake fluid. Attach a bleeder tube hose to the right rear wheel cylinder bleeder valve (screw). Submerge the free end of the hose in brake fluid in a partially filled glass jar, Fig. 2.

Apply steady pressure to the brake pedal and open the bleeder valve. When fluid coming from submerged end of hose is free of air bubbles, close bleeder valve and release brake pedal. If pedal goes to the toe board while bleeding a wheel cylinder without removing all air bubbles, close the bleeder valve and release pedal slowly. Repeat bleeding operation at this same wheel cylinder until clean fluid, free of air bubbles, flows from the submerged end of the drain hose. Repeat same procedure at each wheel cylinder until all air is expelled from system. Check level of brake fluid in master cylinder frequently during the bleeding operations and keep master cylinder reservoir at least half full.

Refill reservoir to correct level with new brake fluid and install reservoir cover.

Fluid withdrawn in the bleeding operation or fluid whose cleanliness is questionable should never be used. Fluid should be replenished in the supply reservoir after each cylinder is bled. Should the supply reservoir be drained during the bleeding operation, air will enter the system and rebleeding will then be necessary.



CHAPTER IV

TROUBLE SHOOTING

Problems pertaining to the brake system are usually those which appear in the TROUBLE SHOOTING CHART. Brake troubles are easily diagnosed if the problem is understood. The driver may report certain symptoms; however, the report may not be of any benefit in your analysis. Be sure to have the driver tell you which of the problems he has encountered. In some instances, you may want to road test the vehicle to assist you in your analysis.

PROBLEM	POSSIBLE CAUSE	REMEDY
Low Pedal (excessive pedal travel to apply	Shoes improperly adjusted.	Adjust brakes.
brakes)	Worn linings.	Replace lining.
	Brake shoes bent or distorted.	Fill reservoir with approved fluid to correct level.
	Air in system.	Bleed system and fill reservoir to correct level.
	Poor quality brake fluid (low boiling point).	Replace with approved brake fluid.
	Soft or weak hoses (expanding under pressure).	Replace.
	Brake drums cracked or too thin (expanding when hot).	Replace.
	Automatic adjuster corroded, distorted or broken.	Repair or replace and lubricate.
	Leak in system.	Check system for leaks with brakes applied. Repair leaks.
	Power cylinder leakage.	Repair or replace power cylinder assembly.
<u>Dragging Brakes</u> (slow or incomplete release of brakes, either one wheel or all wheels)	Mineral oil in system.	Disassemble, clean and flush system. Replace piston cups throughout system. Fill system with approved brake fluid, bleed system
,	Insufficient pedal height.	and refill with fluid. Check pedal for alignment, bind or being bent; incorrectly positioned stop light switch.
	Shoes improperly adjusted.	Adjust brake shoes.
	Shoes distorted or incorrect.	Replace with new lined shoes.
	Linings soiled with mineral oil or grease.	Replace linings.



PROBLEM	POSSIBLE CAUSE	REMEDY
<u>Dragging Brakes</u> (slow or incomplete release of brakes, either one	Shoe return springs weak or incorrect. Normally encountered with one wheel drag.	Replace with new springs.
wheel or all wheels) (Continued)	Shoe ledges grooved or rusted.	Smooth ledges and lubricate.
	Loose backing plate.	Tighten.
	Parking brake improperly adjusted.	Adjust parking brake cables.
	Parking brake cables sticking, dirty or corroded.	Free up and lubricate.
	Wheel bearings loose or worn.	Adjust or replace.
	Fluid sluggish.	Flush and refill with approved fluid.
	Brake lines, hoses or connections kinked, clogged, dented or collapsed.	Repair or replace.
	Master cylinder compensating ports blocked by swollen cups or binding pedal or linkage.	Replace cups and/or check pedal and linkage alignment.
	Faulty residual check valve(s) in master cylinder or power cylinder.	Replace valve(s).
	Wheel cylinder cups swollen.	Flush hydraulic system with alcohol to remove contaminated fluid and replace all cups and seals.
	Wheel cylinder bore rough or corroded.	Repair or replace wheel cylinders.
	Brake pedal linkage binding or misaligned.	Free up linkage, align and lubricate.
	Control valve or power cylinder defective.	Replace defective part or power unit.
	Master cylinder bore rough or corroded.	Repair or replace master cylinder.
	Brake pedal bent.	Straighten or replace.
	Stop light switch incorrectly positioned.	Adjust position of stop light switch.
	Broken master cylinder piston return spring.	Replace spring.

PROBLEM	POSSIBLE CAUSE	REMEDY
Spongy Pedal (springy	Warped brake shoes.	Replace shoes.
sensation to pedal upon application)	Shoes not centered in drum causing partial lining-to-drum contact.	Adjust brake shoe anchors.
	Brake drums tapered, out-of-round or worn thin.	Refinish if practical or replace.
	Air in system. proved hydraulic fluid.	Bleed and refill system with ap-
	Hoses soft or weak (expanding	Replace hoses.
	under pressure). Faulty residual check valve(s) in master cylinder.	Replace valve(s).
	Wheel cylinder cups soft or swollen.	Flush hydraulic system with alcohol to remove contaminated fluid and replace all cups and seals.
Hard Pedal (excessive	Shoes worn, distorted or damaged.	Replace brake shoes.
pedal pressure required to stop vehicle)	Inadequate lining to drum clearance.	Properly adjust brake shoes.
	Linings worn, glazed, soiled (brake fluid or grease) or of poor quality.	Replace linings.
	Brake lines, hoses or connections kinked, collapsed, dented or clogged.	Repair or replace.
	Master cylinder cups swollen.	Flush hydraulic system with alco- hol to remove contaminated fluid
	Master cylinder bore rough or corroded.	and replace all cups and seals. Repair or replace master cylinder.
	Brake shoe anchors out of adjustment	Adjust anchors.
	Brake shoe ledges rusted or grooved.	Clean and smooth ledges and lubricate.
	Wheel cylinder cups swollen.	Flush hydraulic system with alco- hol to remove contaminated fluid
	Wheel cylinder bore rough or corroded	and replace all cups and seals. Repair or replace wheel cylinders.
	Power cylinder check valve defective or sticking.	Replace.
	Vacuum lines to power cylinder loose, broken or collapsed.	Tighten or replace.
	Low vacuum supply to power cylinder. Control valve, power cylinder,	Check for restricted, kinked or leaking line; also engine vacuum. Replace defective part or power
	piston or diaphragm defective.	cylinder.



PROBLEM	POSSIBLE CAUSE	REMEDY
Grabbing or Pulling	Tires not properly inflated.	Inflate tires to correct pressure.
(severe reaction to pedal pressure and out-of-line stops)	Spring U-bolts loose.	Tighte U-bolts to correct specs.
	Shoes improperly adjusted. Brake shoes distorted or incorrect.	Adjust brake shoes. Replace with new correct shoes.
	Linings incorrect, loose on shoes or soiled w/grease or brake fluid.	Install new correct linings.
	Brake shoe anchors not properly adjusted (causes incorrect lining to drum contact).	Adjust brake shoe anchor.
	Loose brake backing plate. bolts and readjust brakes.	Tighten backing plate mounting
	Brake shoe return springs weak, broken or incorrectly installed.	Replace or install correctly.
	Automatic adjuster parts, if equipped, corroded, distorted or broken.	Free up and lubricate or replace.
	Wheel bearings loose.	Adjust wheel bearings.
	Brake drum too thin (expand when hot).	Replace drum.
	Brake drum scored hard, spotted or out-of-round.	Refinish or replace drum.
	Lines, hoses or, connections kinked, clogged, collapsed or dented.	Repair or replace.
	Master cylinder bore rough or corroded.	Repair or replace master cylinder
	Wheel cylinder cups swollen.	Flush hydraulic system with alcohol to remove contaminated fluid and replace all cups and seals.
	Wheel cylinder bore rough or corroded.	Repair or replace wheel cylinder.
	Wheel cylinders mismatched.	Replace with correct cylinders.
	Pedal linkage binding.	Free up and lubricate.
	Power cylinder control valve defective.	Replace control valve.
	Power cylinder diaphragm plate binding and suddenly releasing. Power cylinder control valve rod binding at pedal.	Clean, repair and lubricate. Free up and lubricate.

PROBLEM	POSSIBLE CAUSE	REMEDY
Fading Pedal (pedal falling away under steady foot pressure)	Brake drums cracked or thin (expanding when hot causing too much clearance.	Replace brake drums.
pressure)	Poor quality brake fluid (low boiling point).	Replace with approved brake fluid.
	Hose or line connections loose, ruptured or damaged causing leakage.	Tighten or replace.
	Primary cups of master cylinder pistons worn or damaged; master cylinder bore corroded or worn.	Repair or replace master cylinder.
	Wheel cylinder cups worn or damaged; bores worn or corroded.	Repair or replace wheel cylinder.
Noise and Chatter (squealing, clicking or	Brake shoes twisted, distorted, incorrect or broken; cracked welds.	Replace brake shoes.
scraping noise upon application of brakes)	Linings worn out, glazed, incorrect, loose or soiled w/grease or brake fluid; foreign matter imbedded in linings; incorrect grind or lining position.	Replace with new lined brake shoes.
	Brake shoe rerurn springs weak; anchor pins or backing plate loose or defective; hold-down parts defective.	Tighten or replace parts and lubricate all points of wear.
	Shoe ledges rough or grooved.	Smooth ledges and lubricate.
	Brake drums thin, cracked, loose or scored.	Refinish or replace.
	Power cylinder control valve defective causing excessive noise.	Repair or replace valve.
	Power cylinder check valve broken or leaking.	Replace valve.

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CHAPTER V

TORQUE CHART

BRAKE GROUP MOUNTING BOLT-NUT

Tighten the brake group mounting bolts to the torque values listed from the nut side. Since some of the mounting holes in the steering knuckles are of conical design, the knuckle bolts must utilize conical mounting nuts to coincide with the mounting holes in the knuckle. These conical nuts have a smooth cone surface and the torque values are considerably higher than the torque values for regular nuts or prevailing type lock nuts.

FRONT AXLE BRAKE GROUP MOUNTING BOLTS WITH CONICAL TYPE NUTS

BOLT SIZE	TORG	TORQUE	
	Newton-Meters (N.m)	Foot Pounds (ft. lbs.)	
1/2"	135.6-162.7	100-120	
5/8"	298.3-325.4	220-240	

FRONT AND REAR AXLE BRAKE GROUP MOUNTING BOLTS WITH REGULAR NUTS OR PREVAILING TORQUE TYPE LOCK NUTS

BOLT SIZE	TORQUE	
	Newton-Meters (N.m)	Foot Pounds (ft. lbs.)
7/16"	74.6-81.4	55-60
1/2"	115-129	85-95
9/16"	155.9-169.5	115-125
5/8"	216.7-237.3	160-175
3/4"	373.0-406.7	275-300

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BRAKE SHOE ADJUSTMENT AND SERVICING

SIZE CENTIMETERS (cm) INCHES 04112, 04131 38.1 x 8.9 15 x 3 1/2 04118, 04128 38.1 x 7.6 15 x 3 04120 35.9 x 6.3 14 x 2 1/2 04132 38.1 x 12.7 15 x 5

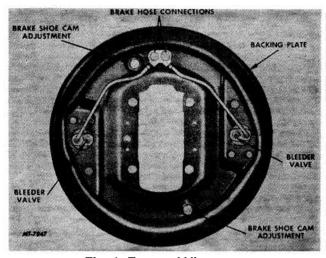
TWO SINGLE-END WHEEL CYLINDERS MOUNTED BETWEEN EACH SHOE TOE AND OPPOSITE SHOE HEEL AUTOMATIC BRAKE SHOE ADJUSTMENT

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Retracting Springs and Self-Adjusting Mechanism Components	4
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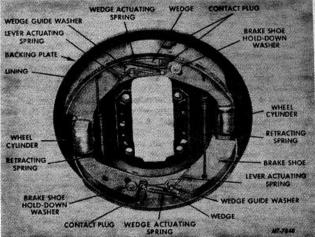


Fig. 1 External View

Fig. 2 Internal View

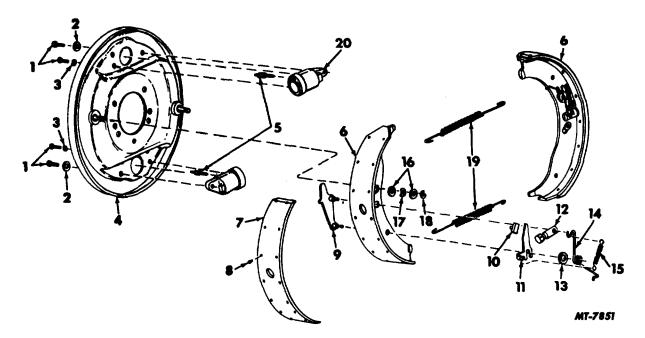


Fig. 3 Exploded View of Brake Group

LEGEND FOR FIG. 3

KEY	DESCRIPTION	KEY	DESCRIPTION
	Bolt, Wheel Cylinder Mounting	11	Wedge, Automatic Adjuster
2	Washer, Wheel Cylinder Mounting Bolt	12	Plug, Drum Contact
3	Washer, Lock, Wheel Cyl. Mtg. Screw	13	Washer, Wedge Retainer
4	Plate, Brake Backing	14	Spring, Adjuster Torsion
5	Valve, Wheel Cylinder Bleeder	15	Spring, Wedge
6	Shoe, Brake	16	Washer, Shoe Guide
7	Lining, Brake Shoe	17	Wave Washer, Shoe Guide
8	Rivet, Brake Lining	18	"C" Washer, Shoe Guide
9	Lever, Automatic Adjuster	19	Spring, Shoe Retracting
10	Guide, Adjuster Wedge	20	Wheel Cylinder

DESCRIPTION

These self-adjusting type brakes have two single end wheel cylinders, each operating a forward acting shoe providing directional braking response. The closed end of the wheel cylinder has a slotted ramp which is the selfcentering sliding anchor for the opposite shoe.

The two wheel cylinder pistons apply equal amounts of hydraulic force to each shoe toe.

Shoes are adjustable manually by means of two hex head friction spring locked studs, exposed on the backing plate (Fig. 1). Each stud rotates an adjuster cam located under a brake shoe table. Shoe hold-downs consist of two plain washers, multi-rattle wave washer between and a C-clip fitted over the extended shank of the cam stud. Two retracting springs are hooked between the shoes and have their longer shanks connected to the anchor end of the shoes.

The function of the contact plug type self adjusting mechanism is to maintain a nearly constant previously set running clearance between brake shoe and drum throughout the life of the brake lining.

The self adjusting mechanism is contained entirely in the brake shoe. This mechanism incorporates a contact plug located in the center of the lining and is the lining wear sensing component. This plug is pinned (lever actuating pin) in a free rotatable manner to the adjusting lever, which in turn makes contact with the manually operated adjusting cam. This lever in turn is pinned (lever pivot pin) in a rotatable manner through a hole in the shoe web. As lining wear progresses, the contact plug is gradually depressed upon successive brake applications and a spring-actuated wedge with serrated teeth on the angular surface advance between the leveractuating pin and a stationary but rotatable serrated wedge pin, thereby maintaining the adjustment.

Force is exerted by the lever actuating spring on the lever actuating pin acting through the wedge and wedge guide pin so as to maintain firm contact between these parts while the brake is in the released position.

Shoe adjustment is accomplished by the adjusting lever changing position with relation to the shoe web as the contact plug is depressed.

The adjusting lever then comes to rest against the adjusting cam, causing the shoe to remain in the advanced or adjusted position.

BRAKE SHOE REMOVAL

- 1. Position vehicle on floor stands so that the wheels are free to turn.
- 2. Remove wheel hub and drum assemblies.
- 3. Secure pistons in wheel cylinders with cylinder clamps.
- 4. Remove brake shoe retracting springs.
- 5. Remove brake shoe guide "C" washer, two shoe guide washers and wave washer from each shoe. Refer to Fig. 3 (items 16, 17 and 18).
- Pull shoes free from adjuster cams and then rotate shoe from brake group freeing ends of wheel cylinders.
- 7. After shoes are removed disassemble self adjuster mechanism on each shoe:
 - a. Disconnect wedge (coil) spring from finger on wedge and remove spring.
 - Unhook torsion adjuster spring from shoe web.
 - Work torsion adjuster spring coil from lever pivot pin and slide U-hook off pluglever pin.
 - d. Pull adjuster lever from opposite side of shoe and contact plug out of shoe table, freeing wedge retaining washer, wedge and wedge guide.

CLEANING AND INSPECTION

Thoroughly clean all parts (except drums) free of dirt and grease with cleaning solvent and wipe dry.

Drums

Friction surface of brake drum must be smooth, true and concentric. Make sure that the drum is not bulged, bell-mouthed, scored or eccentric. Drums must also be inspected for heat checking or chill spotted.

Brake drums should be cleaned thoroughly with a steam cleaner or hot water. Do not use a solvent which leaves an oily residue. If inspection shows the drums may be used without remachining, rub the friction surface with fine emery cloth or sandpaper to remove any foreign deposits. If the drum has been reconditioned, clean the friction surface with fine emery cloth or sandpaper and wash. Next, examine very carefully to see that no metal chips remain in the drum or hub.

Brake Shoes and Lining

Brake shoes must be true and of correct radius.

Wherever brake linings are worn to within 1/16" of rivets, the brake shoes must be removed and relined. It is recommended that all the brakes be relined at the same time since this will maintain balanced braking on the vehicle.

If complete replacement is not desirable or necessary, be sure that lining on one axle (both sides) is replaced at the same time.

When removing worn lining from shoes, drill our old rivets if possible to prevent distorting shoe table. After the old linings are removed from the shoes, the shoes should be cleaned and buffed to remove all dirt and grease. Grease is one of the greatest deteriorating agents of lining.

Examine shoes carefully and discard those which have any of the following defects:

- a. Table twisted or distorted.
- b. Oversize rivet holes.
- c. Cracks in table or web.
- d. Table not square with web.
- e. Anchor end worn.

IMPORTANT

Contact plug must be replaced when new lining is installed. Do not use oversize thickness lining, even though drums are rebored. Do not lubricate adjuster mechanism.

The lining must be installed on the shoe so that it fits smoothly and evenly, contacting the shoe throughout the entire radius. If gaps occur between the rivets, difficulty will be met in adjusting the brakes in that "spongy" or rubbery pedal may occur which makes satisfactory brake application impossible.

To insure complete contact and avoid gaps between lining and shoe, secure lining to shoe with "C" clamp so that rivet or bolt holes are in alignment. Position "C" clamp as close to the holes as possible, clamping the lining firmly in place.

When securing brake lining to shoes, start with the center rivet or bolt and work toward the ends.

When riveting linings, use a roll set to up set the rivets. A star set may split the tubular end of rivet and prevent a tight fit. After the lining is installed, check tightness of lining to shoe with as follows: Use a .152 mm (.006 in.) feeler gauge inserting it between the lining and shoe table. The gauge should not penetrate a gap at any three consecutive pairs of rivets nor at more than three points around the arc of shoe and lining. Nor should it be possible to insert a .2032 mm (. 008 in.)feeler feeler gauge at any point along the arc of the shoe and lining.

If new lining has no contact plug hole, cut a 19.05 mm (3/4") hole and deburr the edges. Locate this hole by making a proper template of the shoe table.

After installing the new lining on the shoes the lining should be ground in a true radius to fit the drum diameter. A brake shoe grinder provided on brake reliner (SE-1272) which is designed to dress the lining in a true radius and fit the drum diameter. This grinder swings the shoe in an arc across the surface of an abrasive wheel.

Wheel Cylinders

Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.

Some brake groups have wheel cylinder piston stops and the wheel cylinder must be removed for reconditioning.

Retracting Springs and Self-Adjusting Mechanism Components

Inspect retracting spring for distortion such as nicks, twisted shanks or spread of coils. Damaged spring must be replaced.

Inspect self-adjusting mechanism components for damage or wear, any piece of which the condition is considered questionable must be replaced.

REINSTALL BRAKE SHOES

 Position wedge guide in shoe web hole on side away from brake backing plate, with serrations facing away from shoe table. Lay wedge with serrations matched against guide and slot aligned over the lever pivot pin hole shoe web (Fig. 4).

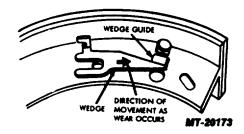


Fig. 4

2. Insert contact plug into the web recess and guide it into the shoe table with plug shank over the wedge guide and wedge. Insert

adjuster lever pins through shoe from the opposite side and mate the actuating (center) pin with the plug shank hole (Fig. 5).

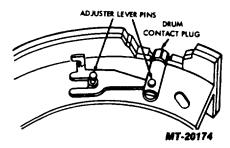


Fig. 5

- 3. Assemble wedge washer over shoulder of pivot pin.
- 4. Slide U-hook of tension spring on pin over contact plug shank.
- 5. Hook one end of wedge (coil) spring on the U-hook, then install coil of torsion spring over the pivot pin and pull free spring hook over the edge of the shoe web. Hook free end of wedge spring over finger on wedge (Fig. 6).

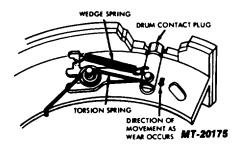


Fig. 6

6. Press lightly upon contact plug to allow wedge to move and fully retract the wedge against the lever pivot pin. In this position, the plug should be even with lining surface +0.00 to -0.512 mm (+0.00 to -0.006 inch). If plug is high, clamp shoe in a vise so that the jaws of the vice bear against the adjuster lever (Fig. 7) and dress down the plug with a file. Take care not to create a flat spot on the lining. An alternate method is to dress the plug when the shoes are ground to a true radius; however, lever must be blocked in its extended position.

7. Make sure that brake backing plate, wheel cylinder anchor bolts and cylinder mounting screws are tightened securely.

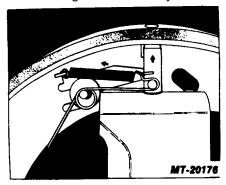


Fig. 7

8. Install shoes on hold-downs, locating each retracting spring so that its long shank is hooked at the anchor end of the shoe.

NOTE

When installing shoe on hold-down, free end of adjuster lever should bear against manual adjuster cam which should be fully backed off to position shown in Fig. 8.

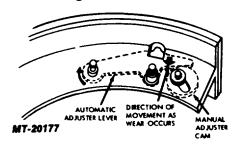


Fig. 8

- 9. Install flat washers and hold-down "C" washers.
- 10. Install brake shoe return springs.
- 11. Remove wheel cylinder clamps.
- 12. Back off manual adjustment cams.
- 13. Center each shoe before installing drum by sliding shoe up or down in its anchor slot until the leading and trailing edges of linings are equal distances from the rolled edge of brake backing plate.
- 14. Repack wheel bearings (refer to LUBRICATION, CTS-2412).

- 15. Reinstall wheel bearings, new seals and install hub and drum assembly. Adjust wheel bearings. Refer to WHEELS, RIMS and TIRES Section (CTS-2032) for proper instructions pertaining to repacking bearings and bearing adjustment.
- 16. Adjust brakes by performing the initial manual adjustment, referring to LINING CLEARANCE ADJUSTMENT procedure.
- If wheel cylinders were rebuilt or replaced the brakes will require bleeding. Refer to BRAKES HYDRAULIC, General (CTS-2055 for single system or CTS-2470 for dual system).
- 18. Remove floor stands from under vehicle.

LINING CLEARANCE ADJUSTMENT

Adjust Each Shoe, in Turn: With drum installed, rotate adjuster cam stud and drum in forward direction of drum rotation until a light drag is noticeable (Fig. 9). Do not apply excessive force on the stud -13.6 N.m (120 inch pounds) maximum. Back off adjuster stud (6 to 12 degrees) until drum turns freely. After the manual adjustment is performed the automatic adjusters will now maintain normal facing-to-drum clearance.

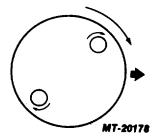


Fig. 9



BRAKE SHOE ADJUSTMENT AND SERVICING

I H CODE	SIZE	
	CENTIMETERS (cm) INCHES	
04108	30.8 x 5.7	12 1/8 x 2 1/4
04109	33.0 x 5.7	13 x 2 1/4
04111	38.1 x 5.7	15 x 2 1/4
04112 04131	38.1 x 8.9	15 x 3 1/2
04118 04128	38.1 x 7.6	15 x 3
04120	35.9 x 6.3	14 x 2 1/2
04132	38.1 x 12.7	15 x 5

TWO SINGLE-END WHEEL CYLINDERS MOUNTED BETWEEN EACH SHOE TOE AND OPPOSITE SHOE HEEL

ADJUSTMENT - SHOE ADJUSTING CAM

INDEX

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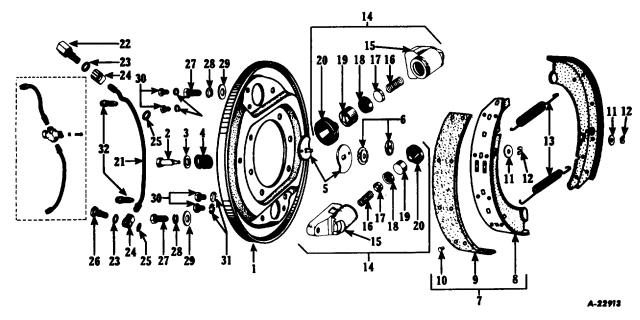


Fig. 1 Exploded View

LEGEND FOR FIG. 1

Key	Description	Key	Description
1	Plate assembly, brake backing	18	Cup, piston
2	Stud, adjusting cam and shoe guide	19	Piston assembly
3	Washer, plain, cam stud	20	Boot
4	Spring, adjusting cam	21	Tube assembly, connector, wheel
5	Cam, shoe adjusting		cylinder
6	Washer, spring, anti-rattle, shoe guide	22	Bolt, fitting, inlet, brake line to
7	Shoe & lining assembly		cylinder & tube
8	Shoe	23	Gasket, bolt
9	Lining	24	Fitting, inlet, fluid, connector tube
10	Rivet, lining	25	Gasket, fitting
11	Washer, plain, shoe guide	26	Bolt, fitting, inlet, connector tube
12	Washer, "C", shoe guide stud		to cylinder
13	Spring, retracting, brake shoe	27	Screw, anchor, cylinder
14	Wheel cylinder assembly	28	Lockwasher, cylinder anchor screw
15	Body, wheel cylinder	29	Washer, plain, cylinder anchor screw
16	Spring	30	Screw, fastening, wheel cylinder
17	Filler, piston cup	31	Lockwasher, fastening screw
		32	Valve, bleeder, cylinder

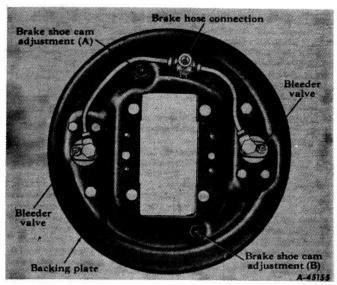


Fig. 2 External View

DESCRIPTION

These self-centering type brakes have two single end wheel cylinders, each operating a forward acting shoe providing directional braking response. The closed end of the wheel cylinder has a slotted ramp which is the self-centering sliding anchor for the opposite shoe. The two wheel, cylinder pistons apply equal amounts of hydraulic force to each shoe toe.

Shoes are adjustable manually by means of two hex head friction spring locked studs, exposed on the backing plate (Fig. 2). Each stud rotates an adjuster cam located under a brake shoe table. Shoe hold-downs consist of two plain washers, multi-rattle wave washer between and a C-clip fitted over the extended shank of the cam stud. Two retracting springs are hooked between the shoes and have their longer shanks connected to the anchor end of the shoes.

Upon brake application, the wheel cylinder pistons transmit pressure to the toes of the shoes, forcing the shoe linings into contact with the brake drum. If the vehicle is moving forward, the drag of the drum against the shoe lining produces "self-energization" which tends to help rotate the shoes outwardly about their anchor points. This action multiplies the forces exerted against the drum and produces additional braking effect. Both shoes are forward acting (primary shoes), self-energizing in the forward direction of drum rotation.

If the vehicle is moving backward, the drag of the drum on the linings is in the opposite direction and produces "de-energization" which tends to move the shoe heels away from their

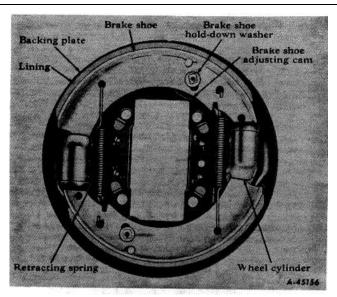


Fig. 3 Internal View

anchor blocks. Piston forces at the shoe toes are large enough to overcome this action, but the shoes tend to rotate inwardly about their anchor points and attempt to leave the drum. Both shoes are reverse acting since neither is self-energized in the reverse direction of drum rotation.

Cylinder anchor block sides are aligned on the axle radius. As the shoes roll upon their anchor blocks to contact the drum, the heels may also slide radially upon the anchor block surface. The shoes thus automatically "sel-center" in relation to the drum.

The self-energization factor causes this brake to be approximately three times as effective during forward operation as it is during reverse operation; therefore its use is generally confined to the front axle of vehicles in conjunction with a rear axle brake of a type providing effective stopping ability in reverse as well as forward motion.

LINING CLEARANCE ADJUSTMENT

Lining to drum clearance adjustment is required when shoes are relined and, on occasion, to compensate for normal lining wear. Clearance should be sufficient to avoid "brake drag" and yet close to afford a good "pedal reserve".

Manually operated and vacuum-hydraulic actuated brakes require adjustment (or relining) when pedal reserve approximates 2"; that is, when the brake pedal drops to within 2" of floor board on hard application.

Adjustment is made with the vehicle resting

BRAKES-HYDRAULIC

on floor jacks. Brake drag is checked by "feel", rotating the drum in the direction of forward rotation as adjustment is made.

Be sure the wheel bearings are properly adjusted (refer to WHEELS, RIMS, TIRES Section, CTS-2032) and with brake drums cool.

Adjust each shoe in turn by rotating adjuster cam stud and drum in forward direction of drum rotation until a light drag is noticeable (Fig. 4). Do not apply excessive force on stud -13.6 N.m (120 inch.lbs.) maximum. Back off adjuster stud slightly (approx. 6 to 12 degrees). Drum should turn freely.

Repeat procedure on opposite cam stud.

Perform same operation on brake group on opposite side of vehicle.

BRAKE SHOE REMOVAL (Refer to Fig. 1 for numbers in parenthesis.)

- 1. Position vehicle on floor stands so that the wheels are free to turn.
- 2. Remove wheel hub and drum assemblies.
- 3 Secure pistons in wheel cylinders with cylinder clamps.
- 4. Remove brake shoe retracting springs.
- 5. Remove each shoe hold-down "C" washer (12) and washer (11).
- Pull shoes free from adjuster cams and then rotate shoe from brake group freeing ends of wheel cylinders.

If wheel cylinder connector tubes (21) are removed, mark wheel cylinder ports to which tubes are attached to avoid error in re-assembly. Difficulty will be encountered in bleeding operation if tubes are assembled in wrong location.

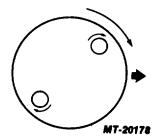


Fig. 4 Brake Adjustment

CLEANING AND INSPECTION

Thoroughly clean all parts (except drums) free of dirt and grease with cleaning solvent and wipe dry.

Drums

Friction surface of brake drum must be smooth, true and concentric. Make sure that the drum is not barrel shaped, bell-mouthed, adored or eccentric. Drums must also be inspected for heat checking or chill spotted.

Brake drums should be cleaned thoroughly with a steam cleaner or hot water. Do not use a solvent which leaves an oily residue. If inspection shoes the drums may be used without remachining, rub the friction surface with fine emery cloth or sandpaper to remove any foreign deposits. If the drum has been reconditioned, clean the friction surface with fine emery cloth or sandpaper and wash. Next, examine very carefully to see that no metal chips remain in the drum or hub.

Brake Shoes and Lining

Brake shoes must be true and of correct radius.

Wherever brake linings are worn to within 1/16" of rivets, the brake shoes must be removed and relined. It is recommended that all the brakes be relined at the same time since this will maintain balanced braking on the vehicle. If complete replacement is not desirable or necessary, be sure that lining on one axle (both sides) is replaced at the same time.

When removing worn lining from shoes, drill out old rivets if possible to prevent distorting shoe table. After the old linings are removed from the shoes, the shoes should be cleaned and buffed to remove all dirt and grease. Grease is one of the greatest deteriorating agents of lining.

Examine shoes carefully and discard those which have any of the following defects:

- 1. Table twisted or distorted.
- 2. Oversize rivet holes.
- 3. Cracks in table or web.
- 4. Table not square with web.
- 5. Anchor end worn.

The lining must be installed on the shoe so that it fits smoothly and evenly, contacting the shoe throughout the entire radius. If gaps occur between the rivets, difficulty will be met in adjusting the brakes in that "spongy" or rubbery pedal may occur which makes satisfactory brake application impossible.



BRAKES-HYDRAULIC

To insure complete contact and avoid gaps between lining and shoe, secure lining to shoe with "C" clamp so that rivet or bolt holes are in alignment. Position "C" clamp as close to the holes as possible, clamping the lining firmly in place.

When securing brake lining to shoes, start with the center rivet or bolt and work toward the ends.

When riveting linings, use a roll set to up set the rivets. A star set may split the tubular end of rivet and prevent a tight fit. After the lining is installed, check tightness of lining to shoe with as follows: Use a .152 mm (. 006 in.) feeler gauge inserting it between the lining and shoe table. The gauge should not penetrate a gap at any three consecutive pairs of rivets nor at more than three points around the arc of shoe and lining. Nor should it be possible to insert a .2032 mm (. 008 in.) feeler gauge at any point along the arc of the shoe and lining.

After installing the new lining on the shoes the lining should be ground in a true radius to fit the drum diameter. A brake shoe grinder provided on brake reliner (SE-1272) which is designed to dress the lining in a true radius and fit the drum diameter. This grinder swings the shoe in an arc across the surface of an abrasive wheel.

Wheel Cylinders

Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.

Some brake groups have wheel cylinder piston stops and the wheel cylinder must be removed for reconditioning.

The two wheel cylinders mounted on one brake are identical; HOWEVER, CYLINDERS FOR LEFT OR RIGHT HAND BRAKES HAVE OPPOSITE CASTINGS.

Clean mating surfaces of cylinders and backing plate before assembly to insure proper alignment.

Retracting Springs

Inspect retracting spring for distortion such as nicks, twisted shanks or spread of coils. Damaged spring must be replaced.

Adjusting Cam and Shoe Guide Studs

Adjustment cam and shoe guide studs are equipped with friction springs. They should easily turn with a wrench, but should not be loose. If frozen, lubricate with penetrating oil and work free.

REINSTALL BRAKE SHOES

Refer to Fig. 1 for numbers in parenthesis.

- 1. Make sure that the backing plate and wheel cylinder mounting bolts are tightened securely.
- 2. Install spring anti-rattle washer (6) on cam and shoe guide stud (2), pronged side facing adjusting cam (5).
- Place shoe assembly on backing plate with cam and shoe guide stud protruding through shoe slot. Locate shoe toe in piston slot and shoe heel in anchor block.
- Replace hold down washer (11) and "C" washer (12) on cam and shoe guide stud. Crimp "C' washer on stud.
- 5. Repeat steps 1, 2 and 3 for second shoe.
- 6. Replace shoe retracting springs (13).

When replacing shoe retracting springs (13), place spring end with long hook in heel of shoe and then, with brake spring pliers, stretch spring to secure short hook end in toe of opposite shoe.

- 7. Back off manual adjustment cams.
- Center each shoe before installing drum by sliding shoe up or down in its anchor slot until the leading and trailing edges of lining are equal distances from the rolled edge of brake backing plate.
- Repack wheel bearings (refer to LUBRICATION, CTS-2412).
- Reinstall wheel bearings, new seals and install hub and drum assembly. Adjust wheel bearings. Refer to WHEELS, RIMS and TIRES Section (CTS-2032) for proper instructions pertaining to repacking bearings and bearing adjustment.
- 11. Adjust brakes by performing the initial manual adjustment, referring to LINING CLEARANCE ADJUSTMENT procedure.
- If wheel cylinders were rebuilt or replaced the brakes will require bleeding. Refer to BRAKES HYDRAULIC, General (CTS-2055 for single system or CTS-2470 for dual system).
- 13. Remove floor stands from under vehicle.

BRAKES-HYDRAULIC

BRAKE SHOE ADJUSTMENT AND SERVICING

IH CODE		SIZI	E
0022		CENTIMETERS (cm)	INCHES
04206		35.9 x 7.6	14-1/8 x 3
04207		38.1 x 10.1	15 x 4
04208	04228	38.1 x 12.7	15 x 5
04210		40.6 x 12.7	16 x 5
04211		40.6 x 15.2	16 x 6
04213		38.1 x 17.8	15 x 7
04214		38.1 x 15.2	15 x 6
04231		38.7 x 17.8	15 x 7

TWO DOUBLE-END TYPE WHEEL CYLINDERS AUTOMATIC BRAKE SHOE ADJUSTMENT

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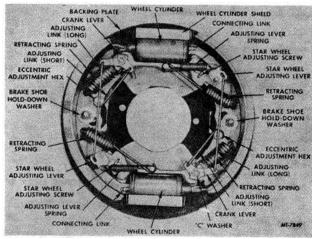


Fig. 1 Internal View

DESCRIPTION

The hydraulic foundation brakes covered herein are equipped with two double-end type wheel cylinders through which hydraulic pressure is applied to both toe and heel of identical self-centering steel shoes. The shoes anchor at either toe or heel, depending upon the direction of drum rotation, thus they are always forward-acting and provide equal braking effort regardless of the direction in which the vehicle is moving. Brake anchor supports have removable slotted anchor pins at the shoe heels and automatic adjuster screws at the shoe toes, which act as anchors in the reverse direction of rotation. The function of the automatic adjuster is to provide a nearly constant normal running clearance between the brake shoe and the drum during the course of full brake lining wear.

The adjustment mechanism feature reacts directly from shoe movement as the result of increased running clearance. This mechanism is made up of a system of links and levers with a combination of ratios such that it will sense lining clearance with respect to movement of the heel abutment lever. If sufficient lining wear has occurred to require adjustment, the starwheel adjusting lever will pivot sufficiently to engage the next tooth on the starwheel; this occurs during a reverse brake application only. Adjustment may or may not be completed at this time, depending on the degree of friction between the adjusting screw and the mating threads. This friction is caused by the axial load on the adjusting screw due to the shoe return spring. However, adjustment in any case will be completed during the next forward brake application when the adjusting screw is free and the adjuster lever spring drives the lever through its full adjusting stroke.

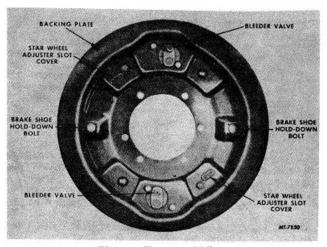


Fig. 2 External View

The adjusting screw is fitted with a rotational frictionretarding expansion ring which prevents reverse rotation of the adjusting starwheel during the ratcheting action of the starwheel adjusting lever prior to the lining clearance take-up stroke.

BRAKE SHOE REMOVAL (Refer to Fig. 3)

- 1. Position the vehicle on floor stands so that the wheels are free to turn.
- Remove wheel hub and drum assemblies. It may be necessary to back off the starwheel adjusting screws in some instances to obtain clearance between brake shoe and drum assemblies.
- 3. Secure both wheel cylinder pistons with cylinder clamps.
- 4. Unhook the two automatic adjuster springs. Remove each long adjuster link by pivoting back the starwheel cranks until their slots align with the link U-hooks. Lift out links, then slide their S-hooks from the anchor pin cranks. Remove short links by rotating anchor cranks until U-hooks clear the eccentrics on the shoe webs, then remove their smaller U-hooks from the cranks. Spread anchor crank "C" washers and lift off cranks (it is usually unnecessary to remove the starwheel cranks). To remove shoes, remove eccentric adjustment hex from the shoe webs by unscrewing the self-tapping screws.
- Remove shoe retracting springs by sliding their looped ends off of pins. Then remove shoe hold-down lockwires, castellated nuts and plain washers and lift off shoes.

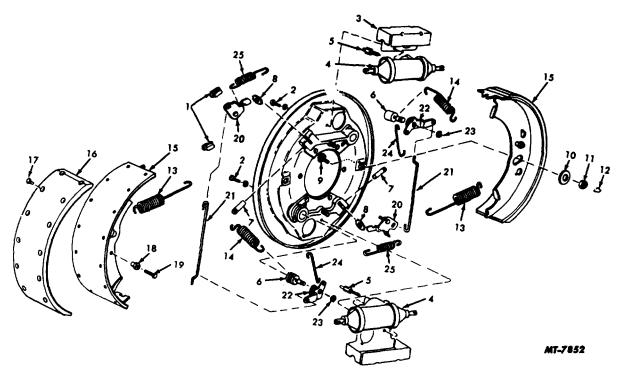


Fig. 3 Exploded View of Brake Group

LEGEND FOR FIG. 3

Key Description

- 1 Cover, Adjuster Slot
- 2 Bolt, Wheel Cylinder Mounting
- 3 Shield, Wheel Cylinder
- 4 Wheel Cylinder
- 5 Valve, Wheel Cylinder Bleeder (Screw)
- 6 Pin, Brake Shoe Anchor
- 7 Screw, Starwheel Adjuster w/Snap Ring
- 8 Starwheel, Shoe Adjuster
- 9 Bolt, Carriage, Shoe Hold-Down
- 10 Washer, Shoe Hold-Down
- 11 Nut, Castellated, Shoe Hold-Down
- 12 Lockwire, Hold-Down
- 13 Spring, Long, Shoe Retracting
- Thread each adjuster screw from the shoe side of the anchor supports. Lift starwheels from support slots. Do not attempt to remove a friction ring from the screw; if necessary, replace the screw assembly instead.
- 7. To remove a wheel cylinder and cylinder shield, remove the two mounting bolts.
- 8. Check to make sure that backing plate and anchor supports are clean and mounting bolts are tight.

Key Description

- 14 Spring, Shoe, Shoe Retracting
- 15 Brake Shoe
- 16 Lining, Brake Shoe
- 17 Rivet, Brake Shoe Lining
- 18 Hex Eccentric, Automatic Adjuster
- 19 Screw, Eccentric Self-Tapping
- 20 Crank Assembly, Starwheel
- 21 Link, Long, Starwheel Crank
- 22 Crank, Automatic Adjuster Anchor
- 23 "C" Washer, Anchor Crank
- 24 Link, Short, Anchor Crank
- 25 Spring, Automatic Adjuster

CLEANING AND INSPECTION

Thoroughly clean all parts free of dirt and grease with cleaning solvent (except drums) and wipe dry.

Drums

Friction surface of brake drum must be

smooth true and concentric. Make sure that the drum is not bulged, bell-mouthed, scored or eccentric. Drums must also be inspected for heat checking, hard or chill spots.

Brake drums should be cleaned thoroughly with a steam cleaner or hot water. Do not use a solvent which leaves an oily residue. If inspection shows the drums may be used without remachining, rub the friction surface with fine emery cloth or sandpaper to remove any foreign deposits. If the drum has been reconditioned, clean or sandpaper and wash. Next, examine very carefully to see that no metal chips remain in the drum or hub.

Brake Shoes and Lining

Brake shoes must be true and of correct radius.

Wherever brake lining is worn to within 1/16" of rivets, the brake shoes must be removed and relined. It is recommended that all the brakes be relined at the same time since this will maintain balanced braking on the vehicle. If complete replacement is not desirable or necessary, be sure that lining on one axle (both sides) is replaced at the same time.

When removing worn lining from shoes, drill out old rivets if possible to prevent distorting shoe table. After the old linings are removed from the shoes, the shoes should be cleaned and buffed to remove all dirt and grease. Grease is one of the greatest deteriorating agents of lining.

Examine shoes carefully and discard those which have any of the following defects:

- a. Table twisted or distorted.
- b. Oversize rivet holes.
- c. Cracks in table or web.
- d. Table not square with web.
- e. Anchor ends worn.

The lining, must be installed on the shoe so that it fits smoothly and evenly, contacting the shoe throughout the entire radius. If gaps occur between the rivets, difficulty will be met in adjusting the brakes in that "spongy" or rubbery pedal may occur which makes satisfactory brake application impossible.

To insure complete contact and avoid gaps between lining and shoe, secure lining to shoe with "C" clamp so that rivet or bolt holes are in alignment. Position "C" clamp as close to the holes as possible, clamping the lining firmly in place.

When securing brake lining to shoes, start with the center rivet or bolt and work toward the ends.

When riveting linings, use a roll set to up set the rivets. A star set may split the tubular end of rivet and

prevent a tight fit. After the lining is installed, check tightness of lining to shoe with as follows:

Use a .152 mm (.006 in.) feeler gauge inserting it between the lining and shoe table. The gauge should not penetrate a gap at any three consecutive pairs of rivets nor at more than three points around the arc of shoe and lining. Nor should it be possible to insert a .2032 mm (.008 in.)feeler gauge at any point along the arc of the shoe and lining.

After installing the new lining on the shoes the lining should be ground in a true radius to fit the drum diameter. A brake shoe grinder provided on brake reliner (SE-1272) which is 'designed to dress the lining in a true radius and fit the drum diameter. This grinder swings the shoe-in an arc across the surface of an abrasive wheel.

Wheel Cylinders

Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders. Refer to BRAKES, HYDRAULIC, General, (CTS-2055 for single system or CTS-2470 for dual system) Star Wheel Adjuster and Screws Thoroughly clean star wheel adjusting screws. Be sure the adjusting screw turns freely in the pivot.

Retracting Springs

Inspect retracting springs for distortion such as nicks, twisted shanks or spread coils. Damaged springs must be replaced.

REINSTALL BRAKE SHOES

- When installing a wheel cylinder with shield, make sure that the longer cylinder end, measured from the hydraulic port will face toward the shoe toe and star wheel. Be sure mounting bolts are tightened securely.
- Insert star wheel in anchor support slots and thread in adjuster screws from the shoe side, friction ring end toward shoe. For new linings, back off adjusters, taking care not to jam the star wheels. Do not lubricate adjuster screws.
- 3. Remove wheel cylinder clamps and install brake shoes by assembling each shoe with toe (cut away side of shoe web) located next to the adjuster screw. Install hold-down bolt, plain washer and castellated nut finger tight, then back off nut one turn and insert lockwire. Install retracting springs in shoe web, longest shank at the adjuster, and hook springs over pins using brake spring pliers.

- Install the eccentric adjustment hex on each shoe web, tightening the self-tapping screw only finger tight to permit final adjustment of eccentrics.
- 5. Locate crank levers on anchor pins, the long arms toward shoes, bushing toward backing plate, so that they rotate freely while resting against retracting spring hooks. Install and crimp the "C" washers. At each crank, assemble the short link small hook into the short arm of the crank from the lower side and hook other link end around the eccentric adjustment hex. Assemble long link S-hook to long arm of crank from upper side, rotate starwheel crank so that slot lines up with link U-hook, insert U-hook rotate starwheel crank back and approximately adjusting position. Install adjuster spring with short hook on starwheel adjusting lever, so that its long shank hook assembles on the upper groove of the spring retainer pin from the wheel cylinder side.
- 6. Adjust brakes initial manual lining adjustment.
 - a. Back off starwheel adjustments.
 - b. Center shoe: Take care not to mar lining. Insert pry tool against backing plate inner edge and shoe and slide shoe up or down in anchor slots until leading and trailing edges of the lining are equal distance from the inner edge of the brake backing plate.
 - c. Set eccentric adjustment hex on each shoe web. Rotate eccentric hex until linkage aligns starwheel crank pawl with center line of adjuster screw. A small indent located on the anchor support is the aligning mark. Lock eccentric adjustment hex with self-tapping screw and install drum.
- 7. Repack wheel bearings (refer to CTS-2412 LUBRICATION,).
- Reinstall wheel bearings, new seals (refer to WHEELS, CTS-2032) and install hub and drum assemblies. Proper adjustment of wheel bearings will be found in WHEELS, RIMS, TIRES Section (CTS-2032).

- 9. At each shoe starwheel remove adjustment slot cover from exposed side of backing plate. Insert a suitable brake adjusting tool and rotate starwheel until lining drags on drum. To tighten, move tool handle toward CTS-2492P axle while using inner side of the adjuster slot as fulcrum for the tool, rotating the starwheel teeth away from the axle. Then back off starwheel while rotating drum forward until drag is just relieved. Provide additional running clearance by backing off 8-10 more notches and replace slot cover, to allow automatic adjusters to seek its running clearance. This sequence must be repeated to each shoe.
- If wheel cylinders were rebuilt or replaced, the brakes will require bleeding. Refer to BRAKES, HYDRAULIC, General (CTS-2055 for single system or CTS-2470 for dual system).
- 11. Remove floor stands under vehicle.



BRAKE SHOE ADJUSTMENT AND SERVICING

IH CODE		SIZE	
		CENTIMETERS (cm)	INCHES
04207		38.1 x 10.1	15 x 4
04208	04228	38.1 x 12.7	15 x 5
04209		40.6 x 10.1	16 x 4
04210		40.6 x 12.7	16 x 5
04211		40.6 x 15.2	16 x 6
04213	04231	38.1 x 17.8	15 x 7
04214		38.1 x 15.2	15 x 6

TWO DOUBLE-END TYPE WHEEL CYLINDERS

ADJUSTMENT - TWO STAR WHEELS

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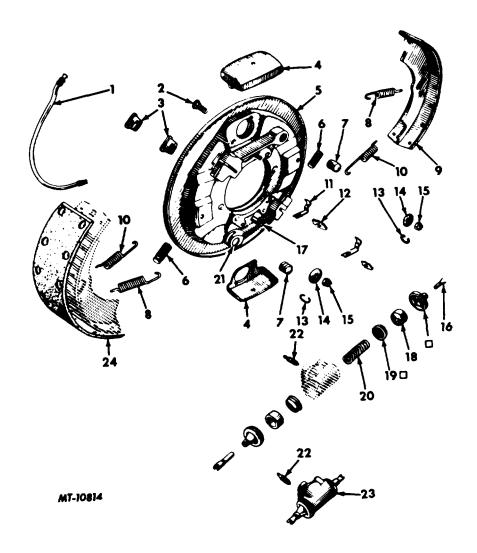


Fig. 1 Brake Group - Exploded View

LEGEND FOR FIG. 1

<u>Key.</u>	<u>Description</u>	<u>Key.</u>	<u>Description</u>
1	Pipe, brake cylinder assembly	13	Ring, shoe guide bolt lock
2	Bolt, shoe guide	14	Washer, shoe guide bolt
3	Cover, brake adjusting hole	15	Nut, shoe guide bolt
4	Shield, brake cylinder	16	Rod, brake shoe push
5	Plate, backing assembly	17	Pin, return spring
6	Screw, shoe adjusting	18	Piston, brake cylinder
7	Pin, shoe anchor	19	Cup, brake cylinder
8	Spring, shoe reverse return	20	Spring w/retainer brake cylinder
9	Shoe w/lining brake	21	Support w/pin
10	Spring, shoe forward return	22	Screw, bleeder
11	Spring, shoe adjusting wheel	23	Cylinder, brake assembly
12	Wheel, shoe adjusting	24	Lining, brake w/rivets

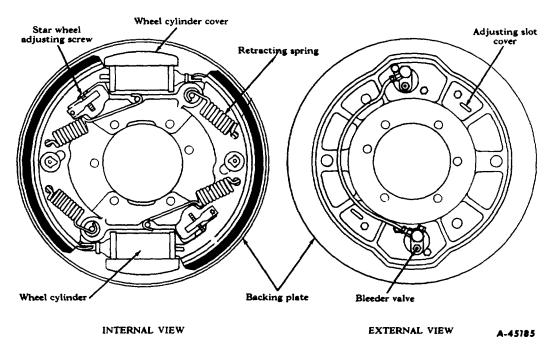


Fig. 2 Brake Group

DESCRIPTION

The hydraulic foundation brakes herein, are equipped with two double-end type wheel cylinders through which hydraulic pressure is applied to both toe and heel of identical self-centering steel shoes. The shoes anchor at either toe or heel depending upon the direction of drum rotation, thus they are always forward-acting and provide equal braking effort regardless of the direction in which the vehicle is moving. Brake anchor supports have removable slotted anchor pins, at the shoe heels, and adjusting screws, at the shoe toes, which act as anchors in the reverse direction of rotation. Each adjusting screw is threaded into or out of its support by means of a star wheel, as required to establish the desired lining clearance.

LINING CLEARANCE ADJUSTMENT

Adjustment for lining wear is made by reducing the excessive working clearance between linings and drum. Booster powered brake systems require adjusting when brake pedal reserve is reduced to 2"-3"; that is, when the pedal drops to within 2"-3" of the floor board on a hard brake application.

Brake adjustments may be made with the vehicle resting on jacks or on the road. On jacks, check brake drag by rotating the drum in the forward direction of rotation. On the road, check brake drag by sound, tapping the drum with the adjusting wrench (SE-1745).

A clear tone is desired; when sound is deadened the linings are dragging on the drum.

The brake adjustment is performed as follows:

- 1. Permit brake drums to cool.
- Check and adjust wheel bearings.
- 3. Check hydraulic fluid level. Bleed system if necessary.

At each brake group and each star wheel in turn:

- 4. Remove adjustment slot covers.
- At one adjustment slot, insert clicker wrench (SE-1745) or screwdriver and engage star wheel (Fig. 3). Move tool handle toward axle, using inner edge of slot as fulcrum for tool, to rotate star wheel and decrease lining clearance until lining drags on drum.
- 6. Hit foot pedal to center shoe and again rotate star wheel and decrease lining clearance until lining drags on drum.
- 7. Relieve drag by rotating star wheel in opposite direction; Back off adjustment as follows:

For worn lining, 3 notches (clicks).

For new lining, 5 notches (clicks).

- 8. At second adjustment slot, repeat steps 5 and 6 to adjust remaining shoe.
- 9. Replace adjustment slot covers.

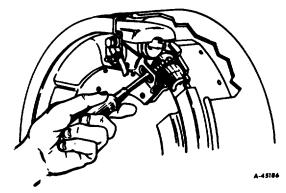


Fig. 3

BRAKE SHOE REMOVAL (Refer to Fig. 1)

- 1. Position the vehicle on floor stands so that the wheels are free to turn.
- 2. Remove wheel hub and drum assemblies. It may be necessary to back off the star wheel adjusting screws in some instances to obtain clearance between brake shoe and drum assemblies.
- 3. Secure wheel cylinder piston with a cylinder clamp.
- 4. Disconnect looped ends of brake shoe retracting springs from pin brake shoes.
- 5. Remove shoe hold-down lock wires, castellated nuts and plain washers and lift off shoes.
- 6. Anchor pins should pull out of the anchor supports easily.
- Always dismantle the adjusting mechanisms. Remove adjuster lock springs by loosening their hold-down screws. Thread each adjusting screw from the shoe side of its support. Lift star wheels from slots.
- 8. Wheel cylinders are removed by uncoupling connector tubes and removing mounting bolts. Mark tubing ports to avoid error in assembly. If tubes are assembled in wrong location (possible on some vehicles) difficulty may be encountered in bleeding operation.

CLEANING AND INSPECTION

Thoroughly clean all parts free of dirt and grease with cleaning solvent (except drums) and wipe dry.

Drums

Friction surface of brake drum must be smooth, true and concentric. Make sure that the drum is not bulged, bell-mouthed, scored or eccentric. Drums must also be inspected for heat checking, hard or chill spotted.

Brake drums should be cleaned thoroughly with a steam cleaner or hot water. Do not use a solvent which leaves an oily residue. If inspection shows the drums may be used without remachining, rub the friction surface with fine emery cloth or sandpaper to remove any foreign deposits. If the drum has been reconditioned, clean the friction surface with fine emery cloth or sandpaper and wash. Next, examine very carefully to see that no metal chips remain in the drum or hub.

Brake Shoes and Lining

Brake shoes must be true and of correct radius.

Wherever brake lining is worn to within 1/16" of rivets, the brake shoes must be removed and relined. It is recommended that all the brakes be relined at the same time since this will maintain balanced braking of the vehicle. If complete replacement is not desirable or necessary, be sure that lining on one axle (both sides) be replaced at the same time.

When removing worn lining from shoes, drill out old rivets if possible to prevent distorting shoe table. After the old linings are removed from the shoes, the shoes should be cleaned and buffed to remove all dirt and grease. Grease is one of the greatest deteriorating agents of linings.

Examine shoes carefully and discard those which have any of the following defects:

- 1. Table twisted or distorted.
- 2. Oversize rivet holes.
- Cracks in table or web.
- 4. Table not square with web.
- 5. Anchor end worn.

The lining must be installed on the shoe so that it fits smoothly and evenly, contacting the

shoe throughout the entire radius. If gaps occur between the rivets, difficulty will be met in adjusting the brakes in that "spongy" or rubbery pedal may occur which makes satisfactory brake application impossible.

To insure complete contact and avoid gaps between lining and shoe, secure lining to shoe with "C" clamp so that rivet or bolt holes are in alignment. Position "C" clamp as close to the holes as possible, clamping the lining firmly in place.

When securing brake lining to shoes, start with the center rivet or bolt and work toward the ends.

When riveting linings, use a roll set to up set the rivets. A star set may split the tubular end of rivet and prevent a tight fit. After the lining is installed, check tightness of lining to shoe with as follows:

Use a .152 mm (.006 in.) feeler gauge inserting it between the lining and shoe table. The gauge should not penetrate a gap at any three consecutive pairs of rivets nor at more than three points around the arc of shoe and lining. Nor should it be possible to insert a .2032 mm (. 008 in.)feeler gauge at any point along the arc of the shoe and lining.

After installing the new lining on the shoes the lining should be ground in a true radius to fit the drum diameter. A brake shoe grinder provided on brake reliner (SE-1272) which is designed to dress the lining in a true radius and fit the drum diameter. This grinder swings the shoe in an arc across the surface of an abrasive wheel.

Wheel Cylinders

Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.

Refer to BRAKES, HYDRAULIC, General, CTS-2055 for single system or CTS-2470 for dual system. Star Wheel Adjuster and Screws

Thoroughly clean star wheel adjusting screws. Be sure the adjusting screw turns freely in the pivot.

Retracting Springs

Inspect retracting springs for distortion such as nicks, twisted shanks or spread coils. Damaged springs must be replaced.

REINSTALL BRAKE SHOES

- When installing a wheel cylinder with shield, make sure that the longer cylinder end, measured from the hydraulic port will face toward the shoe toe and star wheel. Be sure mounting bolts are tightened securely.
- Insert star wheel in anchor support slots and thread in adjuster screws from the shoe side, friction ring end toward shoe. For new linings, back off adjusters, taking care not to jam the star wheels. Do not lubricate adjuster screws.
- Remove wheel cylinder clamps and install brake shoes by assembling each shoe with toe (cut away side of shoe web) located next to the adjuster screw.
- 4. Install hold-down bolt, plain washer and castellated nut finger tight, then back off nut one full turn before installing lock wire.
- 5. Install retracting springs in shoe web, with longest shank at the adjuster and hook brake springs over pins using brake spring pliers.
- 6. Repack wheel bearings (refer to LUBRICATIONCTS-2412).
- Reinstall wheel bearings, new seals (refer to WHEELS CTS-2032) and install hub and drum assemblies. Proper adjustment of wheel bearings will be found in WHEELS, RIMS, TIRES Section (CTS-2032).
- 8. Adjust brake clearance. Refer to LINING CLEARANCE ADJUSTMENT procedure starting at Step 4.
- If wheel cylinders were rebuilt or replaced the brakes will require bleeding. Refer to BRAKES-HYDRAULIC, General (CTS-2055 for single system or CTS-2470 for dual system).
- 10. Remove floor stands from under vehicle.

BRAKES HYDRAULIC RECONDITIONING BRAKE DRUMS, SHOES, ROTORS AND PADS

The text herein is to provide the actual reconditioning of brake drums, rotors, shoes and disc brake pads. For the disassembly and reassembly of brake groups and servicing of other particular components, refer to appropriate section of the service manual.

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DRUM BRAKES

INSPECTION OF DRUMS

The friction surface of brake drums must be smooth, true and concentric. Make certain with a visual check that drums are not barrel shaped, bellmouthed, scored or eccentric.

Hard or chill spots, Fig. 1, in brake drum may produce pedal pulsation and roughness or brake surge. If these effects are present, drum should be replaced.

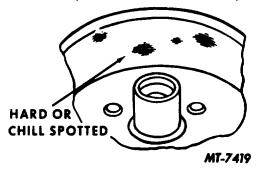


Fig. 1 Hard or Chill Spotted Drum

A barrel shaped drum (Fig. 2) results from overheating. If this barrel shaped condition is not corrected, the braking surface is reduced and uneven lining wear results.

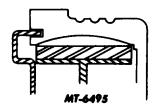


Fig. 2 Barrel Shaped Drum

Extreme pressure which over a period of time will create a bellmouthed drum as shown in Fig. 3. Brake linings on a bellmouthed brake drum will make contact only on the inner surface of the drum. In addition to cutting the braking surface to a minimum, it will also cause uneven and rapid wear.

Scored drums are the result of worn linings to the point where the drum-to-shoe contact is made or an accumulation of small steel particles imbed themselves in the brake lining (Fig. 4). The steel particles form a

tough scale which is sometimes harder than the drum. As a result, deep grooves are formed in friction surface of drum.

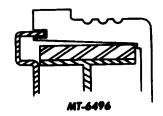


Fig. 3 Bellmouthed Drum

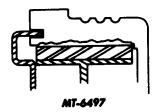


Fig. 4 Scored Drum

Brake drum scoring never improves but continually gets worse until both lining and brake drum are useless. Attempting to reline brakes without turning scored brake drum surface will quickly destroy new lining and make effective braking impossible.

Brake lining in an eccentric or out-of-round drum cannot make full contact with the drum resulting in rapid or uneven lining wear and could even cause brakes to seize or chatter. Maximum allowable out-of-round or eccentricity should be .25 mm (.010 in.)

If inspection shows that any of the preceding conditions exist, brake drum should be either turned or replaced. To assure a balanced braking system, always install turned or new brake drums in pairs on each axle. Any time a new brake drum is to be installed on a vehicle, the runout should be checked as follows. Place the new brake drum with hub and wheel assembled in lathe making certain drum is centered. Mount Dial Indicator SE-1848 on lathe and check runout about 12.7 mm (.5 in.) in from edge of drum as shown in Fig. 5. Runout must not exceed .25 mm (.010 in.).

Before assembling drum, hub and wheel, all parts must be clean and free of foreign matter.

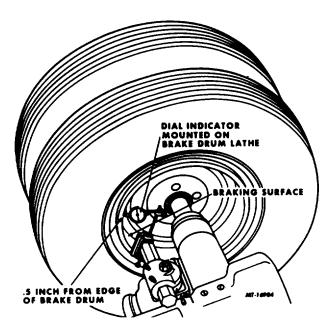


Fig. 5 Checking Drum Runout on Brake Drum Lathe REFINISHING BRAKE DRUMS

On brake drums manufactured after January 1, 1971, the maximum diameter to which drum can be worn is stamped or cast into drum. Drum should be discarded if worn beyond this limit.

Minor scores on brake drum can be removed with fine emery cloth or steel wool, but always clean emery or steel wool particles from drum after this operation. More heavily damaged or out-of-round drums should be ground or turned on brake drum lathe.

If depth of scoring, bellmouth or barrel shaping exceeds .13 mm (.005 in.), measured with micrometer across part or all of brake surface, drum should be refinished. Reboring or remachining limits must not be exceeded and no heat checks, cracks or bluing is evident.

Use a micrometer also to check for an out-of-round drum. Make check by measuring drum brake surface diameter at various points, 450 apart around circumference. Eccentricity (out-of--round) should not exceed .25 mm (.010 in.) on diameter.

Remember that each time brake drums are turned, less metal remains to absorb the heat developed by braking action. Brake drums containing less metal will operate at a higher temperature. As a result, brake fade, slow recovery and erratic wear will be more noticeable. Also, extremely high temperatures shorten lining life and cause heat checks and cracks (Fig. 6) to

form on inner surface of drums. These conditions will become progressively worse until drums fail.



Fig. 6 Cracked Drum

REMACHINING DRUMS

Brake drums that are otherwise in good condition can be turned in a lathe. However, it must be remembered that the recommended remachining or rebore limit for brake drums 355 mm (14 in.) diameter and under must not exceed 1.52 mm (.060 in.) diameter (total cut) and discarded at 2.29 mm (.090 in.) over original diameter.

Brake drums with a diameter over 355 mm (14") may not be increased more than 2.03 mm (.080") diameter (total cut) and discarded at 3.05 mm (.120") over normal diameter.

These dimensions hold true for both drums, which have maximum diameter identification, as well as drums which are not IMPORTANT The dimension located on the drum is the discard dimension. Never remachine drums to maximum wear or discard diameter.

IMPORTANT

The dimension located on the drum is the discard dimension. Never remachine drums to maximum wear or discard diameter.

There are some drums which appear to have an exception to this; however, this is not true. Example:

Original Diameter 11 1/32 or 11.030 inch Maximum remachining limit 11.090 inch Maximum wear or discard limit 11.120 inch

While an 11 inch diameter drum would be:

Original diameter 11.000 inch
Maximum Remachine Limit 11.060 inch
Maximum Wear or Discard

Limit 11.090 inch

To recondition a brake drum in a lathe (Fig. 7), the drum must be mounted so that it is centered. Use proper size cone to provide accurate centering. Turn drum, taking only light cuts and remove just enough material to clean up drum. Then grind the finished surface if grinder is available or use emery cloth on a straight piece of wood and polish the drum friction surface.

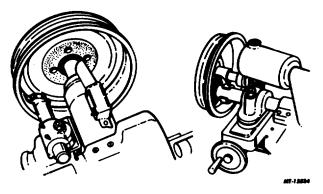


Fig. 7 Reconditioning Drum on Brake Drum

Lathe Brake drums should be cleaned thoroughly with a steam cleaner or hot water. Do not use a solvent which leaves an oily residue. If inspection shows the drums may be used without remachining, rub friction surface with fine emery cloth or sandpaper to remove any foreign deposits. If drum has been reconditioned, clean friction surface with fine emery cloth or sandpaper and wash. Next examine very carefully to see that no metal chips remain in drum.

INSPECTION OF SHOES

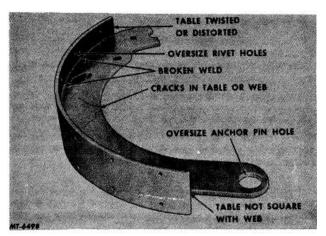


Fig. 8 Defects to be Looked for on Brake Shoe

When brake linings or blocks are worn to within .8 mm (1/32") on light duty vehicles or 1.6 mm (1/16") on medium and heavy duty trucks of rivets, the brake shoes must be removed and relined. It is recommended that all the brakes be relined at the same time since this will maintain balanced braking on the vehicle. If complete replacement is not desirable or necessary, be sure that all lining on one axle (both sides) is replaced at the same time.

Examine shoes carefully and discard those which have any defects as shown in Fig. 8.

REPLACING LINING ON SHOES

When removing worn lining from shoes, drill out old rivets if possible to prevent distorting shoe table. After the old linings are removed from the shoes, the shoes should be cleaned and buffed to remove all dirt and grease. Grease is one of the greatest deteriorating agents of lining.

Discard used lock washers after removing lining bolts. Use new washers when installing new lining. Replace bolts and nuts if signs of distortion or wear are present.

Do not handle new brake linings or relined shoes with greasy hands or allow linings to come in contact with mineral oil or grease.

Care should be used in selecting the correct thickness of lining for each brake shoe and drum. Usually the standard thickness will be used. If the drum has been turned or become worn, increasing the diameter, oversize lining may be required.

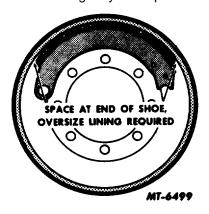


Fig. 9 Lining Selected Too Thin

If it is not known how much material has been removed from the drum during the turning operation, the following simple test may be used to help select the proper lining.

Hold standard size lining snugly to the shoe, position it against the inner surface of the drum, forcing it into contact with the drum surface.

The lining is now in the same position as during a brake application. If space is noted at the ends of the shoe (shoe can be rocked), oversize lining is required (Fig. 9). If lining selected is too thick, only the ends of the lining will contact the drum, see Fig. 10.

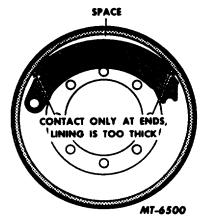


Fig. 10 Lining Selected Too Thick

The lining must be installed on the shoe so that it fits smoothly and evenly, contacting the shoe throughout the entire radius. If gaps occur between the rivets, difficulty will be met in adjusting the brakes in that "spongy" or rubbery pedal may occur which makes satisfactory brake application impossible.

To insure complete contact and avoid gaps between lining and shoe, secure lining to shoe with "C" clamp so that rivet or bolt holes are in alignment. Position "C" clamp as close to the holes as possible, clamping the lining firmly in place.

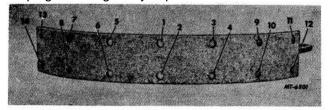


Fig. 11 Sequence in Securing Brake Lining to Shoe

When securing brake lining to shoes, start with the center rivet or bolt and work toward the ends as shown in Fig. 11. When securing brake block lining to shoe, use the sequence as shown in Fig. 12. Always use new lock washers when installing bolt on lining and tighten nuts to 89-111 Nm (20-25 ft. lbs.) torque.

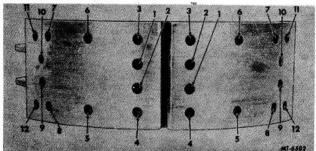


Fig. 12 Sequence in Securing Brake Block Lining to Shoe

When riveting linings, use a roll set to upset the rivets. A star set may split the tubular end of rivet and prevent a tight fit.

After the lining is installed, check tightness of lining to shoe, (Fig. 13) with a .203 mm (.008 in.) feeler gauge at any point along the arc of shoe and lining.

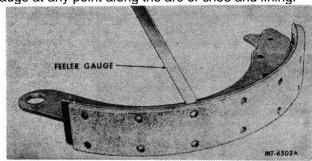


Fig. 13 Checking Tightness of Lining

After installing the new lining on the shoes, the lining should be ground in a true radius to fit the drum diameter. A brake shoe grinder is provided on brake reliner (SE-1272) which is designed to dress the lining in a true radius and fit the drum diameter. This grinder swings the shoe in an arc across the surface of an abrasive wheel.

A brake shoe grinder which mounts on the spindle may be used after installing shoes with new lining. The grinder rotates about on its axis and the grinding head equalizes the distance between the two brake shoe lining surfaces

and drum surface. Grind new lining approximately 1.78 mm (.070 in.) less than the inside diameter of brake drum. Make certain that the brake is fully released before grinding.

DISC BRAKES

INSPECTION OF ROTORS

Inspect rotors for lateral runout, parallelism, (Fig. 14), cracks or burnt marks.

The disc brakes may have a slight amount of runout or wobble due to tolerances which are required in machining the large flat surfaces of the rotor.

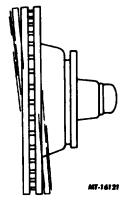


Fig. 14 Rotor Lateral Runout

Lateral runout is the movement of the rotor from side to side as it rotates. Excessive runout causes the rotor faces to knock back the disc pads and can result in chatter, excessive pedal travel, pumping or fighting pedal and vibration during the braking action. This condition can be due to a warped rotor, loose wheel bearing And, especially if symptoms develop immediately after sharp turns, deflection in steering or suspension.

Runout is measured by a dial indicator SE1848 (Fig. 15) set against the rotor surface approximately 25.4 mm (1 in.) from outer edge of rotor. Runout should not exceed .105 mm (.004 in.) Excessive runout will kick back the shoes, cause an increase in pedal travel needed to apply the brakes, and pedal vibration will be felt during applications. It also contributes to "grab", "pull" and noise problems.

Do not overlook wheel bearing adjustment. Wheel bearings which are loose can cause excessive runout indication.

If rotor runout exceeds .105 mm (.004 in.) either refacing or new rotor assembly will be required.

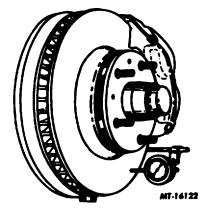


Fig. 15 Dial Indicator Installation

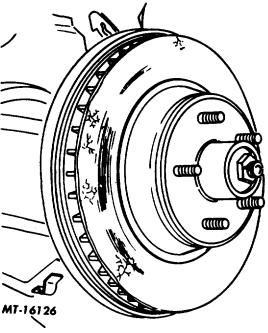


Fig. 16 Motor Not Satisfactory for Service
Rotors should be inspected for parallelism.
Parallelism refers to the amount of variation in thickness of the rotor (Fig. 17).



Fig. 17 Rotor Parallelism or Variation In Thickness

Excessive variation can cause pedal vibration or fight, front end vibrations and possible "grab" during the braking action--a condition comparable to an out-of-round brake drum.

To make the thickness variation or parallelism check on the rotor at the same time the runout is being checked, use a micrometer to check the variation in thickness of the rotor at four equal points around the rotor (Fig. 18).

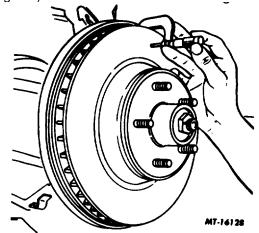


Fig. 18 Checking Rotor with Micrometer

If the thickness varies more than .0127 mm (.0005 in.) refacing of the rotor will be required; or replace it if the rotor will not true up before minimum allowable thickness is obtained.

REMACHINING ROTORS

The rotors can be remachined to provide a new, smooth braking surface (Fig. 19). If the rotor will not true up before minimum allowable thickness (see Specifications) is obtained, it must be replaced.

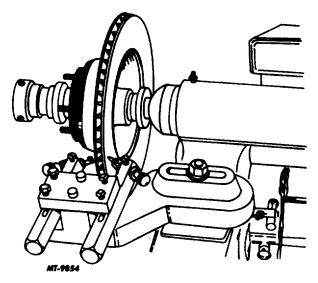


Fig. 19 Correct Method of Refacing Rotor

IMPORTANT

Rotors are identified by the minimum allowable thickness they can be used. Any rotor thinner than the minimum dimension must not be used.

Removal of too much metal would cause overheating and, more important, a thin rotor could permit the seals in the cylinder to "uncover".

To uncover a seal in the cylinder would result in loss of hydraulic brake fluid. An uncovered seal would not be apparent at first, but as the pads wear, more travel of the cylinder would be required; and since the rotor would be too thin, the seals could leak.

ROTOR REMACHINING SPECIFICATIONS							
Brake Group Rotor Original Code No. Thickness (New)			Minimum Allowable Remachining Thickness		Minimum Use- able Thickness		
	in.	mm	in.	mm	in.	mm	
04135	1.240	31.50	1.195	30,353	1.180	29.97	
04138	1.180	29.97	1.135	28.429	1.120	28.45	
04139	1.180	29.97	1.135	28.429	1.120	28.45	
04140	1.180	29.97	1.135	28.429	1.120	28.45	

The terms micrometres, micro-inch or surface finish or smoothness are different from runout and parallelism. These terms refer to degree of how smooth the flat surface is. However, if good, sharp tools and proper cutting feed and speed are used when remachining the rotor, you should be within the .381-2.032 micrometres (15-80 micro-inch) tolerances.

INSPECTION OF PADS

The disc brake pads or shoes can be inspected for wear on the vehicle. It is normal for the inboard lining to show more wear than the out board lining. Always install new pads assemblies in complete axle sets at both wheels on an axle.

Since lining on disc brakes will be bonded (code 04135) and riveted (codes 04138, 04139 & 04140) the useable thicknesses will be different.

Pads with $\underline{\text{bonded}}$ lining (code 04135) must be replaced when lining is worn to .7937 mm (1/32 in.) or less.

Pads with <u>riveted</u> lining (codes 04138, 04139 & 04140) must be replaced when lining is worn to 3.1750-4.7625 mm (1/8 to 3/16 in.) or less.

It is suggested that the pads be replaced whenever they are removed for an inspection or for any other service and they are found to be worn to 2.778 mm (7/64 in.) from shoe surface with bonded material, or from rivet heads to brake lining surface.

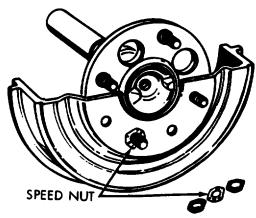
DRUM REPLACEMENT

Different assembly methods are used to hold brake drums in their piloted position on hub while wheels are dismounted.

LIGHT DUTY VEHICLES

Drums which are mounted against wheel flange on light duty vehicles are secured to studs either with speed nut fasteners or by swagging the piloting shoulder of stud to drum. To replace an original drum proceed as follows:

Where threaded fasteners (Fig. 20) are used simply unthread speed nuts and lift drum from flange.



MT-15533

Fig. 20 Threaded Fastener Type Drum Mounting

If <u>swaged stud mounting</u> (Fig. 21) is used, chuck a stud cutter in an electric drill, align cutter over each stud and cut away the swaged material. Separate drum from hub and discard drum.

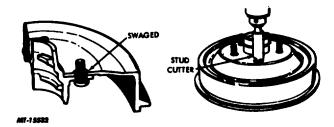


Fig. 21 Swaged Stud Type Drum Mounting
MEDIUM AND HEAVY DUTY VEHICLES

Drum replacement on medium and heavy duty vehicles requires the removal of nuts from bolts securing hub and drum together. The hub and drum can then be separated.

MOUNTING NEW DRUM TO HUB

Clean exposed hub or axle mounting flange with wire brush or coarse file. Use straight edge across surface of flange to make sure it is not bent. Remove excess paint from edge of drum hub hole and wash rust preventive sealer from drum with solvent.

Before installing a replacement drum wash the drum thoroughly with high grade denatured alcohol to remove <u>all</u> protective grease, oil or other residue. <u>DO-NOT use</u> gasoline, mineral spirits or oil.

In most situations replacement drum, whether for previously speed nut retained type or swaged-on type, can be secured with the speed nuts (Fig. 20). However, if swaging is desired, recommended procedure is as follows.

- 1. Obtain appropriate size peen punch (SE-855-7 for ½" stud; SE-1103 for 9/16" stud).
- 2. Position new drum over studs in hub and temporarily fasten it against hub flange by placing oversize washer over three studs and tightening wheel nuts against them.
- Using peen punch over stud, align stud and drum in press with stud properly supported.
 Press the stud shoulder in place against drum.
- 4. Repeat pressing operation on next open stud.
- 5. Reposition washers and repeat pressing operation until all studs have been swaged.
- 6. To assure hub and drum concentricity, take a light machining cut on drum in drum lathe.

When assemblying hub and drum together on medium and heavy duty vehicles, pay special attention to the bolt heads so that they are aligned properly in the drum (Fig. 22).

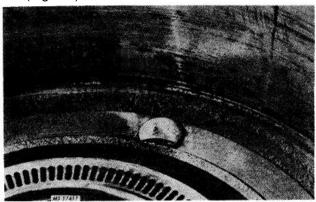


Fig. 22 Drum Bolt Alignment
Refer to Torque Chart for Bolt Tightening sequence and proper torque values of hub to drum mounting bolts as well as rim and wheel mountings.



TORQUE CHART

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Nominal	TORQUE		QUE
<u>Size</u>		<u>N.m</u>	Ft Lbs
1/2"		95 - 115	70 - 85
9/16"		144 - 170	105 - 125
5/8"		194 - 237	145 - 175
3/4"		346 - 407	250 - 300
	Tighten hub-to-drum bolts alternately; across from each other.		
RIM AND WHE	EL MOUNTINGS		
	Cast Wheels (Rim Clamp)		
5/8"	217 - 237	160 - 157	
3/4"	237 - 271	175 - 200	
	Disc Wheels - Light Truck		
5/8"	In-Out Coined Mounting	237 - 304	175 - 225
5/8"	Flanged Nut Mounting	373 - 439	275 - 325
	Disc Wheels - Standard Mounting		
11/16"	Flanged Nut Mounting	475 - 542	350 - 400
3/4"	Standard Square Cap Nut Mounting (13/16" Across Flats)	610 - 678	450 - 500
3/4"	Standard Hex Cap Nut Mounting (1-1/2" Across Flats)	610 - 678	450 - 500
1-1/8"	Standard Hex Cap Nut Mounting (1-1/2" Across Flats)	610 - 678	450 - 500
	Disc Wheels - Heavy Duty Mounting		
1-1/8"	HD Hex Cap Nut Mounting (1-3/4" Across Flats)	882 - 949	650 - 700
15/16"	HD Square Cap Nut Mounting (15/16" Across Flats)	1017 - 1220	750 - 900
1-5/16"	HD Hex Cap Nut Mounting (1-3/4" Across Flats)	1017 - 1220	750 - 900

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BRAKES - PARKING



PARKING BRAKES

DIAPHRAGM TYPE - SPRING ACTUATED

ANCHORLOK

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DESCRIPTION

The "Anchorlok" brake chamber assembly is used as a service brake chamber, a spring-applied parking brake and an emergency brake in case of air pressure loss. The brake chamber assemblies are made in two types to operate "S-cam" type brakes (Fig. 1) and "wedge" type brakes (Fig. 2).

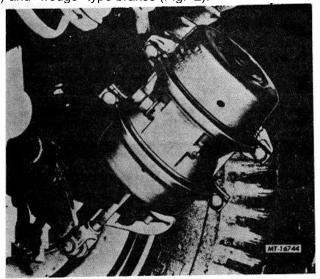


Fig. 1 "S" Cam-Type Brakes

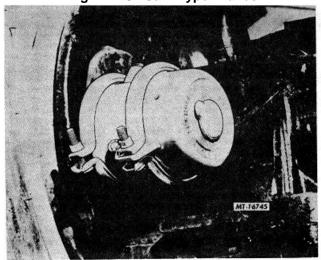


Fig. 2 Wedge Type Brakes

The brake chamber assembly consists of two separate air chambers, each having its own diaphragm and push rod (Fig. 3). The two chambers differ in that the service brake chamber applies the brake by air pressure and releases it by spring pressure, while the spring brake chamber applies the brake by spring pressure and releases it by air pressure.

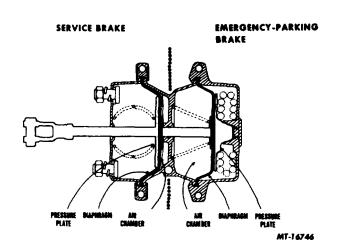


Fig. 3 Cross Section of Brake Chambers OPERATION

In normal driving (brakes released see Fig. 4), the brakes are held released by the diaphragm return spring in the service brake chamber. Air reservoir pressure in the spring brake chamber working against the spring brake diaphragm holds the emergency-parking spring compressed.

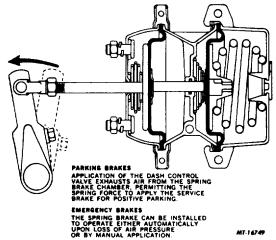


Fig. 4 Brakes Released

In normal braking (service brakes applied see Fig. 5), air pressure from the brake valve working against the service brake diaphragm applies the brakes. Air reservoir pressure in the spring brake chamber holds the emergency-parking spring compressed. Normal service brake operation is not affected by the spring brake.

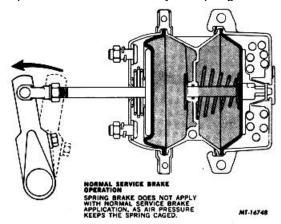


Fig. 5 Service Brakes Applied

For parking or to make an emergency brake application, the air pressure is exhausted from the spring brake chamber. This permits the emergency-parking spring to expand, moving the spring brake push rod and the service brake push rod to apply the brake (see Fig. 6).

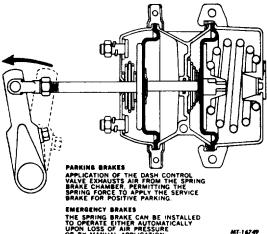


Fig. 6 Emergency or Parking Brake Application

In some installations loss of air pressure in the system results in loss of air pressure in the spring brake chambers and automatically applies the brakes. Other installations have a protected reservoir for the spring brakes. In case of pressure loss in the main air brake system, air pressure from the protected reservoir will

hold the spring brakes released until a manual application is made by the driver.

In the event it is necessary to move the vehicle after an emergency application (before air pressure can be restored), the emergency-parking spring can be compressed mechanically to release the brake. A release stud ("spring caging tool") is furnished with the brake chamber assembly. The release stud engages in the spring pressure plate and its nut is tightened to compress ("cage") the spring and release the brake (see Fig. 7). The release stud is also used to compress the spring to permit servicing the brake chamber assembly. Refer to "Brake Chamber Service."

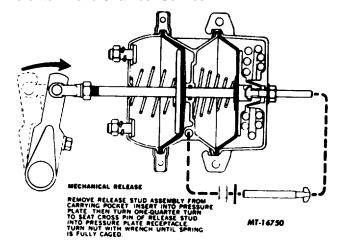


Fig. 7 Mechanical Release

BRAKE CHAMBER SERVICE

If it is suspected that the brakes are not working properly, first check to make sure the diaphragms are intact. To check the spring brake diaphragms, apply the dash control valve to fill the spring brake chambers with air pressure and check for air leakage. If air is escaping from around the brake chamber clamp, the clamp may be loose. Tap each side with a hammer and tighten the clamp bolts. (This operation will be more effective if the spring is first caged as instructed.) If air leakage is still evident, the diaphragm is probably defective.

To check the service brake diaphragms, hold the brake valve applied and check for air leakage at the service brake chambers.

NOTE:

Do not apply the service brakes while the spring brakes are applied or vice versa. This compounding of brake application efforts may damage brake shoes, drums or other brake components.

The brake chamber assemblies can be serviced either on or off chassis. In either instance the parking brake spring <u>must be caged</u> (see <u>Cage Spring</u>). Cage Spring

Do not attempt to disassemble or remove brake chamber before caging the parking brake spring. To cage the parking brake spring, remove the release stud tool and nut from the carrying pocket on the chamber assembly. Remove the access plug from the end of the spring chamber. Insert the release stud through the opening in the chamber and into the spring pressure plate (See Fig. 8).

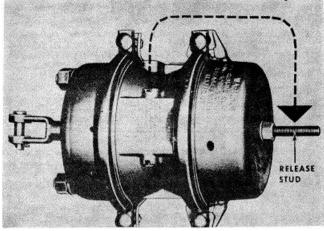


Fig. 8 Release Stud Positioned In Air Chamber and Into Spring Pressure Plate

Turn the release stud 1/4 turn to engage the tangs on the release stud into the slot in the pressure plate. Install the nut on the release stud. Be sure tang on release stud stays engaged with slot on pressure plate while installing the nut. Tighten the nut with a wrench to compress the spring. Apply a lightcoat of engine oil to the threads of the release stud to avoid any unnecessary wear of the threads. In the event the parking brake diaphragm is not leaking excessively use air pressure (spring brake control valve in drive position) to assist in caging springs. Continue turning the nut until the spring is fully caged (see Fig. 9).

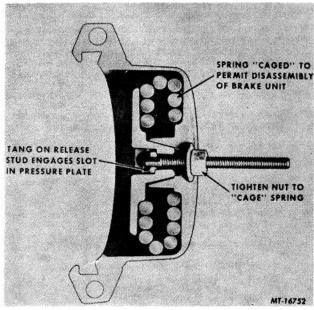


Fig. 9 Parking Brake Spring Caged

Remove Brake Chamber

- 1. Adequately block the vehicle wheels to prevent vehicle from rolling.
- 2. Cage spring as outlined.
- 3. Release air pressure to parking brake and service brake.
- Remove air hoses from parking brake and service brake chambers. Tag hoses for proper reassembly.
- 5. Chassis with "S" cam brakes, disconnect service brake piston rod from slack adjuster by removing pin from clevis. Chassis with wedge brakes, use a drift to straighten lockwasher on air chamber tube. Then use a drift punch or spanner wrench to loosen the locknut. Unscrew the air chamber reassembly from actuating housing.

Disassemble Brake Chamber

(On or Off Vehicle)

Before disassembling the brake chamber, scribe alignment marks on mounting housing to adapter housing to assure proper alignment of hose connections.

After the spring has been caged, remove the spring housing-to-adapter clamp. The spring housing incorporates two safety hooks which will prevent "explosion" of the spring brake assembly due to spring pressure in the event that the clamp is removed without first fully caging the spring (see Fig. 10).

CAUTION:

Do not use a hammer to remove spring housing from adapter.

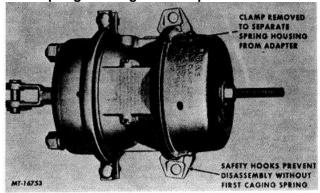


Fig. 10 Spring Housing Safety Hooks In Position

The spring housing assembly (with spring and pressure plate) can now be removed from the adapter and the spring brake diaphragm can be removed (Fig. 11). The adapter assembly can be separated from the service brake chamber and the service diaphragm can be removed by loosening and removing the adapter to service chamber clamp.

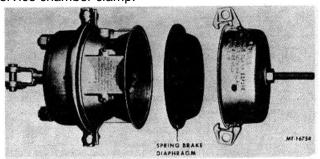


Fig. 11 Spring Housing and Diaphragm Removed

Because removal of the emergency-parking spring from the spring housing requires use of a special fixture, local replacement of the spring is not recommended. The spring, spring housing and pressure plate are provided for service as an assembly.

CAUTION:

Do not loosen or remove the release stud nut unless the brake chamber is completely assembled and securely clamped.

The adapter assembly "O" ring seal and other components can be serviced by removing the push rod plate retaining screw, separating the plate from the push rod and then pulling the push rod from the adapter housing (see Fig. 12). Care should be taken so that the adapter push rod is not marred.

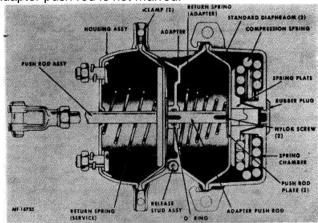


Fig. 12 Cross Section of Brake Chamber

Reassemble Brake Chamber

Reassembly of the brake chamber assembly is performed in the reverse order of disassembly. When assembling the adapter assembly, lubricate the adapter push rod with a film of IH 251H EP grease or equivalent NLGI #2 multi-purpose lithium grease. Be sure that brake diaphragms are centered evenly around their circumference before installing the clamp bolts and line up the alignment marks. Tighten clamp bolts evenly.

If air brake chambers were not removed from chassis, charge spring brake chambers with air pressure and check for air leaks. Apply service brakes and check for air leaks. Remove the release stud and nut from the spring housing and reinstall the access plug in the housing opening. Reinstall the release stud and nut in the carrying pocket on the brake chamber housing.

Reinstall Air Brake Chamber

Some air chambers have a collet spanner nut as shown in Fig. 13. If the chamber has a collet nut and the inside diameter of the actuator is chamfered where the air chamber tube screws in, assemble the collet nut

on the air chamber tube so that the tapered part of the nut, will fit into the actuator.

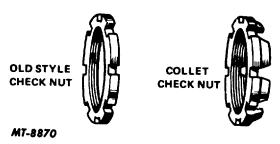


Fig. 13 Air Chamber Tube Spanner (Check) Nut

If the inside diameter of the actuator is not chamfered, assemble the collet nut on the air chamber tube so that the flat side of the nut will be against the actuator. In this case, a lockwasher is required.

Assemble a new lockwasher, if required, over the end of the air chamber tube. Screw the air chamber tube into the actuator until the tube is tight against the wedge stop washer. Be sure the end of the wedge shaft is seated in the diaphragm push rod of the air chamber.

Tighten the tube spanner nut securely (to 150 ft. lbs. torque) against the lockwasher or against the actuator if a collet nut is used without a lockwasher. Bend the outer edge of the lockwasher, if used, into the notches of the nut.

CAUTION:

Do not back the air chamber tube out of the actuator for the purpose of aligning hose connections. If necessary, the clamp ring that secures the two air chamber halves may be loosened and the inner chamber half rotated to align hose connections. When rotating the inner chamber half, be careful to avoid crimping or turning the air chamber diaphragm.

Install the other chamber in the same manner.



PARKING BRAKE ADJUSTMENT AND SERVICING

BAND TYPE

CODE 04006

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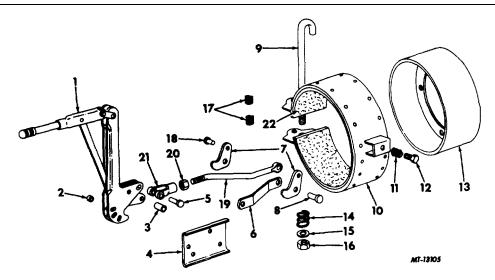


Fig. 1 Band Type Parking Brake (Exploded View)

LEGEND FOR FIG. 1

<u>Key</u>	<u>Description</u>	<u>Key</u>	Description
1	Lever, Hand Parking Brake, Assy.	11	Spring, Anchor Bracket Bolt
2	Spacer, Brake Lever Mounting (2)	12	Bolt, Anchor Bracket
3	Spacer, Brake Lever Mounting (2)	13	Drum, Brake
4	Bracket, Brake Lever Mounting	14	Spring, Adjusting Bolt
5	Pin, Rod End	15	Washer, Flat
6	Link, Brake Spacer	16	Nut, Hex. Jam (2)
	Bolt, Shoulder Link to Trans.	17	Spring, Brake Release (2)
7	Lever, Brake Cam (2)	18	Pin, Rod End
8	Pin, Rod End	19	Rod, Control, Brake
9	Bolt, Brake Adjusting	20	Nut, Hex. 1/2 NF
10	Band, w/Lining, Brake	21	Yoke, (Clevis) Adjusting
	Screw, FIL-HD 1/4 NC x 2-3/4 Nut, Hex. 1/4 NC (2)	22	Lining, Brake

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DESCRIPTION

The parking brake is an open drum type mounted in the drive line and operated by a control lever in the driver's compartment. It consists of a brake drum, flexible band, control lever and suitable linkage.

LINKAGE (ROD TYPE)

On some vehicles, the rod type linkage is used to operate the parking brake assembly. This type linkage should be inspected periodically for worn clevis yokes, pins and clevis eyes. If any of these conditions are encountered, it will be necessary to repair same before adjustment of parking brake is attempted.

LINKAGE (CABLE TYPE)

Vehicles equipped with cable type linkage for operating the parking brake assembly should be inspected periodically for binding, kinks or worn clevis eyes and pins. If any of these conditions are present, they should be corrected before attempting adjustment of parking brake.

CLEANING

If linings are oil soaked or greasy, replace with new lining. If linings are not greasy, brush dirt from linings with a wire brush and then wipe off with a cloth. Wash all parts other than brake lining in cleaning solvent.

INSPECTION

Inspect brake band lining for wear, cracks or breakage. If linings are worn too near heads of rivets, they must be replaced. Inspect brake drum for deep scores or damage; if damaged, replace.

REPAIR

If linings are worn too near rivet heads or are otherwise damaged, punch out old rivets and remove linings from brake band. Install new linings tightly against brake band and install new rivets. Compress rivets tightly using riveting equipment. If any other parts of the brake assembly show signs of wear or damage, replace as required.

ADJUSTMENT

Perform operations in sequence given.

- Place parking brake lever in extreme forward (release) position. Brake cam lever must rest squarely on upper brake band bracket. To correct this position, remove clevis pin and readjsut yoke (refer to Step 4).
- 2. The lining-to-drum clearance is obtained as follows (Fig. 2):

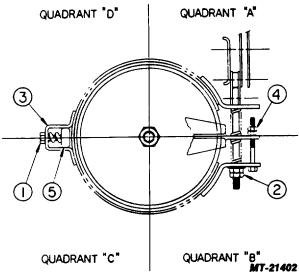


Fig. 2

- a. Torque J-bolt nut (2) to 20-27 N.m (15-20 ft lbs).
- b. Adjust anchor bolt (1) until head of bolt just contacts anchor bolt bracket (3).
- c. Back off anchor bolt (1) approximately one flat of head (1/6 turn).
- d. Back off J-bolt nut (2) until a clearance of .0508 .2032 mm (.002 .008") is obtained at closest point between lining and drum in: Quadrant "A" when lining is pushed away from drum until lining in quadrant "B" is resting squarely on drum.

Quadrant "B" when lining is pulled away from drum until lining in quadrant "A" is resting squarely on drum.

e. Adjust anchor bolt (1) until a clearance of .0508 .2032 mm (.002 .008") is obtained at closest point between lining and drum in:

Quadrant "C" when lining is pushed away from drum until either the lining in quadrant "D" is resting squarely on drum or anchor pin bracket (3) is resting squarely on brake support (5).

Quadrant "D" when lining is pulled away from drum until either the lining in quadrant "C" is resting squarely on drum or anchor pin bracket (3) is resting squarely on brake support (5).

f. Tighten nut (3) to take up excess threads on bolt

without any lower lining movement. Lock all adjustments and recheck clearance.

The foregoing clearances must be obtained by centering lining on drum so that lining surface is parallel with drum.

- 3. With parking brake hand lever in released position, assemble control rod to cam lever at brake assembly if control rod is disconnected (Fig. 3).
- With flat section of cam lever resting squarely on upper brake band bracket, adjust control rod clevis on control rod until hole in clevis aligns with mating hole in bellcrank and tighten clevis lock nut (Fig. 3).
- 5. Assemble clevis to bellcrank.
- 6. If vehicle is equipped with Orscheln parking brake lever (over-center type), turn adjusting knob on end of hand lever until force of 36-41 kg (80-90 lbs) is obtained to apply parking brake.

The Orscheln (parking) brake lever is the overcenter locking type. It is tightened (while released) by turning and adjusting knob clockwise. When properly adjusted, it pulls over center with a distinct click.

PARKING BRAKE BURNISHING (W/Orscheln Lever)

The following burnishing procedure is required to be performed on new vehicles or whenever parking brake lining and/or drum is replaced.

Vehicles with Orscheln Lever

- 1. Vehicle must be loaded near rated GVW.
- Release parking brake, turn adjusting knob until a force is obtained to apply the brake (overcenter position of lever) which will result in vehicle making a somewhat lighter than normal stop (3-5 ft per second) without wheel lockup.
- 3. Make ten (10) stops from 16 km/h (10 mph) on a dry hard surface road using only the parking brake to stop the vehicle.
- 4. After each stop, release parking brake and drive vehicle at 32 km/h (20 mph) for 4 km (2.5 miles) to cool brake.
- Readjust parking brake linkage (between hand lever and brake assembly) and hand lever adjusting knob to suit operational requirements considering load and road grade for vehicle operation.

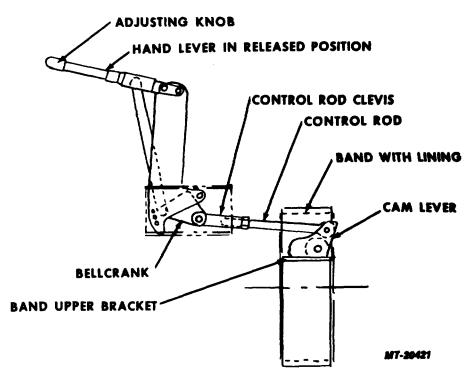


Fig. 3 Parking Brake Adjustment with Orscheln Hand Lever



PARKING BRAKE ADJUSTMENT AND SERVICING

ENCLOSED DRUM - TWO SHOE (DCM)

CO DES 04009,04014,04036,04043

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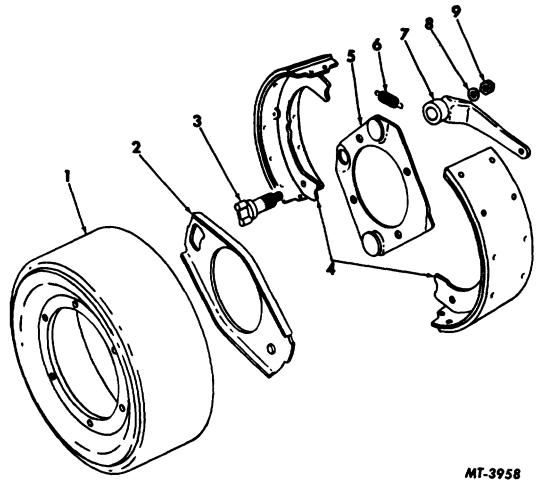


Fig. 1 DCM Parking Brake (Exploded View)

Legend for Fig. 1

<u>Key</u>	Description	<u>Key</u>	<u>Description</u>
1.	DRUM, brake	6.	SPRING, return
2.	STRUT	7.	LEVER, operating
3.	CAM-SHAFT	8.	WASHER
4.	SHOE, brake	9.	NUT, lock
5.	PLATE, backing		

DESCRIPTION

The Model DCM parking brake features a balanced design which provides improved mechanical efficiency and equally divides the input force between both shoes. This extends lining life and reduces transmission rear bearing stress.

The DCM brake operates both as a parking and an emergency brake. Equal torque output is exerted in either direction of vehicle travel with minimum input force and stroke. Stops are controlled with maximum protection against damage to vehicle chassis components. Cam design applies brake with either direction of lever movement.

DISASSEMBLY

There are only nine (9) parts in the DCM parking brake. The following instructions are given as an aid in disassembling and reassembling this unit.

Refer to Fig. 1 for parts identification during "Disassembly" and "Reassembly".

Disconnect end yoke pin connecting control rod or cable, whichever is applicable, to brake operating lever (7).

Remove brake drum mounting bolts and pull drum (1) free of brake or drop prop-shaft, whichever is necessary. Pull one shoe off the anchor pin sufficiently to allow the strut (2) to be pulled free of the retaining lance on the shoe table. Lift the strut (2) away from the cam shaft (3) and pull it free from the retaining lance on the other shoe.

Remove both shoe return springs (6). Brake shoes (4) can now be removed by lifting them off the anchor pins.

The backing plate (5) may be removed after the four mounting bolts are removed. These bolts are shoulder bolts having a thin head to provide clearance for the strut (2).

To remove operating lever (7) from camshaft (3) unscrew lock-nut (9) from cam-shaft and pull lever free. Cam-shaft assembly may then be pulled out of back plate (5).

CLEANING. INSPECTION AND REPAIR

If linings are oil soaked or greasy, replace with new lining preparatory to replacement. If linings are not greasy, brush dirt from them with a wire brush; then wipe off with a cloth. Wash all parts other than brake lining in a clean cleaning solvent and dry with compressed air.

Inspect brake shoe linings for wear, cracks or breakage. If linings are worn to near rivets they must be replaced. Inspect brake drum for deep scores or damage, and if damaged, replace.

If linings are worn too near rivet heads, or are otherwise damaged, punch out old rivets and remove linings from brake shoes. Install new linings tightly against brake shoes using new rivets. Umbrella type rivets may be used for increased lining life. Compress rivets tightly using riveting equipment. If any other parts of the brake assembly show signs of wear or damage, replace as required.

REASSEMBLY

Reassembly of the parking brake unit is essentially the reverse of disassembly, however, a few suggestions mentioned below may prove helpful.

When installing the operating lever (7) on the cam-shaft (3), the cam must be in the neutral position. Position the operating lever on the cam-shaft so that it will connect with the linkage.

The cam-shaft lock-nut (9) should be tightened sufficiently to prevent the assembly from rocking, but still allow it to turn freely.

It is important that the brake shoe return springs (6) be installed on the lever side of the brake shoes (4) as they act as both a hold down and return spring.

LUBRICATION

The only lubrication required on the parking brake unit is to apply a thin coating of grease to all bearing surfaces.

DO NOT overlubricate brake parts.

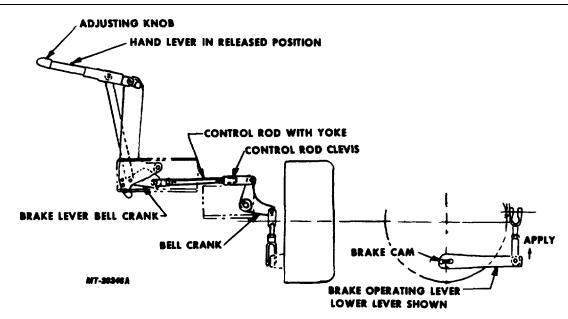


Fig. 2 Parking Brake Adjustment in the Orscheln Hand Lever

ADJUSTMENT

Adjustment of brake will be required when replacement of lining, shoes or drum is required.

Refer to Figure 2 pertaining to the nomenclature in the following adjustment procedure.

- 1. Block wheels to prevent vehicle from moving.
- 2. Position parking brake hand lever in released position (forward).
- Assemble control rod with yoke to brake lever bell crank if disconnected.
- 4. Move brake operating lever in apply direction to a position where contact is made with the brake cam but without any shoe movement. This will remove excess clearance in mechanism (approximately 6.35 to 9.53 mm, 1/4" to 3/8", free play at lever).
- 5. Adjust clevis until hole in clevis aligns with mating hole in bell crank.
- Assemble clevis to bell crank and tighten clevis locknut.
- 7. If vehicle is equipped with Orscheln parking brake lever (over-center type), turn adjusting knob on end of hand lever until a force of 41 kg (90 lbs) is attained to apply the parking brake.

The Orscheln (parking) brake lever is the overcenter locking type. It is tightened (while released) by turning the adjusting knob clockwise. When properly adjusted, it pulls over center with a distinct click.

PARKING BRAKE BURNISHING (W/Orscheln Lever)

The following burnishing procedure is required to be performed on new vehicles or whenever the parking brake lining and/or drum is replaced.

Vehicles with Orscheln Lever

- 1. The vehicle must be loaded near rated GVW.
- Release parking brake, turn adjusting knob until a force is obtained to apply the brake (overcenter position of the lever) which will result in the vehicle making a somewhat lighter than normal stop (3-5 ft per second) without wheel lockup.
- 3. Make ten (10) stops from 16 km/h (10 mph) on a dry hard surface road using only parking brake to stop vehicle.
- 4. After each stop, release parking brake and drive vehicle at 32 km/h (20 mph) for 4 km (2.5 miles) to cool the brake.
- Readjust parking brake linkage (between hand lever and brake assembly) and hand lever adjusting knob to suit operational requirement considering load and road grades for vehicle operation.



DOUBLE DIAPHRAGM SPRING BRAKE CHAMBER

MGM STOPGUARD

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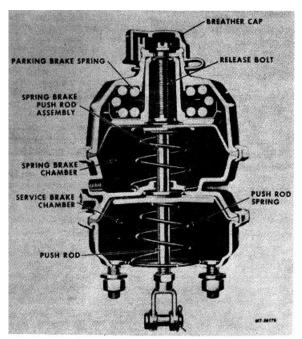


Fig. 1 Double Diaphragm Spring Brake Chamber DESCRIPTION

The double diaphragm spring brake chamber assembly consists of a tandem-type cylinder assembly connected to the foundation brake group either through the air brake slack adjuster or wedge assembly.

The cylinder assembly consists of two basic sections. One section is a conventional service brake chamber while the second section is the spring (parking) brake chamber. The spring brake chamber contains a powerful spring which is completely compressed by air pressure in normal driving mode.

OPERATION

Normal Driving

In normal operation with the parking brake released (Fig. 2) the spring brake control valve on the instrument panel must be in the released position. When the control valve is in the released position, air pressure is permitted to pass through the control valve and provide the spring brake chambers with air, thereby loading the spring brake chamber and compressing the parking brake spring, holding the rear wheel brakes in the released position.

Service Brake Application

When the service brakes are applied, air is forced into the service brake chamber (Fig. 3) forcing the push rod and piston assembly outward, extending the push rod assembly.

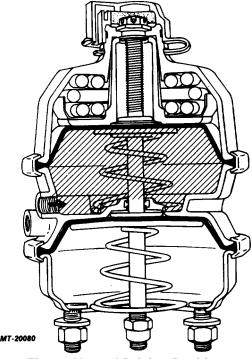


Fig. 2 Normal Driving Position

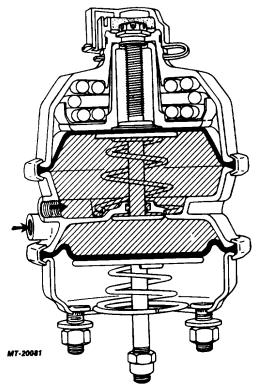


Fig. 3 Service Brake Application

When the brake (foot) valve is released, air in the service brake system is exhausted and the service brake chamber push rod assembly and diaphragm are permitted to return to the normal released position. The push rod spring assists in this function by forcing the push rod and plate assembly into the normal released position.

Parking Brake Application

To apply the spring (parking) brake, the operator of the vehicle positions the control valve in the applied position which exhausts air pressure from the spring brake loaded chamber (Fig. 4). Upon reduction of air pressure in the chambers, the parking brake springs will apply the rear brakes through the spring brake push rod and service brake push rod assemblies which are in turn connected to brake slack adjusters or brake wedge assemblies.

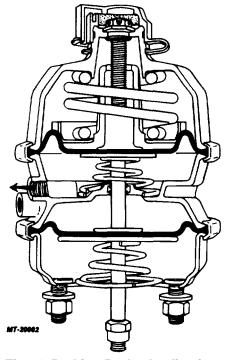


Fig. 4 Parking Brake Application

To release the parking brake, the operator positions the control valve to the released position which actually applies air in the spring brake system, thereby loading the chambers, and air pressure overcomes the heavy springs forcing the spring brake push rod and diaphragms to released position or normal driving position (Fig. 2).

Upon loss of air pressure or reduction of air pressure in the vehicle air system, the spring (parking) brakes will automatically apply, providing an emergency brake.

Refer to AIR BRAKE SYSTEM (FMVSS-121), General Information (CTS-2668) for complete detailed instructions pertaining to the operation of the "air system" in the event loss of air is ever encountered. MANUAL RELEASE OF SPRING BRAKE

To release the spring brake (manual release) in the event there is loss of air and the vehicle must be towed or whenever the spring brake chamber assembly is removed from the vehicle, the spring brake must be manually released or "caged" (Fig. 5).

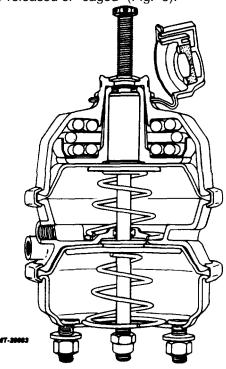


Fig. 5 Spring Brake In Manual Released Position

To manually release the spring brake chamber you are actually compressing the spring to relieve any tension on the push rod assembly.

CAUTION

Before manually releasing the spring brakes be sure to block the wheels so that the vehicle cannot move when the brakes are released. For towing, make sure the vehicle is connected or secured to tow vehicle before releasing the spring brakes.

The spring brake chamber can be manually released (caged) in two manners.

If the vehicle has 586 kPa (85 psi) of air or more, manually releasing the spring brakes can be accomplished easier if the breather cap is removed and the release bolt backed off counterclockwise about 57.15 to 63.5 mm (2-1/4 to 2-1/2") or approximately 30 turns prior to releasing air pressure in the parking brake system. Then after the release bolt has been backed off, the air pressure must be released from the parking brake system by placing the brake control in "apply" position. In this manner, you will have the air pressure in the system to assist in caging the spring.

If the release bolt should bind, apply "Liquid Wrench" or equivalent to the bolt and allow to soak into the threads.

In the event the air source has been depleted, the release bolt may be backed off in the same manner; however, turning the release bolt will require more effort since the parking brake spring will be fully extended, and when turning the bolt you will actually be pulling or collapsing the spring manually.

MANUAL SET OF SPRING BRAKE

If the release bolt threads are dry apply a light coat of "Never Seez" lubricant or equivalent to the threads. Do not apply "Never Seez" lubricant supplied in an aerosol can.

To manually reset parking brake at each spring brake chamber, screw release bolt down into unit until nut is bottomed against the receiver. Torque nut to 67.79 N.m (50 ft lbs) and reinstall breather caps.

REMOVE

- 1. Block the wheels of the vehicle to prevent it from moving.
- Manually release the spring brakes (refer to MANUAL RELEASE OF SPRING BRAKE). After releasing brakes release the air pressure in the parking brake system by placing the parking brake control in "apply" position. Be sure that the service brakes are released also.
- Remove air hoses from parking brake and service brake chambers. Tag hoses for proper identification at reassembly.
- 4. Disconnect service brake push rod yoke from slack adjuster.
- 5. Remove mounting stud nuts and remove complete spring brake assembly.

If the vehicle is equipped with wedge brakes, special instructions which apply to the actual removal of the air chambers are covered in that particular brake section.

REINSTALL

- 1. Assemble parking and service brake assembly on vehicle mounting bracket.
- 2. Connect service brake push rod yoke to slack adjuster.
 - Refer to the specific brake group section if the vehicle is equipped with wedge brakes.
- 3. Connect air supply hoses to their respective inlets on parking and service brake chambers.
- 4. Position parking brake control in released position with at least 620 kPa (90 psi) air pressure and apply service brakes. Inspect both service and parking brake air connections and both chamber assemblies for possible air leakage at diaphragm with a soap solution. Correct any air leaks which may exist.
- 5. Remove vehicle blocks.

DIASSEMBLY

CAUTION

When disassembling the spring brake assembly, follow the instructions as stated. NEVER TAKE ANY SHORT CUTS.

- 1. Be sure spring brake is in the manually released position as shown in Fig. 6.
- 2. Position a locking type pliers (vise-grip) on the service brake chamber push rod, locking pliers to retain push rod, retaining service brake push rod spring (Fig. 7).

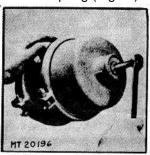




Fig. 6

Fig. 7

- 3. Loosen service brake chamber clamp nuts and separate service brake chamber half from case (body) by removing the clamp ring (Fig. 8).
- 4. Using a 3.175 mm (1/8") diameter punch, knock out the lock pin in the release bolt (Fig. 9); then remove nut.



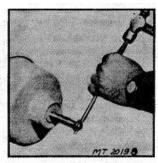


Fig. 8

Fig. 9

- Place the spring brake case in a hydraulic press with release bolt toward the press ram. Then position a split tube type adapter and flat plate over the release bolt assembly (Fig. 10).

 Adjust press so that there is a minimum of 203
 - Adjust press so that there is a minimum of 203 mm (8") of travel available for releasing spring pressure after ram has contacted the plate.
- 6. Apply very light pressure by the ram on the plate; then remove spring brake chamber clamp assembly (Fig. 11).

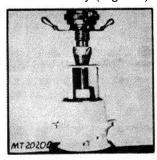




Fig. 10

Fig. 11

7. Very slowly relieve the hydraulic pressure from the ram. At this point there should be no <u>outward</u> pressure from within the actuator and the ram and plate should separate at once.

CAUTION

If tension remains between the ram and the plate, either the unit is not manually released or a failure has occurred in the release mechanism. If the unit is released but pressure is present, continue to relax the press slowly until the spring is fully extended and all parts fall free. Then continue with Item 8.

- Lift off the head-spring-piston subassembly (Fig. 12). Treat this subassembly with caution as the powerful spring is caged between the piston and head.
- Remove diaphragm (Fig. 13). While diaphragm is removed, inspect the inside of the flange case, return spring, push rod plate, screw and guide rings. If service is required on any of these parts, continue with Item 10.





Fig. 12

Fig. 13

10. With one hand holding the spring brake diaphragm plate, remove the screw holding the plate to the push rod (Fig. 14). If screw cannot be removed in this manner use a padded pliers to hold push rod from turning. Use caution when finally unscrewing screw as the push rod plate is under light spring tension.



Fig. 14

- 11. Remove all parts from flange case and wash thoroughly.
- 12. Remove guide rings (Fig. 15) and push rod seal from flange case (body). This seal can best be removed by inserting a small bladed screwdriver behind the seal in the groove and very carefully prying the seat out of the groove (Fig. 16).



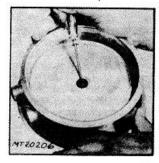


Fig. 15

Fig. 16

13. Position the spring brake, head-spring and piston subassembly in hydraulic press (Fig. 17). It is very important that a 101 to 127 mm (4 to 5") diameter split tube is positioned under the assembly supporting the piston and another split tube over the complete assembly between the head and flat plate under the press ram. If these tubes are not used the final safe disassembly cannot be performed. After the press ram touches the plate, the ram must be able to travel at least 203 mm (8") away from the assembly so that the spring tension will be fully relieved.



Fig. 17

14. Check the complete assembly for straight alignment in press and apply a light pressure in the ram.

- 15. Use a screwdriver and pry off the piston plug in the center bottom of the piston (Fig. 18).
- 16. Use a long, broad-blade screwdriver and unscrew the release bolt from bottom of piston until it falls free Fig. 19). If the release bolt resists removal, apply additional (slight) pressure on the ram.



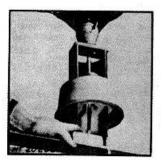


Fig. 18

Fig. 19

- 17. After the release bolt has been removed release (gradually) the ram until the head loses contact with the press ram (Fig. 20).
- 18. Remove spring brake head spring and piston assemblies from press (Fig. 21).



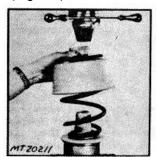


Fig. 20

Fig. 21

CLEANING AND INSPECTION

Thoroughly wash all parts in cleaning solvent. Visually inspect all parts for wear or damage. Any component which is considered questionable for further service must be replaced. Both spring brake and service brake diaphragms must be replaced. The push rod seal assembly must also be replaced.

ASSEMBLY

- Apply a generous amount of IH 251H EP grease of equivalent NLGI #2 multi-purpose lithium grease to inside of spring brake chamber head, outside of piston shank, inside of piston shank and to the release bolt.
- Position one of the split tubes on hydraulic press base and then in the following order place piston, spring shield cup, parking brake spring thrust washer and head on top of the split tube. Then position the second split tube and flat plate on spring brake head (Fig. 22).



Fig. 22

- 3. Check straight up-and-down alignment of all parts and standing to the side of the press, take up tension very slowly on ram. Check alignment continually as straight-in reassembly is important. If misalignment occurs, release press and begin compression of spring again.
- 4. With spring completely compressed between piston and head and with piston bottomed up inside the head, install the release bolt up through the piston shank. Screw the bolt in until approximately 76 mm (3") of the bolt extends through the head insert.
- 5. Slowly release the ram tension until all parts separate from ram.
- Remove subassembly from press and thread release nut on release bolt. Lock in place in lock pin.
- Replace piston plug in center hole of piston. Firmly tap center plug with hammer so it moves over center to flat attitude (Fig. 23).



Fig. 23

- 8. Be sure seal groove in case is clean and lightly lubricate groove with IH 251H EP grease or equivalent NLGI #2 multi-purpose lithium grease. Also, apply same lube to new push rod seal; then install seal into groove carefully so it is not damaged. Seat seal in groove by running your finger around the I.D.
- Install guide rings on both sides of seal.
 The widest flange side always faces away from the seal.
- 10. Install smaller push rod plate back on push rod if it was removed and securely lock with screw. Apply two drops of Loctite #271 to the screws. Be careful not to damage the surface of the push rod. Apply a small amount of lubricant to tip of push rod and insert it through seal from service brake chamber side of case.
- 11. Position push rod and case subassembly on a 76 mm (3") diameter support. Position return spring in case and compress spring with large push rod plate enough to reinstall screw through plate and into push rod (Fig. 14).

IMPORTANT

The screws holding the two plates to the push rod must be tightened securely. To properly tighten both screws, grip the O.D. of bottom plate with a soft jaw vise and tighten screw holding upper large plate. This will tighten both screws at the same time.

12. Check the alignment of return spring in

BRAKES - PARKING

- flange case and to large push rod plate. Straight alignment is important.
- 13. Position new diaphragm on flange case; then position head, spring and piston subassembly over diaphragm and check for straight alignment of all parts (Fig. 12).
- 14. Position case and head subassemblies in press with a split tube and plate on head.
- 15. Apply light pressure to plate with press ram and reinstall clamp ring (Fig. 11). Tighten clamp nuts to 33.9 to 47.5 N.m (25 to 35 ft lbs) torque. Using a soft hammer, tap the circumference of clamp ring to assure proper seating; then retighten clamp nuts to 33.9 to 47.5 N.m.
- 16. With assembly still in press, attach a shop air line with 689.5 to 724 kPa (100-125 psi) pressure to "spring brake" inlet (Fig. 24). With assembly charged with air, soap-test the clamp ring area to verify leak-free reassembly. If leak is discovered, disassemble unit. Reposition parts and reassemble.



Fig. 24

- 17. After passing leakage test, retighten clamp bolts and remove from press.
- 18. Place the service brake spring in the service (non-pressure) brake chamber half; then position the service brake, piston and push rod through the chamber half. Compress the piston enough to compress the spring and install a locking type pliers (vise-grip) on the piston push rod (Fig. 7).

- 19. Place the service brake diaphragm on the case flange; then the non-pressure service brake chamber half on the diaphragm. Install clamp ring and tighten clamp nuts to 33.9 47.5 N.m (25 to 35 ft lbs) torque. Using a soft hammer, tap the circumference of clamp ring to assure proper seating.
- 20. Apply a light coat of "Never Seez" lubricant to push rod threads.
- 21. Attach a shop air line to the "service brake" inlet. With the service chamber charged with air, soap-test the clamp ring area to be sure of leak-free reassembly.
- 22. Exhaust the air in the service brake chamber and retorque the clamp bolts. The spring brake assembly is now ready to be installed on the vehicle.

SUSPECTED DEFECTIVE PARKING BRAKE SPRING

If a broken power spring is suspected, confirmation can usually be made (after removing the suspected unit from the vehicle) by screwing the release bolt all the way into the unit and vigorously "shaking" the assembly. Noticeable "rattling" from within the head end of the assembly normally confirms a fractured spring. Further evidence would be supplied by only light resistance when screwing the release bolt down.

Even though a broken spring may have been confirmed, it is important to manually release the actuator again before further disassembly.

LUBRICATION

Regular lubrication of the double diaphragm spring brake chamber is not required; however, when the unit is disassembled, all parts must be washed in clean solvent and IH 251H EP grease or equivalent NLGI #2 multi-purpose lithium grease applied to all interior parts and surfaces, except both diaphragms.

If the threads on the release bolts are dry a light coat of "Never Seez" lubricant should be applied to the threads. Do not use "Never Seez" lubricant supplied in an aerosol can.



CLUTCH

12, 13 AND 14 INCH 12 AND 15 SPRING CODES 11121, 11123, 11127, 11130, 11133, 11134, 11140, 11142, 11143 AND 11148

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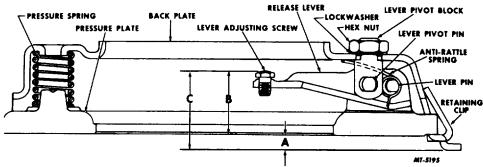


Fig. 1 Sectional View-- 12" RTA Clutch

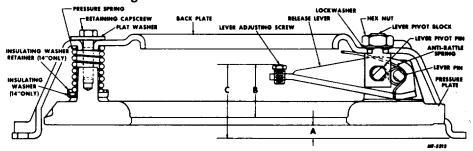


Fig. 2 Sectional View-- 13", 14" RTA Clutch

DESCRIPTION

The clutch is of the single dry plate type; release lever adjustments should not be required during the normal life of the clutch driven plate facings. As pedal free travel is reduced by wear of the clutch driven member facings, the correct amount of pedal free travel should be restored by means of the pedal adjustment, which will also give the proper clearance between clutch release levers and the release bearing. It is extremely important to maintain specified free travel at all times to avoid clutch slippage and to protect the throwout bearing.

Whenever it is necessary to do any service work on the clutch, advantage should be taken of the opportunity to thoroughly recondition it. This is a comparatively short job and will assure satisfactory operation over a long period of time, whereas failure to do this may necessitate another teardown within a short time.

REMOVAL

When removing the transmission for the purpose of gaining access to the clutch or for any other reason, extreme care should be

taken to support the weight of the transmission until it is completely removed, so that the main shaft splines will clear the driven member. There is a possibility of distorting the driven member, which will not permit a free release of the clutch.

When removing the clutch assembly, observe that balance mark (spot of white paint) on back plate flange, Fig. 6, is located as near as possible to the balance mark ("L") stamped on the flywheel face. These balance marks should be located in the same relative position at clutch installation. If the clutch balance mark cannot be located, scribe a line on the back plate flange at the flywheel balance mark for installation purposes.

Two methods are used to hold the clutch assembly compressed during removal. On the 13" and 14" clutch the pressure plate is drilled and tapped so that three retaining capscrews and flat washers may be installed. To remove clutch assembly, insert retaining capscrews through the back plate and install in pressure plate. Tighten each capscrew until flat washer and capscrew head are seated on the back plate. Remove back plate-to-flywheel mounting capscrews.

The 12" clutch assembly is held in a compressed position with retaining clips, Fig. 1. On this clutch assembly place a retaining clip between the back plate and pressure plate lug and slightly loosen the back plate-to-flywheel mounting capscrews to wedge the clip in place. Turn the flywheel one-third turn and install a second clip in the same manner. Repeat the procedure for installing the third retaining clip.

DRIVEN MEMBER ASSEMBLY

The clutch driven member assembly should be carefully inspected. Facings showing considerable wear or facings that are rough or oil soaked should be replaced.

When removing old facings from a driven member, drill out the rivets to prevent possible distortion or damage to the driven member.

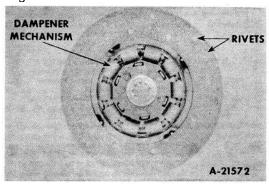


Fig. 3 Solid Type Driven Member (Each Rivet Secures Both Facings)

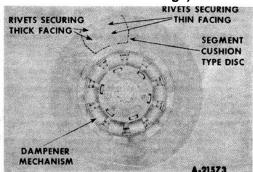


Fig. 4 Cushion Type Driven Member (Half of Rivets Hold Thin Facing and the Other Half Secure Thick Facing to the Disc)

When installing new facings of the continuous ring type and in cases where two different thicknesses are used on each plate, the thick

facing is installed on the pressure plate side. The thin facing is installed on the flywheel side. Hold facings tight against the driven member during riveting operation. Loose or uneven facings due to improper riveting may result in a dragging clutch.

Installation of clutch facings on the cushion type driven member differs from the other type in that each facing is attached to the discs separately and independently, Figs. 3 and 4.

Driven member assemblies are balanced at initial assembly and any attention in this respect is not required.

CLUTCH OVERHAUL

The back plate and pressure plate are balanced at initial assembly. To preserve proper balance of the assembly, mark both components, Fig. 5, before dismantling, so that each part may be reassembled in the same relative position.

<u>Disassembly</u>

- 1. Position clutch assembly in an arbor press on a smooth flat surface plate of adequate size to support the assembly.
- Select spacers of proper thickness from the SE-2068 Spacer Plate Set and place the three spacers at equal distance under the pressure plate, Fig. 5. See specifications for spacer plate requirement.

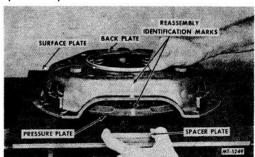


Fig. 5 Selecting Proper SE-2068 Spacer Plates

 Bridge a bar across the top of the back plate and slightly compress the assembly to relieve spring pressure at retaining clips. Remove retaining clips, Fig. 6. If retaining capscrews are used to hold the clutch assembly compressed, remove capscrews at this time.

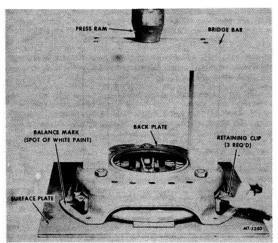


Fig. 6 Removing Retaining Clips

 Continue to compress the assembly until the back plate flange is firmly seated on the surface plate. Remove three pivot block hex nuts, Fig. 7, and shakeproof lockwashers.

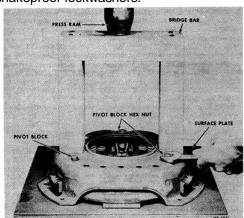


Fig. 7 Removing Pivot Block Hex Nuts

Gradually release press pressure and lift off the back plate noting the position of the pressure springs, Fig. 8. Remove pressure springs.

NOTE

On 14" clutch assemblies remove spring insulating washer and retainer.

6. Remove the cotter pin and washer from the lever pin and remove lever pin, release lever and antirattle spring, Fig. 9.

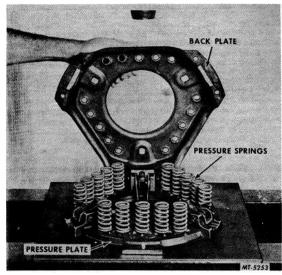


Fig. 8 Removing Back Plate and Pressure Springs

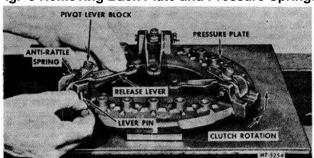


Fig. 9 Removing Release Lever Pin

7. Remove the lever pivot pin, Fig. 10, to disassemble the release lever pivot block.

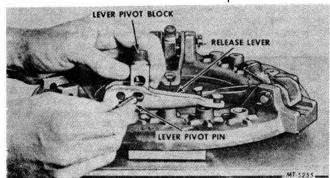


Fig. 10 Disassembling Release Lever and Pivot Block Assembly

<u>Inspection</u>

 Check the pressure springs for proper tension (see specifications) using SE-2241 tester, Fig. 11, or similar equipment. If a tester is not available, make a comparison test with new springs. Discard those not of the same length or discolored due to heat.

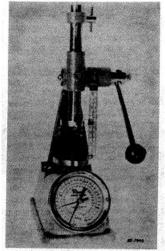


Fig. 11 Checking Clutch Pressure Springs on SE-2241 Tester

- Check release lever assemblies for excessive wear. Those showing wear at contact points must be replaced. The service release lever assembly consists of a lever, pivot block, lever pivot pin, lever pin and anti-rattle spring. A loose adjusting screw will require replacement of the release lever assembly.
- Inspect pressure plate. A plate that is badly scored, checked or warped should be replaced, as it will not perform satisfactorily and will damage the clutch driven member.
- 4. Examine engine flywheel surface. If the clutch surface on the flywheel is not smooth, the flywheel should be removed, mounted in a lathe and smoothed with emery cloth using first a coarse cloth and finishing with a fine emery cloth. Where the surface is extremely rough, a light cut nay be taken with a lathe tool and then polished with emery cloth. However, excessive material must not be removed from the flywheel. If a light cut will not improve the flywheel surface, the flywheel should be replaced.

Assembly

 Position the lever pivot block in the lever and install the lever pivot pin, Fig. 10, through the lever and pivot block. Lubricate

- all pivot points at assembly with IH 251 H.E.P. grease or equivalent NLGI #2 multi-purpose lithium grease.
- Position the anti-rattle spring over the pivot block and place the release lever assembly between the pressure plate lugs and install lever pin, Fig. 9. Secure pin with fiat washer and cotter pin. Assemble and install the remaining release levers in the same manner.
- 3. Place the pressure plate with assembled release levers in an arbor press on a flat, smooth surface plate. Place each of the three spacer plates selected to disassemble the clutch at equal distance under the pressure plate.
- Position pressure springs on the pressure plate, Fig. 8. Make certain the springs are properly seated on the plate.

NOTE

On 14" clutch assemblies install insulating washer and retainer under each spring.

- 5. Place the back plate over the pressure springs and align the reassembly marks applied to back plate and pressure plate during disassembly. Also make certain the lever pivot blocks align with the holes in the back plate.
- 6. Bridge a bar across the top of the back plate and slowly compress until the lever pivot blocks can be guided through the back plate. Continue to compress the assembly until back plate flange is firmly seated on the surface plate. At this point check the back plate, pressure plate, release levers and springs for proper alignment.
- Install three shakeproof lockwashers and pivot block hex nuts, Fig. 7. Tighten pivot nuts to 45 ft. lbs. (61 N-m) torque.
- 8. Adjust release lever height, Fig. 12, by turning lever adjusting screws to dimension "C" shown in the specifications. Burnish the levers with a hydraulic press several times to seat the levers to the outer or normal operating position. Recheck the lever adjustment to make certain the setting is correct. Place the clutch assembly on a flat, smooth surface plate and adjust release lever height to dimension "B" shown in the specifications. Recheck each lever height to assure accuracy.
- Install retaining capscrews or clips to hold the assembly in a compressed position for installation on flywheel.

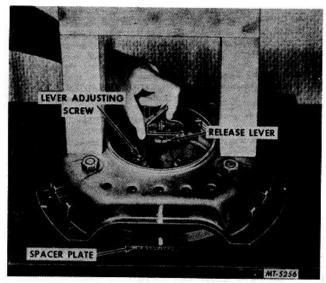


Fig. 12 Adjusting Release Lever Height

INSTALLING CLUTCH ASSEMBLY TO FLYWHEEL

Position the clutch driven member against the flywheel so that long portion of the hub is toward the rear. Place the clutch in position on the flywheel over the driven member assembly.

Locate the clutch so the balance mark (spot of white paint) on back plate flange is as near as possible to the letter "L" stamped on the flywheel and install two or three mounting capscrews and lockwasher loosely. Insert a clutch aligning arbor if available or a

transmission main drive gear shaft through the clutch driven member hub spline and into the clutch pilot bearing. Hold the clutch driven member in position while completing installation of the remaining mounting capscrews and lockwashers in the back plate flange. Tighten all capscrews alternately, evenly and securely. Remove the three retaining capscrews and flat washers which were installed to hold the clutch assembly compressed.

NOTE

The clutch will not operate properly unless these retaining capscrews are removed.

LUBRICATION

Lubricate clutch release sleeve, bearing and release fork contact pads every 15,000 to 20,000 miles (24,000 to 32,000 km). Under frequent "stop and go" operations, lubricate every 10,000 miles (16,000 km).

Using a low pressure gun, completely fill the sleeve cavity with lubricant through the lubricator fitting. Rotate the bearing to four 90 degree positions when lubricating the sleeve. Pack lubricant between release fork and contact pads on sleeve. Do not overlubricate.

For lubricant types, refer to LUBRICATION Section CTS-2412 of the Service Manual.



TROUBLESHOOTING

COMPLAINT	POSSIBLE CAUSE				
Chattering	Incorrect lever adjustment. S. Glazed facing.				
	2. Oil or grease on facing.				
	6. Bent driven member.				
	3. Binding release levers.				
	4. Incorrect facing. 7. Loose rivet.				
Grabbing	 Improper lever adjustment. Worn or binding release lever. 				
	5. Incorrect facing.				
	2. Oil or grease on facing.				
	6. Engine mounts loose.				
	3. Worn pressure plate, flywheel				
	or driven member. 7. Clutch assembly dose on flywheel.				
Slipping	 Weak or broken pressure springs. Oil or grease on facing. 				
	 Worn or burned facing. Binding release levers. 				
	3. Improper adjustments. 6. Driver riding clutch pedal.				
Dragging	 Oil or grease on facing. Release bearing sticking. 				
	 Incorrect lever adjustment. Warped pressure plate. 				
	3. Incorrect pedal height.				
	8. Driven member too thick.				
	4. Broken facing.				
	9. Improper driven member or				
	5. Bent driven member. pressure plate.				
Rattling	 Weak or broken anti-rattle spring. Unequal contact of release levers. 				
	 Damaged pressure plate. Excessive backlash in transmis- 				
	sion or propeller shaft.				
	3. Worn release bearing 7. Warped driven member.				
	4. Dry or worn pilot bearing. 8. Incorrect driven member.				
Vibrating	 Improper balance of assembly. Loose flywheel. 				
	Improper clutch alignment. Improper balance of propeller shaft.				

SPECIFICATIONS

		11121	11130	1114
IH Codes		11123	11133	11142
		11127	11134	11143
				11148
Clutch Size, in (mm)		12 (304.8)	13 (330.2)	14 (355.6) *
Description		12 or 15 Springs	15 Springs	15 Springs
Manufacturer's No.		12-RT	13-RT	14-RT
No. of Plates		1	1	1
Pressure Springs:				
No. Used		12 or 15	15	15
Free Length, in. (mm)		2-5/32 (54.77)		2-5/16 (58.74)
Pressure, lbs. (Newtons)		140-150 (662-667)	160-170 (712- 756)	170-180 (756-800)
At Test Length, in. (mm)		1-7/16 (36.51)	1-13/16 (46.05)	1-13/16 (46.05)
Release Lever Adjustment:	Dimension (Fig. 2)			
Pressure Plate-to-Fly- Pressure Plate-to-Fly- wheel Surface, in. (mm)	А	388 (9.86)	405 (10.29)	464 (11.76)
Release Lever-to-Pres- sure Plate Surface, in. (mm)	В	1.737 (44.12)	2.157 (54.79)	2.099 (53.31)
Release Lever-to-Fly- wheel Surface, in. (mm)	С	2-1/8 (54)	2-9/16 (65.09)	2-9/16 (65.09) ** 2-3/4 (69.9)
Release Lever Setting Spacer Plate		SE-2068-3	SE-2068-4	SE-2068-5

^{*} Flat-faced flywheel.

^{**} With Ferramic-lined driven member.



CLUTCH

14, 15 1/2 INCH TWO PLATE PULL TYPE CODES 11145, 11252, 11346

(LIPE Types LP, PT)

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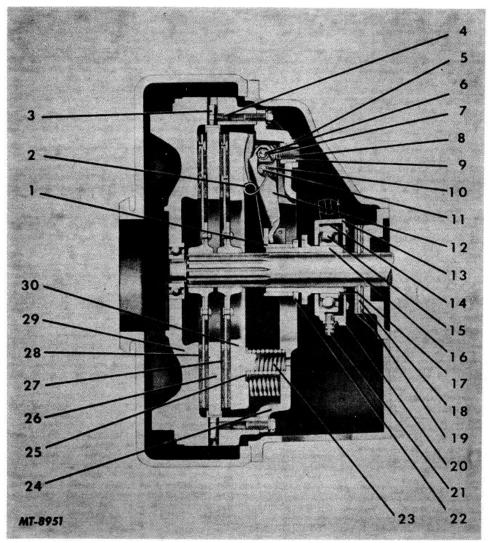


Fig. 1 Sectional View of PT Type Clutch (14 Inch Shown)
Legend for Fig. 1

Legend for Fig. 1				
Description	Key	Description	Key	Description
Release Lever Spider	11	Pressure Plate Pin	21	Lubrication Fitting
Retractor Spring	12	Release Lever	22	Sleeve Locknut
Intermediate Plate Drive	13	Release Bearing Housing	23	Pressure Spring
Pin	14	Bearing Retaining Spring	24	Flywheel Ring (Cover)
Socket Head (Allen) Set	15	Release Bearing	25	Insulating Washer
Screw	16	Sleeve and Bushing As-	26	Intermediate Plate
Locknut		sembly	27	Driven Disc Assembly
Eyebolt Pin	17	Snap Ring		(P.P. Side)
Needle Bearing (Eyebolt)	18	Steel Disc (Clutch Brake)	28	Driven Disc Assembly
Eyebolt	19	Friction Discs (Clutch		(F.W. Side)
Adjusting Nut		Brake)	29	Engine Flywheel
Needle Bearing (Pres-	20	Bearing Housing Cover	30	Pressure Plate
sure Plate)				
	Release Lever Spider Retractor Spring Intermediate Plate Drive Pin Socket Head (Allen) Set Screw Locknut Eyebolt Pin Needle Bearing (Eyebolt) Eyebolt Adjusting Nut Needle Bearing (Pres-	Release Lever Spider Retractor Spring Intermediate Plate Drive Pin Socket Head (Allen) Set Screw Locknut Eyebolt Pin Needle Bearing (Eyebolt) Adjusting Nut Needle Bearing (Pres-	DescriptionKeyDescriptionRelease Lever Spider Retractor Spring11Pressure Plate Pin Release LeverIntermediate Plate Drive Pin13Release Bearing Housing Release Bearing Retaining SpringSocket Head (Allen) Set Screw15Release BearingScrew16Sleeve and Bushing AssemblyLocknut Eyebolt Pin Needle Bearing (Eyebolt)17Snap RingNeedle Bearing (Eyebolt)18Steel Disc (Clutch Brake)Eyebolt Adjusting Nut Needle Bearing (Pres-20Bearing Housing Cover	DescriptionKeyDescriptionKeyRelease Lever Spider11Pressure Plate Pin21Retractor Spring12Release Lever22Intermediate Plate Drive13Release Bearing Housing23Pin14Bearing Retaining Spring24Socket Head (Allen) Set15Release Bearing25Screw16Sleeve and Bushing Assembly27Eyebolt Pin17Snap RingNeedle Bearing (Eyebolt)18Steel Disc (Clutch Brake)28Eyebolt19Friction Discs (ClutchAdjusting NutBrake)29Needle Bearing (Pres-20Bearing Housing Cover30

DESCRIPTION

The type LP and PT clutch is a two-plate, pull type, dry disc design incorporating an adjustable sleeve connecting the release levers to the. release bearing. Adjustment of this sleeve compensates for facing wear, maintains pedal lash (free travel) and provides operating clearance for the clutch brake. Antifriction bearings are used in the pressure plate release lever system to provide a low release load (pedal effort).

The clutch brake is used with nonsynchronized transmissions to aid in making initial (starting) shifts into low or reverse gear positions without gear clashing. The clutchbrake is not required with synchronized transmissions.

OPERATION

Operation of the type LP and PT clutch is explained below. Key numbers refer to Fig. 1.

The flywheel ring (cover) (24) is attached to the engine flywheel (29) by twelve capscrews. 3/8 inch capscrews are used with 14 inch clutches. 7/16 inch capscrews are used with 151/2 inch clutches.

On 14 inch clutches, Figs. I and 13, the pressure plate (30) is driven by means of driving lugs extending into mating slots of the flywheel ring (cover) (24). The intermediate plate is driven by drive pins (3) located in the engine flywheel (29).

On 15 inch clutches, Fig. 14, the pressure plate is driven by drive pins attached to the flywheel cover that engage the d rive lugs of the pressure plate. The intermediate plate is driven by extended lugs that engage matching slots in the flywheel ring.

Depressing the clutch pedal pulls the release bearing (13) toward the transmission. The release bearing, being connected to the release levers (12), retracts the pressure plate (30) from the rear driven disc assembly (27), thereby relieving the pressure on the intermediate plate (26) and the forward driven disc assembly (28) and disengaging the clutch.

Releasing the clutch pedal allows the release bearing assembly (13) to move toward the engine, permitting the pressure plate (30) to move forward, gripping the driven disc assemblies and intermediate plate and engaging the clutch.

On vehicles equipped with clutch brake, depressing the clutch pedal fully to the toe board beyond the point of full clutch release applies the clutch brake. The brake friction discs (19)

and the steel disc (18) are located between the release bearing housing and the transmission front bearing retainer. When the clutch pedal is fully depressed, the brake discs are squeezed between the release bearing housing and the transmission bearing retainer to stop rotation of the transmission main drive gear and clutch driven disc assemblies.

LUBRICATION

The release bearing rotates with the engine and should be lubricated with a small amount of high temperature lubricant every 1000 to 2000 miles, preferably with the engine idling.

The clutch fork shaft bores in the clutch (bell) housing and the clutch relay shaft (w-.-ere used) are equipped with grease fittings and should be lubricated every 1000 to 2000 miles.

NOTE

Do not overlubricate release bearing or clutch fork shaft. Excessive grease will contaminate the clutch disc facings.

Lubricate clutch linkage clevis pins and mating surfaces of yokes and levers at assembly and periodically as needed with a light coat of grease.

At the time of clutch installation pack clutch release bearing and flywheel pilot bearing with high temperature grease.

For all applications, use IH 251H EP grease or equivalent.

PERIODIC CLUTCH ADJUSTMENT

The need for clutch adjustment can be determined by inspection of the clutch pedal free travel, which is the first easy movement of the clutch pedal. Clutch pedal free travel will diminish gradually as the clutch driven disc facings wear and must be re-established periodically by adjustment of the release bearing sleeve. Never wait until the clutch begins to slip before making the adjustment.

Check clutch pedal free travel by hand. Correct free travel should be approximately one and one-half inches (1-1/2"). Make sure free travel is the result of actual release bearing clearance and is not caused by worn linkage.

If inspection reveals that the clutch pedal free travel is less than three-fourths inch (3/4"), an immediate adjustment of the release bearing sleeve should be made. If the pedal linkage was correctly adjusted at the time of installation, it should require further adjustment only as needed to compensate for wear in the linkage or at the clutch brake friction discs.

For adjustment procedures refer to "RELEASE BEARING AND LINKAGE ADJUSTMENT."

TRANSMISSION AND CLUTCH REMOVAL

When removing the transmission, disconnect the external clutch linkage, as it will be necessary to allow the release yoke to turn up and over the release bearing housing as the transmission is being moved away from the engine. As transmission is being removed, support the weight of the transmission and keep transmission in alignment with engine until the main drive gear (input) shaft splines clear the clutch driven discs. Failure to do so could cause distortion of the clutch discs.

After transmission has been removed, install three hold-down bolts (3/8"16 x 21/2") with flat washers through the clutch flywheel ring (cover) into the tapped holes in the pressure plate. Tighten hold-down bolts evenly to compress clutch springs and release pressure plate tension. Remove twelve clutch mounting bolts and remove the clutch assembly from the flywheel

DISASSEMBLY

If the clutch is to be overhauled locally, disassemble the major components for inspection and repair as outlined below. Key numbers refer to Fig. 1.

Cover/Pressure Plate Assembly

- Loosen locknut (22) and remove release bearing and sleeve assembly (16) from release spider (1).
- Remove cotter pins holding spider (1) to release levers (12). Lower and turn spider sufficiently to clear levers, then lift out spider.

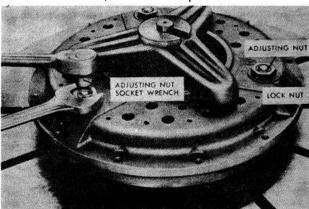


Fig. 2 Disassembling Cover/Pressure Plate
Assembly

3. Place cover/pressure plate assembly on arbor press or table of clutch rebuilding machine--pressure plate down, Fig. 2. For

15-1/2 inch clutches use blocks between the press table and pressure plate to support the assembly. Compress clutch assembly to relieve spring tension from lever assemblies.

- Remove hold-down bolts, Fig. 8, and eyebolt adjusting nuts, Fig. 2. Special socket wrenches are available to hold eyebolt adjusting nuts while loosening locknuts. Use SE-2301 for 14 inch clutches and SE-2338 for 151/2 inch clutches.
- 5. Release press slowly. Remove flywheel ring (cover) (24), springs (23) and insulating washers (25) from pressure plate.
- 6. Remove retaining rings from ends of pressure plate pins (11). Remove pins and remove lever retractor springs (2); release lever and eyebolt assemblies from pressure plate.
- 7. Remove eyebolt pins (6) and separate eyebolts (8) from release levers (12).

Release Bearing and Sleeve Assembly

Some bearing housing covers are retained with rivets and the bearing can only be serviced as a complete assembly. Those release bearings which have covers retained with screws can be disassembled as follows:

- Remove bearing housing cover screws and remove cover.
- Remove snap ring; then press sleeve and bushing assembly from bearing and housing. Remove bearing from housing.
- 3. Remove wear pad mounting screws and remove wear pads from bearing housing.

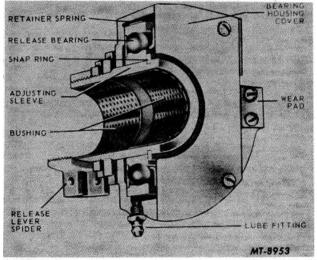


Fig. 3 Release Bearing and Sleeve Assembly

INSPECTION AND REPAIR

After clutch assembly has been disassembled, clean all parts thoroughly.

Inspect all parts carefully as indicated in the following procedure. Replace any worn or damaged parts. If the condition of any part is doubtful, it is best to replace the part with a new one.

Flywheel

Inspect the flywheel friction surface for heat checks, scoring and taper. On recessed type flywheels (14 inch clutch) measure the depth of flywheel cavity from clutch mounting flange to friction surface. (See "SPECIFICATIONS.") Replace flywheel if excessively worn or damaged.

If necessary to replace flywheel, make sure new flywheel is mounted on engine crankshaft within specified limits of flywheel run-out with a dial indicator. Refer to engine specifications! for runout limit.

Inspect condition of flywheel pilot bearing and replace if evidence of wear or roughness is found.

Inspect intermediate plate drive pins (14 inch clutch) for wear and replace if necessary. Socket head screws (key No. 4, Fig. 1) must be loosened to remove drive pins.

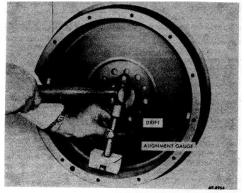


Fig. 4 Installing Intermediate Plate Driving Pins (14 Inch Clutch)

Be sure that drive pins are a press fit in holes in flywheel and that pin heads are perfectly square with the friction surface. Drive pins must be square to provide proper clearance and alignment for the drive slots in the intermediate plate.

Drive pin alignment gauge (SE-2330) will hold pins properly aligned while they are being driven into place with a drift. See Fig. 4. If alignment tool is not available, a machinists square and feeler gauge may be used to check for squareness. Lock drive pins in place by tightening socket head set screws.

Pressure Plate

The pressure plate must be replaced if: friction surface is severely heat checked, plate is warped in excess of 1/32", or there is excessive wear at driving slots.

Pressure plates may be salvaged by regrinding if friction surface cleans up without removing more than 1/32" material (maximum) from original thickness of the plate (dimension "C", Fig. 5). See "SPECIFICATIONS" for .thickness specifications of new pressure plates.

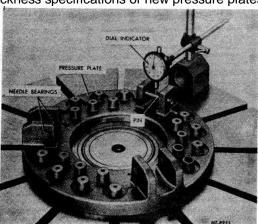


Fig. 5 Checking Thickness of Pressure Plate (Dimension "C")

Inspect condition of pressure plate pin needle bearings and replace if wear or roughness is indicated. Remove and install bearings by pressing (using a bearing driving tool) on that end of bearing on which part numbers are stamped. This will prevent damage to bearing case.

Intermediate Plate

The intermediate plate should be replaced if driving slots (14") or driving lugs (15-1/2") are worn or if deep cracks are present on either friction surface.

If driving slots (or driving lugs) are not worn excessively and plate is not warped over .015", plate may be reground to clean up the

friction surfaces. \underline{Do} not grind more than . 015" from each side or a total of . 030" from the original thickness of the plate. See "SPECIFICATIONS" for thickness dimension of new intermediate plates.

On 14 inch clutches there should be not less than .006" or more than .014" movement between contact surfaces of intermediate plate drive slots and flywheel drive pins. Twelve (12) driving slots are provided in intermediate plate to permit use of a new set of slots (with new drive pins) to obtain correct clearance. After all slots are worn, plate must be replaced. Try intermediate plate in different positions and select the position which provides the greatest freedom of movement (within specified clearance). Mark the plate for location to flywheel.

On 15-1/2 inch clutches intermediate plate should be replaced if there is more than .012" clearance between plate driving lugs and mating slots in flywheel ring.

Flywheel Ring (Cover)

The flywheel ring (cover) should be replaced if: any cracks are present, driving lugs or slots are worn, or cover is distorted.

Check for proper clearance between pressure plate and flywheel ring (cover) driving surfaces. A tight fit may hamper smooth release and engagement, while excessive clearance may cause noise and unbalance.

On 14 inch clutches pressure plate is driven by engagement of driving slots to mating lugs machined in the cover. There should be not less than .004" or more than .010" movement between contact surfaces of cover lugs and pressure plate slots.

On 15-½ inch clutches pressure plate is driven by engagement of driving lugs to mating drive pins attached to the cover. There is to be not less than . 004" or more than .014" movement between mating parts. Replace drive pins if worn excessively.

Pressure Springs

To assure proper clutch performance, pressure springs should be of proper tension. Weak springs will reduce clutch capacity and possibly cause clutch slippage.

Test compression tension of all pressure springs. Replace any springs failing to meet minimum specified tension. (See "SPECIFICATIONS.") Use springs of the correct part number and tension (as identified by color code) for the clutch model being serviced.

Release Lever Assembly Components

- Replace release levers if pin holes are worn or elongated or if ends of the levers that contact spider are worn.
- 2. Replace spider if lever contact surfaces are worn.
- Inspect condition of eyebolt needle bearings and replace if wear or roughness are indicated. Remove and install bearing by pressing (using a bearing driving tool) on that end of bearing on which part numbers are stamped to prevent damage to bearing case.
- 4. Replace pressure plate and eyebolt pins if worn. Always use new pins when pressure plate and eyebolt needle bearings are replaced.
- Replace lever retractor springs if weak, worn or damaged.

Release Bearing and Sleeve Assembly Components

- Thoroughly clean and inspect release bearing. Replace bearing if wear or even the slightest roughness is detected.
- 2. Inspect sleeve and bushing assembly and replace if bushing is worn.
- 3. Inspect bearing housing and housing cover and replace if worn or cracked.
- 4. Replace bearing housing wear pads if worn.

Driven Disc Assemblies

The driven disc assemblies should be replaced if any of the following conditions are present: hub splines are worn or damaged, disc is distorted, disc is cracked or spring damper element is loose or damaged.

If discs are acceptable for further service, remove worn lining and reline as instructed under "ASSEMBLY" below.

Clutch Brake Discs

Examine steel disc for wear of the lugs at inside diameter and for wear or scoring of friction surfaces. Replace disc if damaged or worn.

Replace fabric friction discs if worn, damaged or grease soaked.

ASSEMBLY

After all parts have been cleaned and inspected and the necessary new parts have been procured, reassemble clutch as outlined below.

Driven Disc Assemblies (Reline)

Use proper facing kit to obtain correct rivets and facing material of original thickness dimension. Facing kits are available for all discs.

Rivet new facing material to driven discs. When installing new facings use a suitable riveting fixture and support disc assembly during riveting operations so that disc will not be damaged or distorted. Make sure proper riveting method is used. Fig. 6 illustrates correct riveting techniques for various types of facing materials.

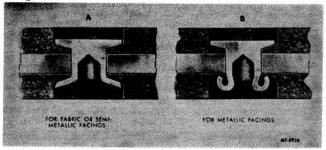


Fig. 6 Correct Methods for Riveting Facings

View A, Fig. 6, shows the correct method of riveting fabric or semimetallic facings using a star set anvil, resulting in split end of rivet conforming to tapered counterbore of facing.

View B, Fig. 6, shows the correct method of riveting metallic facings using roll set rivets.

Rivets should be alternated so that heads of adjacent rivets face in opposite directions.

Cover/Pressure Plate Assembly

- Place pressure plate face down on an arbor press or table of clutch rebuilding machine. For 15-1/2 inch clutches use blocks between press table and pressure plate as required.
- Assemble adjusting nuts to eyebolts and then assemble eyebolts and eyebolt pins to release levers.
- 3. Position release lever assemblies and release lever retractor springs on pressure plate and install pressure plate pins, washers and retaining rings. See Fig. 7.

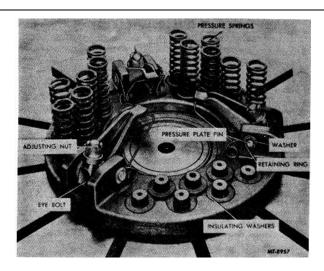


Fig. 7 Assembling Pressure Plate Assembly

- 4. Place insulating washers over spring bosses on pressure plate and install pressure springs. See Fig. 7.
- Position flywheel ring (cover) on pressure plate springs, aligning driving surfaces of cover and pressure plate. Press cover into position, making sure driving surfaces engage as springs are being compressed.
- With press holding flywheel ring (cover) in position, pull release lever (eyebolt) adjusting nuts up through holes in flywheel ring and install locknuts.

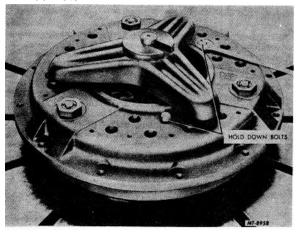


Fig. 8 Installing Hold-Down Bolts

7. Install three hold-down bolts (3/8"-16 x 21/2") through holes in flywheel ring (cover) into tapped holes in pressure plate. See Fig. 8. Tighten hold-down bolts evenly

until snug. (This will hold pressure springs compressed to facilitate assembly of clutch to engine flywheel.)

8. Release press and remove clutch assembly.

Release Bearing and Sleeve Assembly

If the release bearing has been disassembled, proceed as follows:

- 1. Position bearing housing on sleeve and bushing assembly.
- 2. Repack bearing with high temperature grease (see LUBRICATION).
- 3. Press bearing onto sleeve assembly (into bearing housing). Install snap ring.
- Install bearing retaining spring in housing opposite grease fitting. See Fig. 3. Fill (pack) housing with high temperature grease (see LUBRICATION). Install bearing housing cover and screws.
- 5. Assemble bearing housing wear pads and screws to bearing housing.
- 6. Assemble sleeve locknut to sleeve assembly.

NOTE

Do not assemble release bearing and sleeve assembly to cover/pressure plate assembly until clutch has been installed on flywheel and release levers have been adjusted.

CLUTCH INSTALLATION

Before installing clutch be sure engine flywheel has been prepared to receive clutch assembly. See "INSPECTION AND REPAIR. " Be sure clutch driven disc hubs slide freely on splines of transmission main drive gear (input) shaft.

Assemble clutch to flywheel as follows:

- Place clutch driven discs and intermediate plate into position in flywheel clutch cavity (14 inch clutch) or flywheel ring (cover) (15-1/2 inch clutch). Driven discs are marked "Flywheel Side" and "Pressure Plate Side" to indicate their proper position.
- Position clutch cover/pressure plate assembly on flywheel and install mounting bolts loosely. Insert clutch disc aligning tool or splined main drive gear shaft through clutch disc hubs and into flywheel pilot bearing to position clutch driven discs.
- 3. Tighten clutch mounting bolts progressively and evenly around flywheel to 35-40 foot -pounds torque.

- Remove three hold-down bolts from cover to release spring tension and engage pressure plate. Remove aligning tool from clutch disc hubs.
- 5. Check release lever height setting (dimension "A") and adjust if necessary.

NOTE

If clutch assembly has been repaired or rebuilt locally, it will be necessary to establish correct lever height setting. If a new or rebuilt exchange unit is being installed, levers should not require adjustment.

Adjust lever height setting as follows:

- Use hook type rule and straightedge to measure lever height setting as shown in Fig. 9.
- Turn slotted eyebolt adjusting nut (key No. 9, Fig. 1) as needed to obtain correct lever height (dimension "A"). Refer to "SPECIFICATIONS."
- c. Hold adjusting nut and tighten locknut to 60 foot pounds torque.

Special socket wrenches are available to turn and hold eyebolt adjusting nuts. Use SE-Z301 for 14 inch clutchesandSE-2338 for 151/2 inch clutches.

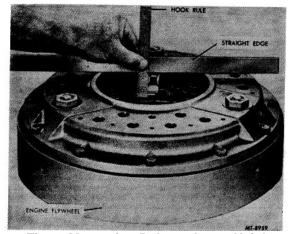


Fig. 9 Measuring Release Lever Height (Dimension "A")

- After release levers have been properly adjusted and locknuts securely tightened, assemble release spider to release levers and install retaining cotter pins.
- Install release bearing and sleeve assembly into spider. Be sure to include sleeve locknut and thread sleeve assembly well into spider.

 Lubricate bushings (inside diameter) of release sleeve assembly, release yoke fingers and wear pads of release bearing housing with a light coat of grease (see LUBRICATION).

TRANSMISSION INSTALLATION

Lubricate splines of transmission main drive gear (input) shaft with a light coat of grease (see LUBRICATION).

On unsynchronized transmissions place clutch brake discs on transmission shaft with keyed steel disc between the two fabric friction discs. (Clutch brake partsare not used on synchronized transmissions.)

Raise transmission and enter spline shaft into clutch release sleeve assembly. Align transmission with engine and move it forward to enter driven disc hubs. It may be necessary to rotate transmission shaft slightly to align the splines. While moving transmission forward, allow release yoke to pass over top of release bearing housing and fall into its operating position on bearing housing wear pads.

NOTE

It is extremely important that transmission be adequately supported in line with engine crankshaft while transmission is being installed to avoid damaging splines or distorting clutch driven discs. Do not force transmission into clutch or allow transmission to hang unsupported in hubs or clutch discs.

RELEASE BEARING AND LINKAGE ADJUSTMENT

After transmission has been securely attached to engine, release bearing sleeve and clutch linkage must be adjusted as follows:

- 1. Hold or block clutch pedal down (clutch disengaged).
- 2. Loosen release sleeve locknut, Fig. 10. This can be accomplished by use of a spanner wrench (SE-2329) or a punch and a hammer.
- 3. Release clutch pedal (engage clutch).
- 4. On vehicles with clutch brake rotate sleeve adjusting nut, Fig. 10, to obtain specified clearance between release bearing housing and clutch brake front disc. Clearance should be 1/2 inch on 14 inch clutches and 15-1/2 inch clutches. On vehicles without clutch brake adjust sleeve to obtain 9/16 inch clearance between release bearing

NOTE

Keep a light tension on release yoke or clutch pedal while turning sleeve adjusting nut. This will keep release spider snugly against release levers and prevent a false clearance reading.

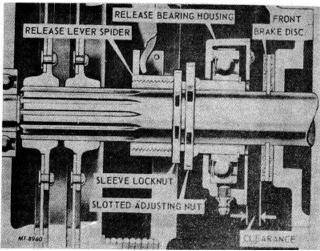
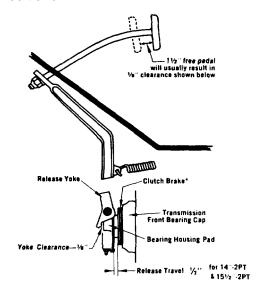


Fig. 10 Release Bearing Adjustment

 Adjust clutch control linkage to obtain approximately 1/8 inch clearance between release bearing housing and release yoke. (See Fig. 11.) This will provide approximately 1-1/2 inches pedal free travel.



"The Clutch Brake is not used with synchronized transmissions—in which case adjust the release Bearing Housing to be approximately %," from the Front Bearing Cap.

MT-8907

Fig. 11 Typical Clutch Linkage with Clutch in Engaged Position and Properly Adjusted

- 6. Check travel of release bearing by depressing clutch pedal. On vehicles with clutch brake release bearing housing should contact clutch brake disc before clutch pedal touches cab floor board. (See Fig. 12.) On vehicles without clutch brake release bearing housing should not contact transmission front bearing cap. -'press and release clutch pedal a few times and recheck clearance between release bearing housing and clutch brake disc or transmission bearing cap. Readjust if necessary.
- 7. Hold or block clutch pedal down (clutch disengaged). Turn sleeve locknut up against release sleeve spider and tighten it securely.

NOTE

Always disengage clutch while sleeve locknut is being locked or unlocked but have clutch engaged while turning sleeve adjusting nut to obtain correct release bearing clearance.

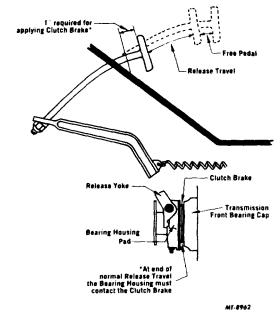


Fig. 12 Typical Clutch Linkage with Clutch
Disengaged and Clutch Brake Applied

Illustrations Courtesy Lipe-Rollway Corporation

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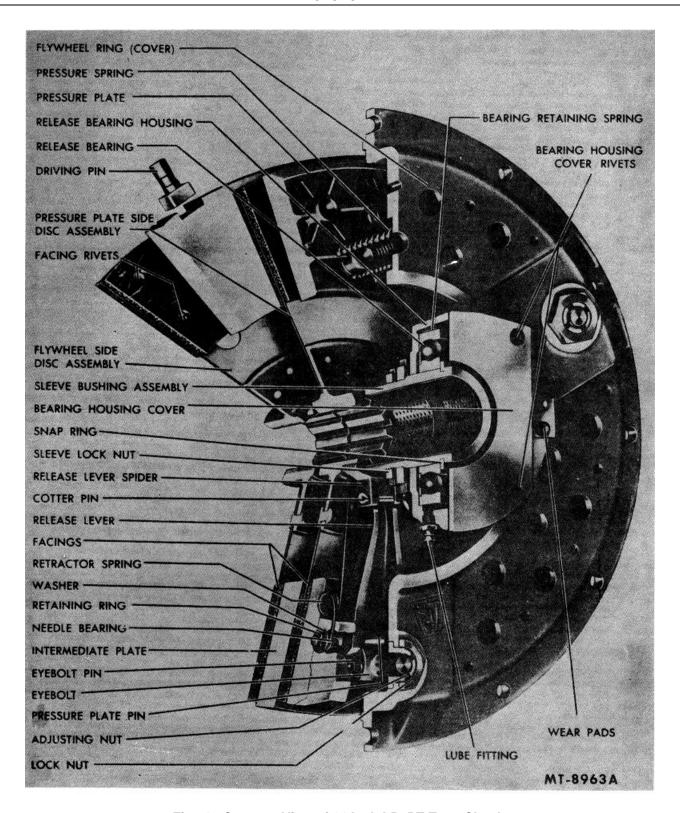


Fig. 13 Cutaway View of 14 Inch LP, PT Type Clutch



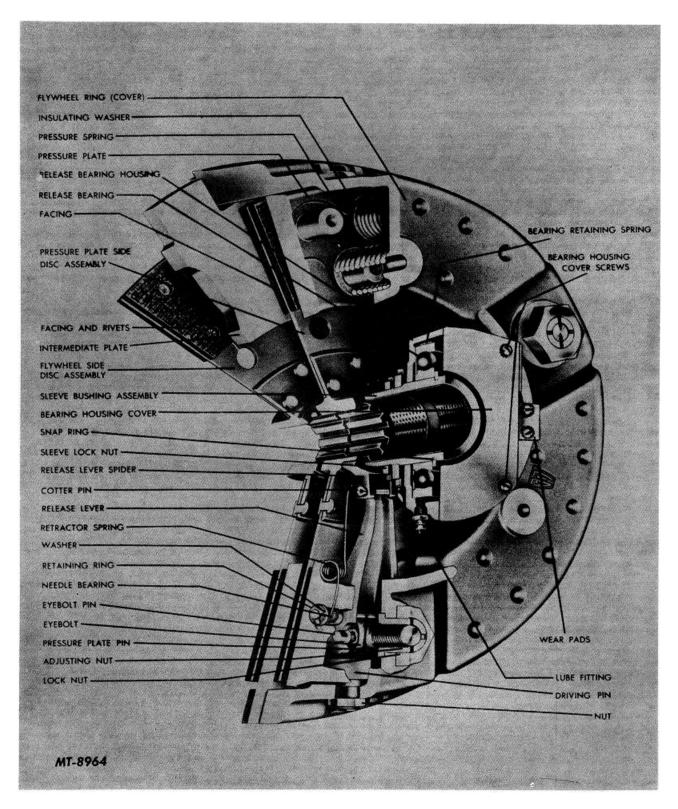


Fig. 14 Cutaway View of 15-1/2 Inch LP, PT Type Clutch



SPECIFICATIONS Types LP, PT Two-Plate Clutches (14, 15-1/2 Inch)

Pressure Plate Assembly		Dimension	Dimension	Spring Data		Disc Data			Intermediate	
		"A" Lever	"C" Pressure			Minimum			Flywheel	Plate
	Mfgr's.	Height	Plate Thick-	No.	Color	Tension,	Spline	Facing	Depot	Thickness
IH Part No.	Model No.	Setting	ness (New)	Used	(Stripe)	Lbs.	Dia.	Thickness	± .005"	(New)
					Dark					
402799-C91	140-72-901	1-9/32"	1.875"	6	Maroon	130 @ 1-27/32"	1-3/4"	3/16"	2.937"	.630"
				12	Bronze	170 @ 1-27/32"				
					Light					
402800-C91	140-72-1041	1-9/32"	1.875"	6	Green	150 @ 1-27/32"	1-3/4"	3/16"	2.937"	.630"
				12	Red	180 @ 1-27/32"				
					Light					
				9	Green	150 @ 1-27/32"				
435256-C91	140-702-1138	1-1/8"	1.875"		Dark			3/16"	2.937"	.630"
				12	Maroon	130 @ 1-27/32"				
					Light					
510149-C92	140-702-1139	1-1/8"	1.875"	9	Green		2"	3/16"	2.937"	.630"
					Dark					
				12	Maroon					
392861-C92	155-702-1498	1-15/32"	1.906"	24	Purple	174 @ 2-1/16"	2"	.184" *	Flat	.750"
								.169" **		
	155-72-970							.184" *		
512210-C91	155-702-1495	1-15/32"	1.906"	18	Purple	174 @ 2-1/16"	1-3/4"	.169" **	Flat	.750"
								.184" *	Flat	
798476-C91	155-702-1497	1-15/32"	1.906"	18	Purple	174 @ 2-1/16"	2"	.169" **		.750"

Flywheel side. Pressure plate side.



METRIC EQUIVALENTS

LENGTH

INCH	MILLIMETERS
.004	1
.006	152
.010	254
.012	304
.014	354
.015	381
.030	762
1/32	794
1/8	3.175
.169	4.29
.187	4.75
3/16	4.763
3/8	9.525
7/16	11.113
1/2	12.7
9/16	14.288

INCH	MILLIMETERS
630	16.0
3/4, .750	19.05
1	25.4
1-1/8	28.575
1-9/32	32.544
1-15/32	37.306
1-1/2	38.10
1-3/4	44.45
1-27/32	46.434
1.875	47.63
1.906	48.41
2	50.8
2-1/16	52.358
2.937	74.599
14	355.6
15-1/2	393.7

SPRING TENSION

Pounds (Force)	Newtons
130	578.269
150	667.233
170	756.197
180	800.680

BOLT TORQUE

Pound-feet	Newton-meters
35 - 40	48 - 54



ANGLE SPRING TYPE

14" AND 15 1/2 " 2-PLATE

${\bf CODES~11155,\,11239,\,11249,\,11250,\,11251,}$

11252, 11254, 11255, 11340 AND 11341

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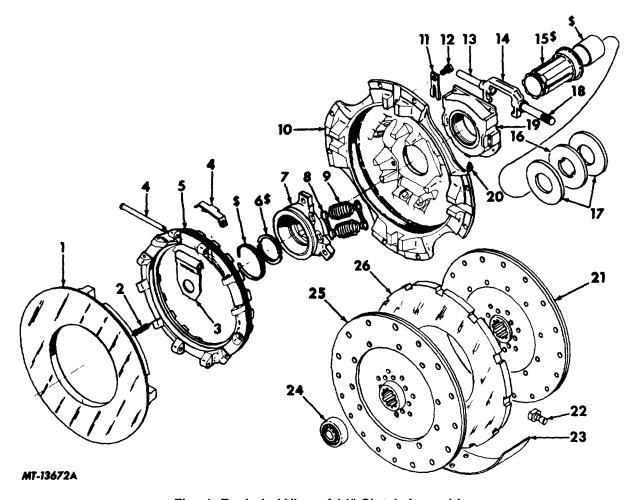


Fig. 1 Exploded View of 14" Clutch Assembly

Legend for Fig. 1

<u>Key.</u>	Description	<u>Key.</u>	<u>Description</u>
1	PLATE, Pressure	14	YOKE, Clutch Release
2	SPRING, Clutch Plate Return	15	SLEEVE, Clutch Release
3	LEVER, Clutch Release	16	WASHER, Brake Disc
4	PIN W/Clip, Release Lever	17	DISC, Clutch Brake
5	RING, Adjusting	18	SHAFT, Clutch Release
6	RING, Release Sleeve Retainer	19	COVER, W/Bearing, Clutch Release
7	RETAINER, Release Sleeve	20	LUBRICATOR, Straight
8	SEAT, Pressure Spring Pivot	21	DISC, W/Facing Rear
9	SPRING, Clutch	22	PIN, Intermediate Plate
10	PLATE, Clutch Back	23	NOT USED
11	LOCK, Adjusting Ring	24	BEARING, Pilot
12	BOLT, 3/8 NC x 3/4	25	DISC, W/Facing, Front
	WASHER, Lock 3/8	26	PLATE, Disc Intermediate
13	SHAFT, Clutch Release		

DESCRIPTION

This clutch is a dry disc, adjustable, pull-type design for heavy-duty service, utilizing centrally located pressure springs entirely isolated from the heat of the pressure plate. See Fig. 2.

Driven discs with solid centers and riveted organic facings are considered standard.

The intermediate plate--separating the driven discs-is mounted inside a "cup-type" flywheel and carried on drive pins mounted in the flywheel itself.

The pressure plate is driven by four drive lugs which mate with four or six drive slots in the clutch flywheel ring itself. The pressure plate also carries four return springs to retract the pressure plate when the clutch is disengaged.

The clutch release bearing rotates continuously, since the inner race of the bearing is pressed on the release sleeve. However, the clutch release bearing only carries a thrust load when the clutch is released.

The clutch is ventilated to circulate cooling air through the clutch whenever the engine is running.

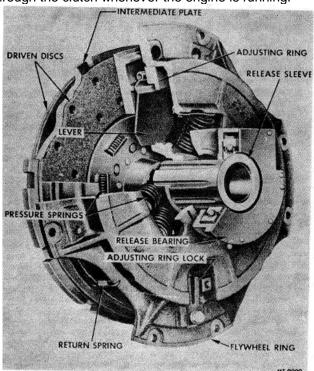


Fig. 2

The clutch design is such that maintenance is readily accomplished without special tools other than a hand arbor press, which should be available for easier clutch disassembly and assembly.

TRANSMISSION REMOVAL

A suitable "sling" or transmission jack should be used to properly support and maintain the engine/transmission alignment when removing or installing a transmission on an engine. DO NOT let the rear end of the transmission drop down and hang unsupported in the splined hubs of the clutch discs to avoid bending or distorting the friction discs. Disconnect the external linkage from the clutch release arm to permit the release yoke to turn up and pull free of the release bearing thrust pads.

CLUTCH REMOVAL

- 1. Prior to actual clutch removal, assemble a clutch disc aligning tool to the driven disc and release bearing assembly.
 - It is important that two 3 /4" blocks of wood (1), Fig. 3, be inserted between the clutch release bearing housing (2) and clutch flywheel ring (3) as the clutch mounting blocks will relieve the heavy internal spring load, preventing cocking and bending within the clutch and insure easy removal of remaining mounting bolts.
- 2. When all bolts have been removed, slide clutch assembly back and off using caution to keep aligning tool in place to retain discs and intermediate plate.
- 3. Carefully remove aligning tool, rear disc, intermediate plate and front disc.

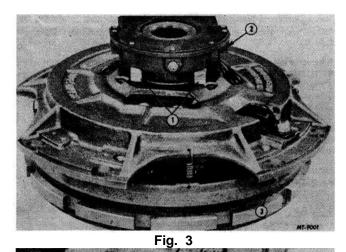
DISASSEMBLY

- 1. Remove adjusting ring lock (1). Use screwdriver (2) or similar wedge to remove adjusting ring lock, Fig. 4.
- 2. Set clutch assembly (without driven discs and intermediate plate) upside down on a flat table or workbench. Unhook four return springs (1) from flywheel ring (2) and lift pressure plate (3) off, Fig. 5.

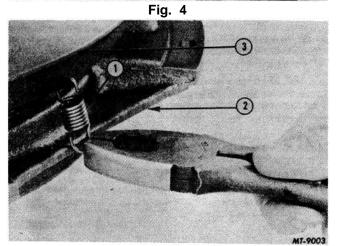
NOTE:

Mark pressure plate in relation to the flywheel ring for reassembly purposes.

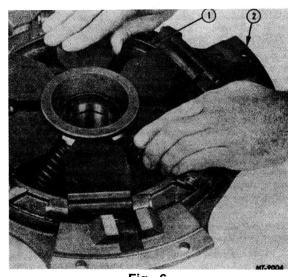
3. Turn the adjusting ring (1) and lever assembly counterclockwise until free of flywheel ring (2). Then lift and remove assembly, Fig. 6.

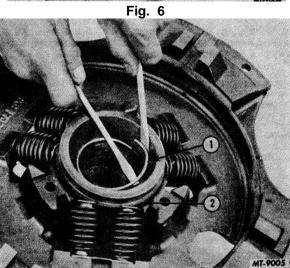


Pig. 3



- Fig. 5
- 4. Remove snap ring (1) from release sleeve retainer (2), Fig. 7.
- 5. Install three 3/8" x 5" threaded rods (1) through clearance holes in release sleeve retainer (2) and into tapped holes provided in flywheel ring, Fig. 8.





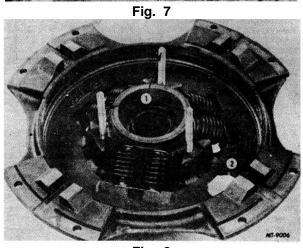


Fig. 8

- IMPORTANT: Threaded rods must not pass through flywheel ring but should be flush with back of flywheel ring to prevent interference with bearing cover.
- 6. Place assembly on an arbor press (1) with a piece of tubing supporting the release sleeve. Compress retainer until drive lugs bottom on flywheel ring and draw three hex nuts (2) tightly against retainer, (3), Fig. 9.

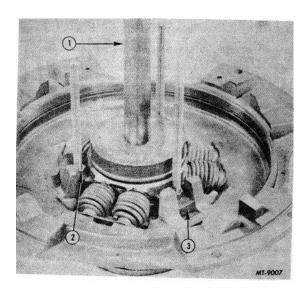


Fig. 9

NOTE: Use a short piece of 2-1/2" or 2-3/4" O. D. tubing to support release sleeve assembly. DO NOT support on clutch release bearing cover rivet heads.

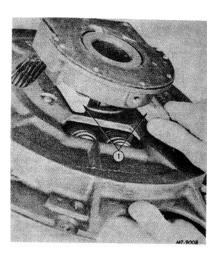


Fig. 10

- 7. Raise arbor. Tilt assembly and remove 3/4" wooden blocks (1), Fig. 10.
- 8. Again support release sleeve on tubing. Remove half ring locks (1). Now release sleeve and bearing assembly are free to slide through retainer toward rear of clutch, Fig. 11.

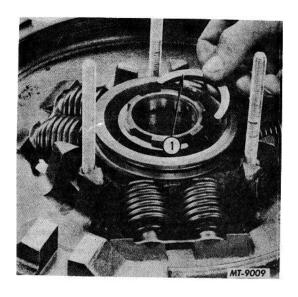


Fig. 11

9. To disassemble pressure springs (1) and retainer (2), compress retainer to relieve load on pressure springs. Remove pressure springs and spring pivots (3), Fig. 12.

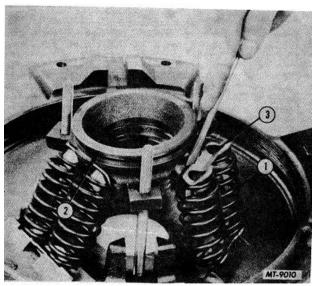


Fig. 12

10. Remove release levers and pins from adjusting ring. To remove the release lever pin, push down on the tang of the retainer clip then the release lever pin can be removed. The release lever pins may be secured in place with either collar pins or "E" rings as well as the retainer clips.

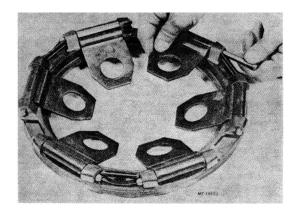


Fig. 13

NOTE: The release sleeve and bearing assemblies used with the 1-3/4"-10 spline drive gear, Fig. 14, will be different than the sleeve and bearing assembly used with the 2"-10 spline drive gear, Fig. 15. Follow correct disassembly procedure outlined below.

1-3/4"-10 spline: To disassemble release bearing assembly and sleeve subassembly, support housing cover and press sleeve (1) out of bearing, Fig. 14.

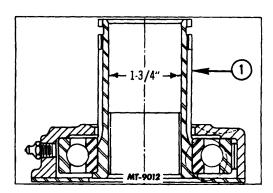


Fig. 14

2"-10 spline: To disassemble release bearing assembly and sleeve subassembly (1), press or slide release bearing assembly back on release sleeve to expose

snap ring. Remove snap ring. Support back side of housing (2) and press sleeve out of bearing, Fig. 15.

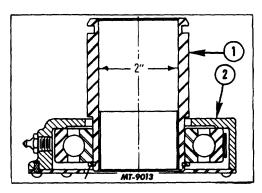


Fig. 15

To disassemble release bearing assembly (1), Fig. 16, cut or grind rivet heads off and remove cover. Remove release bearing (2) and two flat springs (3). Drive rivets out of housing to remove wear pads (4).

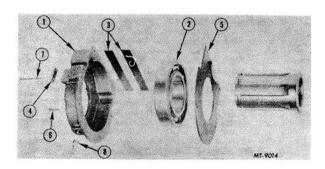


Fig. 16

INSPECTION

Pressure Springs

Weak springs cause clutch slippage. Check free length and weight of springs for correct load at assembled height on an accurate spring tester. Refer to specifications for correct weight of springs used in your particular clutch model.

Release Levers

Inspect levers for excessive wear at points of contact with pressure plate, release sleeve retainer and pivot pin. If levers are bent or worn, replace with new levers. It is good practice to replace levers during clutch rebuild.

Release Sleeve Retainer

Inspect for wear in lever groove and internal splines. Refer to specifications for driving slot clearance between flywheel ring drive slots and release sleeve retainer drive lugs.

Spring Pivots

Inspect for cracks; if visible, replace.

Release Sleeve Subassembly

Check bushing for excessive wear. Check bushing diameter for tight fit. Refer to specifications and replace if necessary.

Inspect the flywheel ring for cracks. Replace if cracks are visible. Check slots for indentation caused by wear of pressure plate driving lugs. See specifications for slot limits.

Inspect bolt circle face and pilot for nicks and burrs due to removal or handling. Remove burrs with file to insure proper seating and squareness when clutch is mounted to flywheel.

Adjusting Ring

Check pivot pin holes for wear. Clearance may not exceed .010" between pin and hole. Inspect for cracks; replace if cracks are visible.

Flywheel Ring

Inspect flywheel ring for excessive drive slot wear--all locations.

Pressure Plate

Inspect fulcrum for wear. If wear exceeds .015", remachine. See specifications for maximum rework.

Inspect friction surface of pressure plate for scoring, burning, heat checking or distortion. If friction surface is badly scored, heat checked, warped or dished in excess of .010", resurface or replace with new pressure plate. Smooth and flat pressure plate surfaces must be used for satisfactory clutch life.

Check drive lugs for wear. See specifications.

Intermediate Plate

Inspect friction surfaces of intermediate plate for heat checks, scoring or distortion. Inspect driving slots of intermediate plate for wear. See specifications.

Driven Discs

Inspect disc assembly for cracks, loose rivets, worn splines, warped or dished condition. Restraighten if dished or warped--. 015" maximum runout. Replace if hub is cracked or splines are worn excessively.

Replace facings if they are glazed, scored, worn down to rivet heads, burned, or if grease or oil are on them. Check specifications for proper thickness of clutch discs and facings. Make sure facings used are of proper thickness. Proper riveting is essential. Use a star set anvil to spread the rivet so it contacts the tapered counterbore of the facing. DO NOT USE a roll or eyelet anvil.

REASSEMBLY

Release Bearing and Cover Subassembly and Release Sleeve Subassembly

The release sleeve and bearing assemblies used with the 1-3/4", 10-spline drive gear will be different than the sleeve and bearing assembly used with the 2", 10-spline drive gear. Follow the correct assembly procedure as outlined below.

- Referring to Fig. 16, assemble two flat springs

 inside and across top of release bearing housing (1) with the ends of the springs inside cast relief sections. Hand pack bearing with proper lubricant and assemble release bearing (Z) to housing, compressing flat springs (3). Seat bearing against flats inside housing.
- 2. Coat edge of release bearing housing with Permatex sealer and assemble cover (5) to housing with five short rivets (6). Assemble new wear pads (4) to housing with long rivets (7). NOTE: Rivet heads must be set tight to maintain grease-tight seal between release bearing housing and cover. Assemble zerk fitting (8) to housing and fill cavity with proper lubricant.
- 3. Assembly 1-3/4" 10-Spline: Place release bearing and cover assembly (1) on bed of arbor with cover up. Press release sleeve subassembly (2) into release bearing. NOTE: Make sure shoulder of release sleeve is seated against the inner race of bearing, Fig. 17.

Assembly 2" 10-Spline: Set release sleeve subassembly (1) vertically on bed of arbor press, splined end down. Position with cover up. Use 2-3/8" I. D. thin wall tubing and press inner race of bearing onto ground diameter of sleeve.

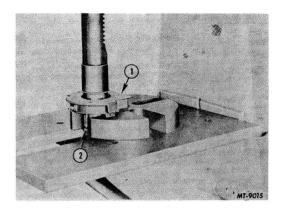


Fig. 17

CAUTION: <u>Do not press on rivet heads or cover during this assembly</u> (Fig. 18).

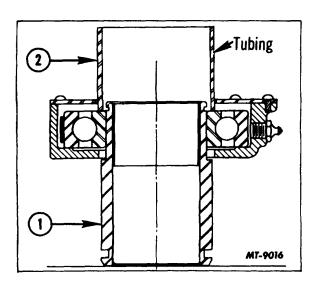


Fig. 18

Assemble snap ring to end of sleeve. NOTE: Make sure inner race of bearing is seated firmly against snap ring.

4. Support release sleeve (1) with release bearing assembly (2) on the arbor press bed with a piece of 2-1/2" 2-3/4" O.D. tubing approximately 3" long (Fig. 19).

IMPORTANT: Use tubing--do not support this assembly on the release bearing cover as this

will result in distortion and excessive end loading on the ball bearing.

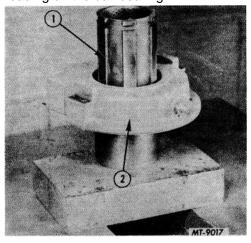


Fig. 19

- 5. Place flywheel ring upside down on a table or workbench. Use a small paint brush and coat threads of adjusting ring and internal threads of flywheel ring with Molykote or similar lubricant such as powdered graphite mixed with SAE-30 anti-corrosion oil in a 50/50 mixture.
- 6. Assemble adjusting ring to flywheel ring with "notches" down. Preset adjusting ring by placing two pivot pins in adjusting ring bosses directly opposite each other. Dimension from flywheel ring mounting surface to straight edge to be approximately 1/2" for 14" clutch (Fig. 20), or 2-11/16"for 15-1/2" clutch (Fig. 21).

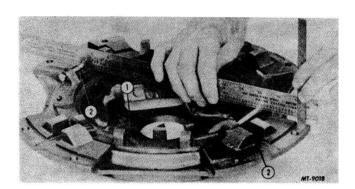


Fig. 20 14" Clutch

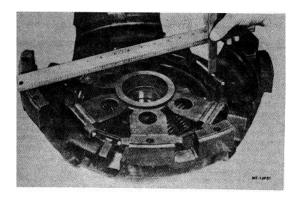


Fig. 21 15-1/2" Clutch

7. Install three threaded rods (1) in holes provided in flywheel ring. Place spring pivots (2) on bosses in flywheel ring (3) and retainer (4), Fig. 22.

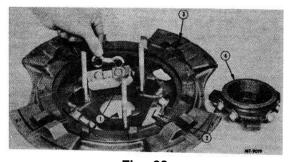


Fig. 22

8. Place release sleeve retainer (1) in position guided on threaded rods. Install pressure springs (2)between spring pivots (3), Fig. 23.

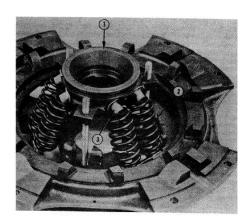


Fig. 23

 Place flywheel ring and release sleeve retainer assembly on an arbor press and depress retainer until it bottoms against flywheel ring. Place three hex nuts (1) on threaded rod and draw tightly against retainer (2), Fig. 24.

NOTE: Visually check pressure springs (3) to assure seating on spring pivots.

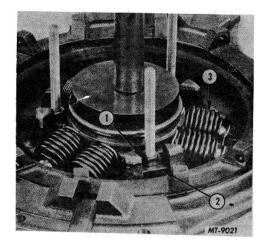


Fig. 24

10. Install release sleeve (1) and release bearing assembly through flywheel ring and release sleeve retainer. Place half ring locks (2) in groove of release sleeve, Fig. 25.

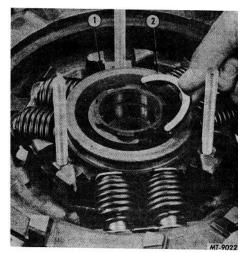


Fig. 25

11. Install 3/4" wooden blocks (1) between flywheel ring (2) and release bearing housing (3). Place assembly on arbor press, supporting sleeve on 2-1/2" 2-3/4" O.D. tubing, Fig. 26.

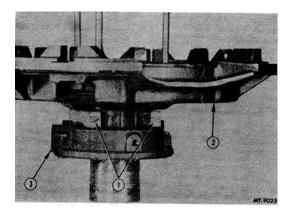


Fig. 26

Compress retainer to relieve load on hex nuts. Remove threaded rods and release load against wooden blocks.

NOTE: <u>Do not</u> support assembly on clutch release bearing cover rivet heads.

12. Complete subassembly by placing snap ring (1) in groove above the half ring locks, Fig.27.

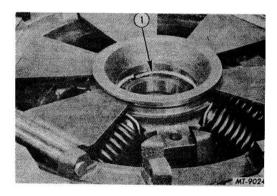


Fig. 27

13. Return assembly to workbench and place levers between adjusting ring bosses with narrow end or "nose" in groove of release sleeve retainer. Lever fulcrum or raised area of lever <u>must</u> be facing pressure plate. Move adjusting ring either clockwise or counterclockwise as necessary to insert pivot pins. Return adjusting ring to previously set position.

NOTE: When pivot pins have a flat surface on the head, it is imperative that the flat surface mates with the milled surface on adjusting ring boss.

- 14. Install pivot pin retainers.
 - a. Cotter pins: position cotter in pivot pin hole. Assemble from outside in and flatten head securely to insure clearance between flywheel ring lugs and adjusting ring. Roll opposite end around pivot pin.
 - b. "E" rings: place in pivot pin holes.
 Assemble from outside in and flatten head securely to insure clearance between flywheel ring lugs and adjusting ring.
 - c. Spring retainer clips: must be installed so that one spring clip retains two pivot pins, Fig. 28. Place retainer clip into position and insert pivot pin through clip hole into adjusting ring and lever holes until pin head snaps into position, Fig. 29. Clips will only fit in every other opening because of casting interference.

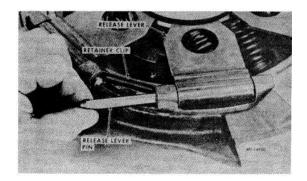


Fig. 28

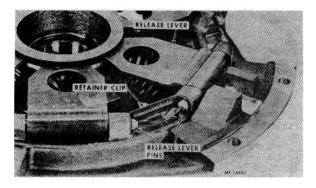


Fig. 29

15. Place pressure plate (1) in drive slots (2) on flywheel ring (3). Check clearance between driving lugs on pressure plate and drive slots in flywheel ring (3). Clearance should be .004" to .008", Fig. 30.

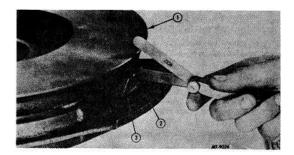


Fig. 30

- 16. Install return springs.
 - NOTE: Springs to be hooked from inside of pressure plate first (Fig. 5). Then hook opposite end from outside of flywheel ring.
- 17. Complete reassembly by turning assembly on pressure plate side and install adjusting ring lock (1) and bolt assembly (2), Fig. 31.

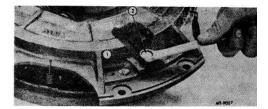


Fig. 31

INSTALLATION

Before installing any clutch, it is advisable to check the following items:

- Inspect friction face of flywheel for smoothness, heat checks, scoring, excessive wear or runout on contact surface. The inspection for heat checks and scoring must be visual and based on experience; however, measure friction surface wear with straight edge and feelers. Replace or repair flywheel if wear is excessive.
- 2. A new pilot bearing should be used with a new or rebuilt clutch. If the old bearing must be reused, clean and check the bearing thoroughly.

- Check fit of splined hubs of front and rear friction discs on main drive gear splines of transmission to be used. Hubs must slide free if clutch is expected to release properly.
- 4. If the flywheel has been replaced, always indicate the face and pilot diameters to make sure total indicator runouts are within specifications.

Installing 14" Clutch to Flywheel (See Fig. 1)

- 1. Install the drive pins (10) in the flywheel if removed. Make sure that shanks of drive pins are a press fit in the flywheel rim and the heads are square with the friction face.
 - NOTE: Drive pins must be square with flywheel to insure proper clearance with notches in intermediate plate (see information on intermediate plate drive pins).
- 2. Check clearance of slots in intermediate plate by positioning intermediate plate on the drive pins. Measure clearance between drive pins and slots, Fig. 32. Clearance should be .006" to .010" and measured on same side of pins. If alignment and clearance are satisfactory, remove intermediate plate and lock drive pins in place with socket head set screws if provided.

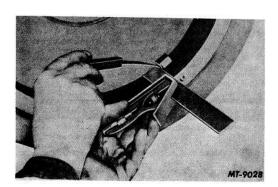


Fig. 32

- 3. Place front driven disc assembly (8), Fig.
- 1 in flywheel with hub flange away from engine or toward transmission.
- 4. Install intermediate plate (9), Fig. 1, in flywheel, locating the drive slots on the drive pins (10).
- Install rear driven disc assembly (8) with long hub of clutch disc away from the engine or toward the transmission.

- 6. Position pressure plate and flywheel ring assembly (7) on flywheel and start mounting capscrews and run in finger tight to hold in place. Insert spline aligning tool (or the main drive gear from transmission) through the clutch assembly and align rear and front driven disc assemblies. Tool should be inserted into pilot bearing to insure central location of clutch discs.
- 7. Tighten the capscrews progressively and evenly to pull the clutch ring into its proper position in the flywheel pilot.
 - IMPORTANT: Do not try to pull the clutch into place by running one capscrew completely down with an impact wrench. This procedure can crack or break the pilot shoulders causing eccentricity, off-square mounting and out-of-balance conditions. For the final check progressively tighten all capscrews to 35-40 ft. lbs. of torque.
- 8. As the capscrews are tightened, the 3/4" wood spacers should fall free. If they do not, remove them at this time. The final tightening will clamp the front and rear driven discs in position, so the disc aligning tool can be removed at this time.

NOTE: Assembling the clutch on the flywheel will establish a location for the clutch release bearing assembly. If the clutch is to be used with a synchronized transmission (no clutch brake), the 19/32" dimension can be checked at this time. Clutches used with non-synchronized transmissions cannot be checked until the transmission has been installed. Refer to Internal Adjustment as outlined in ADJUSTMENT.

Installing 15-1/2" Clutch to Flywheel

- Install two 7/16" 14 N.C. x 5" long guide studs into two upper mounting holes of the flywheel. Rotate flywheel if necessary to level guide studs.
- Slide clutch disc aligning tool or drive gear stem through release bearing sleeve and assemble rear disc on tool.
 - NOTE: Long hub of rear disc is positioned toward release bearing. Place intermediate plate in clutch cover assembly aligning driving lug of plate with slots provided. Assemble front disc on tool with flange of hub toward release bearing.
- 3. Use a small chain hoist or jack to lift clutch assembly. Position the clutch assembly on the two assembly guide studs.

- 4. Slide clutch assembly forward and position alignment tool in flywheel pilot. Start ten retaining capscrews with lockwashers and run in finger tight. Tap clutch disc aligning tool in to make sure it has entered and centered in pilot bearing.
- 5. Tighten the capscrews progressively and evenly to pull the clutch ring into its proper position in the flywheel pilot.
 - IMPORTANT: Do not try to pull the clutch into place by running one capscrew completely down with an impact wrench. This procedure can crack or break the pilot shoulders causing eccentricity, off-square mounting and out-of-balance conditions.
- Remove the two guide studs and install two remaining capscrews and lockwashers.For the final check progressively tighten all

capscrews to 35-40 ft. lbs. of torque.

- 7. As the capscrews are tightened the 3/4"1 wood spacers should fall free. If they do not remove them at this time. The final tightening will clamp the front and rear discs in place and the clutch disc alignment tool can be removed now.
 - NOTE: Assembling the clutch on the flywheel will establish a location for the clutch release bearing assembly. If the clutch is to be used with a synchronized transmission (no clutch brake), the 19/32" dimension can be checked at this time. Clutches used with non-synchronized transmissions cannot be checked until the transmission has been installed. Refer to Internal Adjustment as outlined in ADJUSTMENT.

Installation of Transmission to Clutch and Engine

- If a clutch brake is used with this transmission, assemble the fiber washer, steel tang washer and a second fiber washer to drive gear shaft.
 IMPORTANT: When new, each clutch brake washer will be 1/8" thick for a total thickness of 3/8".
- 2. Apply a light coating of high temperature grease to the sides and bottom of the main drive gear splines. This will help prevent rust, fretting, corrosion, etc., while the clutch is in service and easier transmission removal at a later date.

 Avoid the common practice of smearing a
 - Avoid the common practice of smearing a handful of grease over the splines of the drive gear.

Most of this grease will be wiped off by the release bearing sleeve when the transmission is assembled to the clutch. Spread a small amount of grease inside the clutch release bearing sleeve filling the void between the two bushings.

- 3. Always check wear on clutch release yoke fingers and replace the yoke if necessary.
- Shift transmission into gear so that main drive gear can be rotated during assembly to line up with clutch driven disc hub splines.
- Use a suitable sling or transmission jack to properly support and maintain the engine/ transmission alignment when installing the transmission. Raise transmission and position it square to and aligned with engine.
- 6. Rotate top of clutch release yoke (1), Fig. 33, rearward and center the yoke on drive gear bearing cap. Yoke must be held in this position during early part of assembly. Enter main drive gear into clutch release bearing sleeve (2). Slide transmission forward slowly to pick up driven disc splined hubs. It may be necessary to rotate companion flange slowly to align the splines of drive gear and clutch discs.

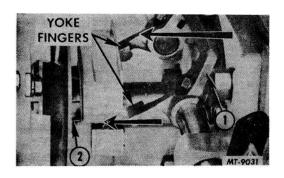


Fig. 33

 Observing through handhole opening in bell housing, make certain release bearing assembly is vertical with flat section on top and clutch release yoke fingers tipped up and centered to pass over release pads, Fig. 34, of release bearing assembly.

IMPORTANT: Use care to avoid springing the driven discs when the transmission is being installed. Do not force the transmission into the clutch or flywheel housing if it does not enter freely. Do not let the transmission drop or hang unsupported in the driven discs.

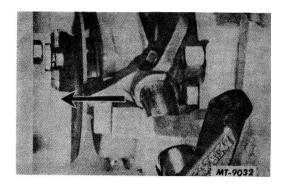


Fig. 34

8. As soon as the fingers of the clutch release yoke pass thrust pads of release bearing assembly, turn the release shaft to swing the yoke fingers down in front of release pads, Fig. 35.

IMPORTANT: Interference of release yoke fingers with the clutch flywheel ring will prevent assembly of transmission or cause binding of release shaft if it is not rotated.

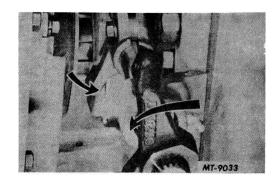


Fig. 35

- Enter pilot of clutch housing into flywheel housing and align capscrew holes. Start all capscrews and tighten progressively around housing.
- Connect clutch release linkage and check for proper free pedal, release bearing travel, clutch brake squeeze, etc. , as outlined under clutch adjustment.
- 11. Readjust clutch and linkage, if required, at this time. If new clutch facings were used, it may be necessary to readjust clutch shortly after clutch is placed in service.

ADJUSTMENT

Periodically when pedal-free travel is reduced, there are two adjustments which may be made. The first of these adjustments is the internal clutch adjustment and the second is the external or pedal and control linkage adjustment. Do not change or readjust the external linkage without checking the internal adjustment first. Changing the external linkage to restore free pedal will not compensate for an improperly adjusted clutch adjustment ring.

External adjustments are provided to compensate for variations encountered during manufacturing of vehicle or to permit proper readjustment of the clutch release mechanism when new clutches are installed.

Internal Adjustment

The internal clutch adjustment is checked by removing clutch housing inspection cover and inspecting the running clearance between release fork and bearing housing of 1/8 inch and clearance between release bearing and clutch brake, or clearance between clutch cover hub and release bearing housing (if not equipped with clutch brake).

Gauges of proper thickness may be made locally using stock material as follows:

Vehicles with clutch brake: Weld a piece of 1/2" thick stock material to a rod (handle) to check gap between release bearing and clutch brake assembly, Fig. 36, and use a 1/8" thick wire rod to check release bearing to release lever clearance.



Fig. 36

2. <u>Vehicles without clutch brake:</u> Weld a piece of 19/32" thick stock material to a rod (handle) to check gap between release bearing and clutch cover hub, Fig. 37, The same 1/8" thick rod above can be used to check clearance between release bearing and release lever.

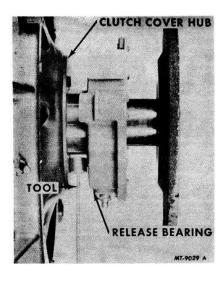


Fig. 37

If clearance is more or less than specified, readjust as follows:

- Rotate engine flywheel until adjusting ring lock is exposed. Remove adjusting ring lock bolt and pry lock free of adjusting ring. Use caution when prying lock from adjusting ring as it is spring loaded.
- 2. Release clutch by blocking pedal in depressed position.
- 3. Use a large screwdriver to turn the clutch adjustment ring. Turn adjusting ring counterclockwise to move release bearing toward flywheel; turn adjusting ring clockwise to move bearing housing away from flywheel. Rotation or movement of each notch will move the release bearing housing approximately .020". Thus, three notches moved means about 1/16 inch release bearing movement.
- 4. Re-engage the clutch and recheck clearance. A tolerance of plus or minus 1/32 inch is allowable.
- After clutch is adjusted properly, install lock plate with bolt and washer and reinstall clutch cover plate.

External or Pedal Adjustment

External or pedal adjustment is dependent upon the type of clutch control system used on the truck. The clutch release bearing may be actuated by mechanical, hydraulic, or a combination of air over hydraulic means. For this reason, the Operator's Manual should be checked to determine how much free travel will be required for the particular model being serviced.

In general, the mechanically-controlled clutch should have 1-1/2" to 1-3/4" of free travel before the clutch starts to disengage, Fig. 38.

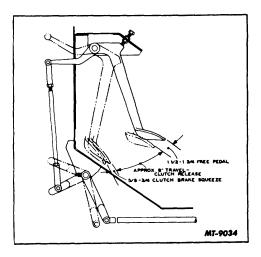


Fig. 38

The important points for the serviceman to remember are:

- Pedal clearance or free travel in linkage must be sufficient to prevent clutch from being partially disengaged. A clearance of 1/8 inch should be maintained between the yoke fingers and release bearing wear pads. Use the 1/8 inch thick wire rod described in <u>Internal</u> Adjustment.
- 2. External linkage should be adjusted to give a line-to-line setting or free pin fit with gauge in place. When gauge is removed, a free pedal travel of approximately 1-1/2" to 1-3/4" should be noted on the clutch pedal in the cab.
- Now check for clutch release by depressing clutch pedal to floor. If a clutch brake is used, the release bearing assembly should start to squeeze the brake discs when the pedal is

approximately 5/8" to 3/4" from the full travel or floor board, Fig. 38.

INTERMEDIATE PLATE DRIVE PINS

New intermediate plate drive pins should be installed any time the clutch is replaced. Worn or damaged drive pins can cause faulty clutch operation.

Two socket head set screws per drive pin are used to lock the pin in position. These set screws must be removed in order to replace the pins.

Be sure that drive pins are a press fit in holes in flywheel and that pin heads are perfectly square with the friction surface. Drive pins must be square to provide proper clearance and alignment for the drive slots in the intermediate plate. Drive pin alignment gauge (S-2330) will hold pins properly aligned while they are being driven into place with a drift, Fig. 39. If alignment tool is not available, a machinist's square and feeler gauge may be used to check for squareness. Lock drive pins in place by tightening socket head set screws.

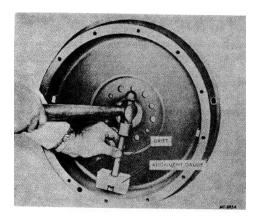
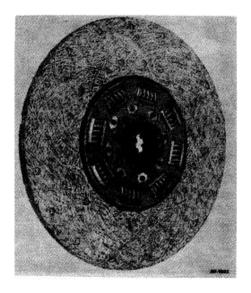


Fig. 39 Installing Intermediate Plate Driving Pins

DRIVEN DISCS

These driven discs use high-quality facings, Fig. 40, or ceramic buttons, Fig. 41, riveted to the steel disc. Used discs with facings can be reworked in the field by drilling out the rivets to remove old facings. Use the correct size drill when removing old rivets to avoid enlarging holes in disc. Use proper facings and a star set anvil to reline used discs. NOTE: It is not recommended that discs with ceramic buttons be reworked due to special manufacturing procedures required with this type disc.





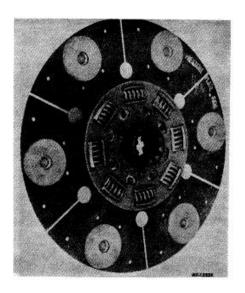


Fig. 41

SPECIFICATIONS

Type	14" 2-Plate	15-1/2" 2-Plate
Code	11239, 11249, 11250,	11155, 11251, 11252,
	11340, 11341	11254, 11255
Pilot Diameter, Inches	14.750/14.747	17.156/17.153
Bolt Circle, Inches	15-1/2	16.625
Flywheel Pot Depth, Inches	2-15/16	Flat
Disc and Facing Thickness - Standard	.463/.428	.487/.452
Disc Assembly Maximum Runout (T.I.R.)	.015	.015
Disc Assembly Maximum Out-of-Flat		.020
Intermediate Plates, Driving Lugs-to-Slot	020	
Clearance: New Minimum		.006 to .010
Maximum Worn	.006 to .010	.015 to .021
Pressure Plates, Driving Lugs-to-Slot	.015 to .020	
Clearance: New		.003 to .010
Maximum Worn	.004 to . 008	.016 to .021
Intermediate Plates and Pressure Plates,	.020	.000 to .004
Out-of-Flat	.000 to .004	
Scoring - Maximum Depth that can be reused		.015
Regrind Maximum Removal per side	.015	.015
Flucrum Wear (Maximum) Rework	.015	.030
Release Sleeve Retainer, Driving Lugs-to-Slot	.030	
Clearance: Maximum Worn		.020
	.020	

TROUBLE SHOOTING					
CAUSE	CORRECTION				
Poor Release					
 Intermediate plate sticking on drive lugs (14" two-plate clutch only). 	Drive pins must be 90' square to the flywheel surface with .006 minimum clearance between drive pins and intermediate plate slots.				
2. Pressure plate not retracting.	 a. Check pressure plate drive lugs for proper clearance of .006 minimum. b. Check pressure plate return springs for being bent or stretched. Replace if necessary. c. Insufficient amount of release travel. d. Lever nose out of groove in release sleeve 				
3. Driven disc distorted or warped.	retainer. a. Driven disc assembly must be straight within .015" total indicator reading. Replace discs. b. Damage to driven disc can be caused by poor installation methods. Do not force transmission drive gear into disc hubs. This will distort or bend driven disc causing poor release.				
4. Splines worn on main drive gear of transmission.	Replace drive gear and check driven disc hubs for excessive wear. If worn, replace disc. Check flywheel housing alignment of engine and transmission. Make sure driven discs slide freely on drive gear splines.				
5. Internal clutch adjustment not correct.	Readjust clutch for standard release travel. Refer to adjusting instructions. Proper clutch adjustment must be maintained for good clutch release and proper brake squeeze.				
6. Flywheel pilot bearing fitting too tightly in flywheel or on end of drive gear.	Free pilot bearing to a light push. Fit in fly- wheel and on drive gear pilot. If bearing is rough, replace.				
7. Facings gummed with oil or grease.	Replace facings or entire driven disc assembly.				
8. Damaged clutch release bearing.	Replace bearing. If bearing is grease type, lubricate with engine running only if grease tube extends through the hand hole cover of bellhousing. Use only high-temp. recommended lube.				
9. Clutch release shaft projecting through release yoke.	Relocate release shaft so it does not project. Check bell housing bushings and release yoke for wear.				
Release yoke contacting cover assembly at full release position.	Replace release yoke with proper yoke.				

CAUSE	CORRECTION
Poor Re	elease (continued)
Release yoke will not align with release bearing properly.	Flywheel has been resurfaced more than the recommended .060 removal.
12. Broken intermediate plate.	Replace damaged intermediate plate driven disc assembly. This is caused by driver abuse or excessive heat. a. Holding vehicle on hill with the clutch. b. Overload. c. Starting off in the wrong gear. d. Wrong cover assembly installed allowing clutch to slip. e. Intermediate plate hanging allowing clutch to slip.
<u>Clu</u>	utch Slippage
 Weak pressure springs. No free pedal. Worn clutch facings. Release mechanism binding. Grease or oil on facings. 	Replace springs. Readjust clutch. Replace facings or complete driven disc assembly. Free up mechanism and adjust clutch. Replace facings or complete driven disc assembly.
<u>N</u>	loisy Clutch
 Clutch release bearings dry or damaged. Flywheel pilot bearing dry or damaged. Clutch release bearing housing striking flywheel ring. 	Lubricate bearing or replace. Lubricate bearing or replace. Adjust clutch. Also check wear on cross shafts, bell housing bushings and release yoke fingers. If badly worn, replace parts.
4. Excessive clearance between drive slots and drive lugs on intermediate and pressure plates.	Check clearance.

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CLUTCH

14 INCH SINGLE PLATE

CODES 11245, 11342, 11343, 11344

Lipe Rollway - DLB Type

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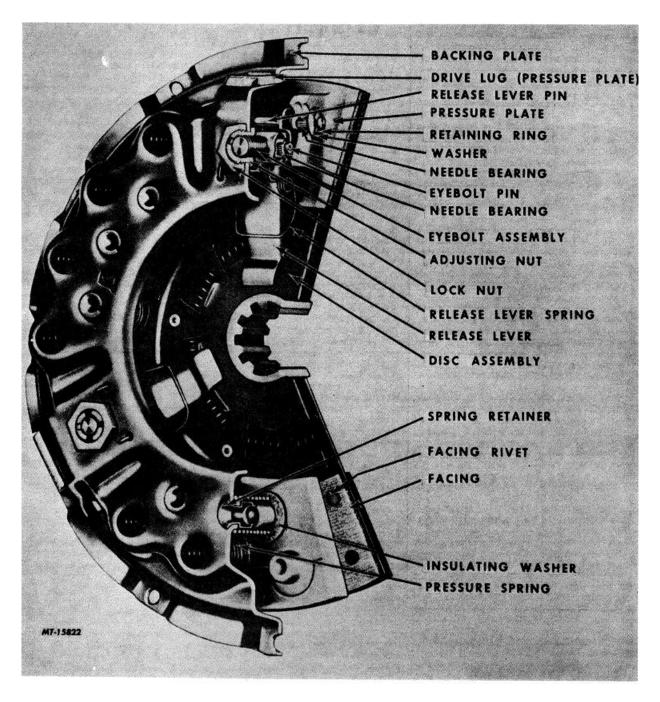


Fig. 1 Sectional View of 14" Single Plate Clutch Assembly

DESCRIPTION

The 14 inch, single plate (Lipe-Rollway) DLB type clutch is a direct pressure, dry disc design incorporating a push-type release bearing.

Release lever adjustments should not be required during the normal life of the clutch disc facings. As pedal free travel is reduced by wear of the driven member facings, the correct amount of pedal free travel should be restored by means of pedal adjustment which is also the proper clearance between release levers and release bearing. It is important that the clearance be maintained to avoid slippage and protect the release bearing.

OPERATION

The clutch assembly consists of a pressure plate assembly and a disc with facings. The driven disc uses high-quality organic facings or ceramic button-type facings.

To identify the nomenclature of the components in the following text, refer to Fig. 1.

The backing plate (pressure plate assembly) is attached to the engine flywheel by twelve cap screws. The pressure plate is driven by means of driving lugs extending into mating slots in the backing plate.

Depressing the clutch pedal forces the release bearing into contact with the release levers and moving them toward the flywheel. This retracts the pressure plate from contact with the driven disc assembly, thus disengaging the clutch.

When the clutch pedal is released the clutch will be engaged, by allowing the release bearing and release levers to move away from the engine flywheel. The pressure springs then exert pressure against the pressure plate resulting in the disc to be gripped between the friction surfaces of the pressure plate and engine flywheel.

ADJUSTMENT

To assure correct clutch operation and long service life of clutch components, the clutch control linkage must be kept in proper adjustment.

Proper clutch pedal free travel is approximately 1-1/2". A gradual reduction from this amount is a normal condition caused by wearing of the facings. Free travel is the first easy movement of the pedal.

Check the clutch pedal "free travel" with hand to be positive that "free travel" is a result of actual release bearing clearance and not that of worn linkage.

To assure that the clutch is properly adjusted, an inspection of the clearance between the clutch release levers and release bearing should be made rather than just checking the pedal "free travel". The clutch release bearing to clutch lever clearance is 1/8".

NOTE: Excessive clutch pedal "free travel" or too much release bearing clearance may prevent complete clutch disengagement while insufficient clutch pedal "free travel" or too little release bearing clearance will cause clutch slippage and short clutch life.

TRANSMISSION AND CLUTCH REMOVAL

As the transmission is being removed, support the weight of the transmission and keep transmission in alignment with engine until the main drive gear (input) shaft spline clears the clutch driven disc. Failure to do so could cause distortion of clutch disc.

After transmission has been removed, install three hold-down bolts (1/4" 20 x 2-1/4") with flat washers through the clutch backing plate into tapped holes in the pressure plate. Tighten hold-down bolts evenly to compress clutch springs and release pressure plate tension. Remove twelve mounting bolts and remove clutch assembly from flywheel.

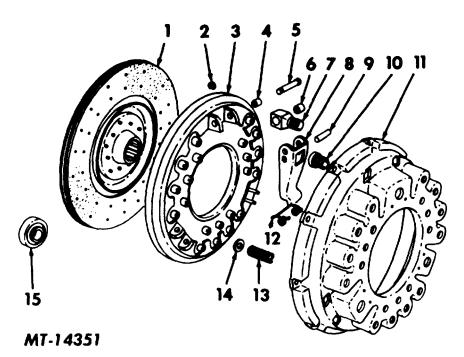


Fig. 2 Exploded View of 14" Single Plate Clutch Assembly

<u>Key</u>	<u>Description</u>	<u>Key</u>	<u>Description</u>
	PLATE, Pressure Assembly	8	LEVER, Clutch Release
	(Items 2 thru 14)	9	PIN, Eyebolt
1	DISC, With Facings	10	NUT, Adjusting
2	RING, Clutch Pin Retaining		NUT, Lock (Not Shown)
3	PLATE, Pressure	11	PLATE, Backing
4	BEARING, Clutch Pin Needle	12	SPRING, Release Lever
5	PIN, Release Lever	13	SPRING, Pressure
	WASHER, Flat (Not Shown)	14	WASHER, Insulating
6	BEARING, Eyebolt Needle	15	BEARING, Clutch Pilot
7	BOLT Release Lever Eve		

DISASSEMBLY

All key numbers in parentheses refer to the clutch components in Fig. 2.

I. Position pressure plate assembly in an arbor press on a smooth flat surface of size to support the assembly. Select spacers of correct thickness from SE-2068 Spacer Plate Set and place the three spacers at equal distances under the pressure plate. See SPECIFICATIONS for spacer plate requirement.

- 2. Bridge a bar across the top of the backing plate. Using the press, compress the assembly to relieve the spring tension.
- 3. Remove the three eyebolt lock nuts. Then remove the three (1/4" 20 x 2-1/4") holddown bolts.
- 4. Slowly release the press. Remove backing plate, pressure springs (13) and insulating washers (14).
- 5. Remove retaining rings (2) and pressure plate pins (5). Remove release lever assemblies (8), eyebolt assemblies (7) and adjusting nuts (10).

CLEAN AND INSPECTION

Clean all parts thoroughly. Inspect parts indicated as follows. Remember: If in doubt as to the condition of any part, replace it with a new part.

Pressure Plate

The pressure plate must be replaced if:

Friction surface is severely heat checked.

It is warped in excess of .015".

Driving surfaces are worn.

Pin holes elongated.

It is recommended that not over 1/32" be removed from friction surface by regrinding. Refer to SPECIFICATIONS for pressure plate thickness. Fig. 3 illustrates checking pressure plate thickness.

NOTE: If a scored, warped or heat checked pressure plate is used, early failure of clutch disc could result.

Install new bearings (4) using a suitable tool by pressing on the end of bearing on which the part number is stamped. This will prevent damage to the bearing case.

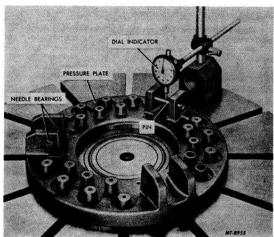


Fig. 3 Checking Thickness of Pressure Plate (Dimension "C")

Backing Plate

Inspect backing plate for distortion or cracks. Bolting flanges should be flat to within .015" when checked on a surface plate.

Pressure Springs

Check pressure springs (13) for proper tension using SE-2241 Spring Tester or similar spring test tool (see SPECIFICATIONS). If spring tester is not available, compare old springs with new spring.

Discard those not of same length or discolored due to heat.

Eyebolt and Adjusting Nut

In cover assemblies incorporating needle bearings (6), each eyebolt (7) will include a needle bearing. The needle bearing must be replaced or install new eyebolt assemblies.

When installing new bearings, use suitable tool and press on the end of the bearing having numbers stamped thereon. This will prevent damage to bearing cage.

In cover assemblies not incorporating needle bearings, the eyebolt pin hole is elongated to allow the pin to move as the clutch is disengaged. If this hole indicated wear, the eyebolt should be replaced.

Eyebolt and adjusting nut threads must be free fitting but not excessively loose.

Release Lever Assembly

The release levers must be replaced if the holes for the eyebolt or pressure plate pins are worn, or if worn severely by the release bearing.

Pressure Plate and Eyebolt Pins

Replace pins if any signs of wear are evident.

Disc Assemblies

Driven discs with high-quality facings of organic (Fig. 4) and ceramic buttons (Fig. 5) are used on these types of clutch assemblies.

The discs with organic facings can be reworked in the field by drilling out the rivets to remove old facings. Use correct size drill when removing old rivets to avoid enlarging holes in disc. Use proper facings and a star set anvil to reline discs.

NOTE: Discs with ceramic buttons are not reworked due to special procedures in assembling these special type discs.

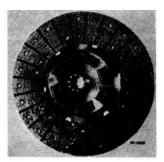


Fig. 4 Disc with Organic Facing

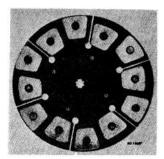


Fig. 5 Disc with Ceramic Button Facing

Disc facings with rivets are available. However, the disc should be replaced if:

Hub splines are worn. Disc is distorted. Disc cracked or broken.

When installing new facings use a suitable riveting fixture and support disc assembly during riveting operations so that disc will not be damaged or distorted. Made sure proper riveting method is used. Fig. 6 illustrates correct riveting techniques for various types of facing materials.

View A, Fig. 6, shows the correct method of riveting fabric or semi-metallic facings using a star set anvil, resulting in split end of rivet conforming to tapered counterbore of facing.

View B, Fig. 6, shows the correct method of riveting metallic facings using roll set rivets.

Rivets should be alternated so that heads of adjacent rivets face in opposite directions.

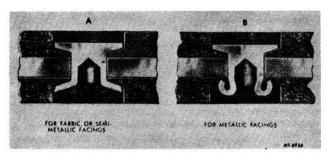


Fig. 6 Correct Methods for Riveting Facings

ASSEMBLY

1. Place a small amount of IH 251H E. P. grease or equivalent NLGI #2 multi-purpose lithium grease on all pins.

NOTE: Do not overlubricate.

- Position the three spacers of correct thickness from SE-2068 Spacer Plate Set (See SPECIFICATIONS) on a smooth flat surface in an arbor press. Position the spacers so that they are located at equal distances under the pressure plate when plate is positioned under the ram of the press.
- 3. Assemble adjusting nuts (10) to eyebolts (7), then assemble to release lever (8) using new pins (9), see Fig. 7.

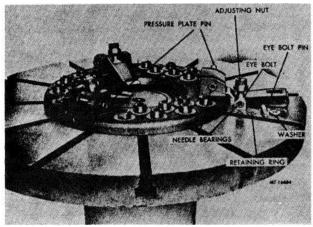


Fig. 7 Assembly of Eyebolts in Release Levers

4. Assemble levers to pressure plate and install release lever pins (5). Clutches with needle bearings require flat washers installed on both ends of pressure plate pin.

5. Position insulating washers (14) over spring bosses on pressure plate (Fig. 8), then install pressure springs (13) on bosses.

NOTE: In the event the base of the spring boss is equipped with webs, the insulating washers are not used.

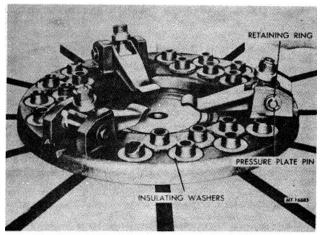


Fig. 8 Installation of Release Levers

 Assemble release lever springs (12) on backing plate and position cover over pressure springs making sure each spring is in place on backing plate (Fig. 9). Be sure to line up "O" marks on backing plate and pressure plate.

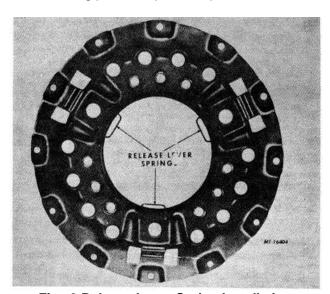


Fig. 9 Release Lever Spring Installation

- 7. The backing plate can now be pressed into position taking care to engage the driving lugs on pressure plate into slots on the plate to avoid damage to plate.
- 8. After the backing plate has been pressed into position pull the adjusting nuts up through the holes in the plate and install lock nuts (Fig. 10).

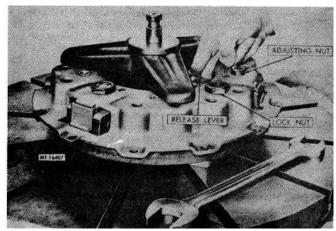


Fig. 10 Installing Lock Nuts

- 9. Before releasing the press, install three 1/4" 20 x 2-1/4" bolts with flat washers through backing plate into tapped holes in the pressure plate.
- 10. The release levers must be adjusted to the proper height and lock nuts tightened. For proper lever settings, see "A" dimension in SPECIFICATIONS and follow ADJUSTING LEVER HEIGHT procedures.

ADJUSTING LEVER HEIGHTS

This adjustment applies to rebuilt assemblies only.

The SPECIFICATIONS page lists the lever height setting (Dimension "A") which is the distance from the backing plate to the ends of the release lever (at the point of release bearing contact). The accuracy of the adjusting depends upon the operation of the clutch, as this adjustment controls the parallel movement of the pressure plate.

A straight edge position on the backing plate and checking the dimension from the plate surface to the release bearing contact surface of release levers must be correct (Fig. 11).

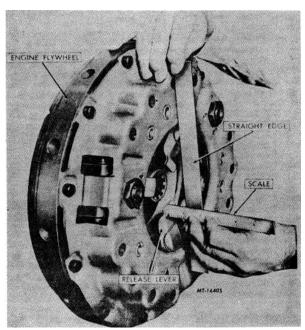


Fig. 11 Checking Release Lever Height (Dimension "A")

Special tool SE-2301 can be used for adjusting the slotted nut (Fig. 12). Starting with the levers low and with the lock nut just snug, turn the adjusting nut and lock nut as a unit clockwise until the lever is raised to the desired height. Then hold slotted adjusting nut firm with tool and tighten the lock nut.

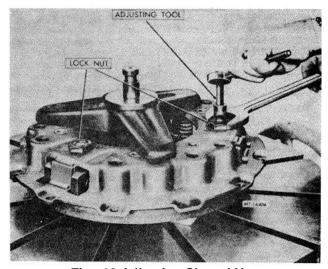


Fig. 12 Adjusting Slotted Nut

INSTALL CLUTCH AND TRANSMISSION

- 1. Replace flywheel pilot bearing and release bearing and carrier if needed. Pilot bearing should be a hand press fit in the flywheel recess and on transmission main drive gear.
 - The release yoke or fork should contact the release bearing carrier pads evenly to avoid a bind on the bearing cap extension.
- The friction face of the flywheel must be free of cracks, score marks and taper.The presence of these conditions will have an

adverse effect on clutch function and life.

- Position the pressure plate assembly on flywheel and install mounting bolts loosely.
 Insert clutch disc aligning tool or splined main drive gear shaft through clutch disc hubs and into flywheel pilot bearing to position clutch disc.
- 4. Tighten clutch mounting bolts progressively and evenly around flywheel to 34 to 40 ft-lbs torque.
- Remove hold-down bolts from backing plate releasing spring tension and engage pressure plate. Remove alignment tool from clutch disc.
- 6. Recheck release lever height and adjust if necessary.
- 7. Apply a coating of IH 251H E. P. grease or equivalent NLFI #2 multipurpose grease to the clutch release fork fingers and pad.
- 8. Inject sufficient oil through oil hole in release sleeve to saturate felt in release sleeve cavity. Use SAE 40 engine oil.
- Lubricate splines of transmission main drive gear with a light coat of IH 251H E. P. grease or equivalent NLGI #2 multipurpose lithium grease.
- 10. Raise transmission and enter spline shaft into clutch release sleeve assembly. Align transmission with engine and move it forward to enter driven disc hub and release bearing. It may be necessary to rotate transmission shaft slightly to align the splines.

NOTE: It is extremely important that transmission be adequately supported in line with engine crankshaft while transmission is being installed to avoid damaging splines or distorting clutch driven discs. Do not force transmission into clutch or allow transmission to hand unsupported in clutch disc hub.

11. To obtain complete disengagement of clutch assemblies, the release levers must be actuated a specified distance from the engaged position.

Pressure Plate Assembly

Assuming the release bearing clearance (distance between the clutch release levers and release bearing) to be 1/8" when the clutch is in the engaged position, the release bearing must move forward 1/8" to take up this clearance before it contacts the release levers and then move the normal amount of travel required to disengage the clutch as follows:

Release Bearing Clearance: 1/8 Normal Release Bearing Travel: 1/2" Total Release Bearing Travel Required: 5/8"

SPECIFICATIONS

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IH Part Number	394 292 C93	445 412 C91
Lipe Model No.	140-301-1086	140-301-1107
Lever Height Setting, Dimension "A"	29/32"	29/32"
Pressure Plate Thickness, Dimension "C"	1.687"	1.687"
Spring Data:		
Number Used	18	21
Color	Dark Maroon Stripe	Light Green Stripe
Tension, Min. Lbs.	133 @21-27/32	153 @ 1-27/32
Disc Data		
Spline Diameter	1-1/2"	1-3/4"
Facing Thickness	3/16".	11/64"
Flywheel Depth	Flat	Flat
Spacer Plate	SE-2068-5	SE-2068-5



CLUTCH LINKAGE

S SERIES VEHICLES

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DESCRIPTION

The clutch control linkage (Figure 1) consists of a suspended clutch pedal connected by a rod to a relay (bellcrank) which is, in turn, connected by another rod to the clutch release shaft lever

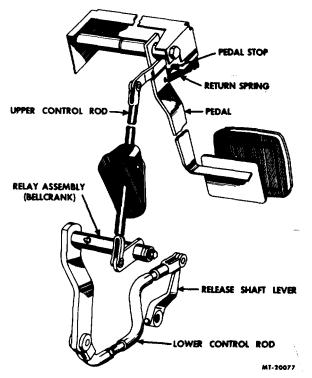


Fig. 1 Clutch Control Linkage (Typical)

The clutch pedal and relay shaft pivot on low friction bushings of non-metallic (Acetal) material.

Adjustments are provided to establish correct initial settings and to compensate for wear of clutch disc facings.

MAINTENANCE

LUBRICATION

Clutch control components (release bearing, release shaft, relay shaft and linkage yoke pins) should be lubricated at the intervals specified in the vehicle Operator's Manual and at the time of clutch or clutch control linkage service.

For lubricant types, refer to LUBRICATION section, CTS-2412 of the Truck Service Manual.

Some clutches are equipped with prelubricated, sealed release bearings which do not require periodic lubrication.

INSPECTION

At the time of vehicle chassis lubrication, check clutch pedal free travel. If free travel is less than the specified dimension, make necessary adjustments (see ADJUSTMENT).

At least once each year and in the event of clutch service, inspect clutch control linkage for worn or damaged parts. Worn yoke pins and yoke pin holes in control rods and levers could affect linkage adjustment and clutch operation. Replace any worn or damaged parts. When installing new parts, clutch linkage should be lubricated and readjusted.

ADJUSTMENT

To assure correct clutch operation and long service life of clutch components, the clutch and linkage must be kept in proper adjustment.

Adjustment factors are clutch release bearing clearance and clutch pedal free travel. Pedal free travel is determined by release bearing clearance.

Adjustment must be made periodically to compensate for wear of clutch disc facings (as indicated by reduction of pedal free travel) and at the time of clutch or clutch control linkage service.

Some clutches have a self-adjusting feature which automatically maintains proper release bearing clearance to compensate for wear of clutch disc facings. However, initial settings must be established by manual adjustment at the time of clutch or clutch control linkage service.

Adjustment procedures, which vary between clutch types, are outlined on the following pages.

PUSH TYPE CLUTCHES

To obtain specified release bearing to clutch finger clearance (Figure 2), adjust clutch linkage as outlined below. This adjustment will provide specified pedal free travel.

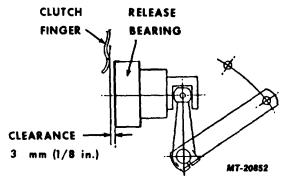


Fig. 2 Release Bearing Clearance (Push Type Clutches)

<u>Vehicles With Adjusting Yoke at Front End of Lower</u> (Horizontal) Control Rod:

- Loosen lower (horizontal) clutch control rod adjusting yoke lock nut.
- 2. Remove coller pin and clevis pin and disconnect lower control rod from relay inner lever.
- 3. Insert a 7 mm (.28") spacer gauge between clutch pedal shank and pedal return stop. (Gauge can be made locally).

IMPORTANT Use 8.8 mm (.34") spacer gauge on vehicles having pedal return spring connected to upper (vertical) clutch control rod.

- 4. Pull lower control rod forward until release bearing contacts clutch fingers.
- Holding rod in forward position (per Step 4), adjust control rod yoke until clevis pin can be freely inserted through yoke and relay shaft lever.
- Tighten control rod yoke lock nut and install new cotter pin.
- 7. Remove pedal spacer gauge.
- 8. Operate clutch pedal and check clutch release. Clutch should fully release before clutch pedal contacts floor panel.

<u>Vehicles With Adjusting Yoke at Rear End of Lower</u> (Horizontal) Control Rod:

- 1. Loosen lower (horizontal) clutch control rod adjusting yoke lock nut.
- Remove cotter pin and clevis pin and disconnect lower control rod from release shaft lever.
- 3. Insert a 7 mm (.28") spacer gauge between clutch pedal shank and pedal return stop. (Gauge can be made locally).

IMPORTANT Use 8.8 mm (.34") spacer gauge on vehicles having pedal return spring connected to upper (vertical) clutch control rod.

- 4. Pull release shaft lever forward until release bearing contacts clutch fingers.
- Holding lever in forward position (per Step 4), adjust control rod yoke until clevis pin can be freely inserted through yoke and release shaft lever.
- 6. Tighten control rod yoke lock nut and install new cotter pin.
- 7. Remove pedal spacer gauge.
- 8. Operate clutch pedal and check clutch release. Clutch should fully release before clutch pedal contacts floor panel.

PULL TYPE CLUTCHES

Two types of adjustments <u>must</u> be made: (1) clutch internal (release bearing) adjustment and (2) external (linkage) adjustment.

IMPORTANT <u>Do not</u> change external (linkage) adjustment without checking the internal adjustment first. Changing the external adjustment to restore pedal free travel will not compensate for an improperly adjusted clutch.

The following procedures cover both internal and external adjustments.

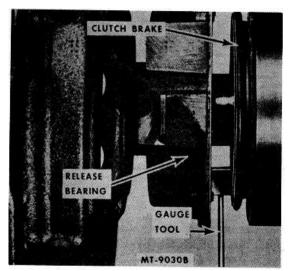


Fig. 3 Checking Release Bearing Adjustment With Clutch Brake (Dana Angle Spring Clutch)

For Dana Angle Spring Clutches:

1. Remove clutch housing inspection cover and check release bearing clearance as follows:

<u>Vehicles with clutch brake</u>: Check clearance between release bearing housing and clutch brake disc (Figure 3*).

<u>Vehicles without clutch brake</u>: Check clearance between release bearing housing and clutch cover (Figure 4*).

 Clutch brake and/or clutch cover in vehicle may differ in appearance from those illustrated.

Gauge tools can be made locally by welding a piece of stock material to a rod (handle). Refer to SPECIFICATIONS for specified clearance dimensions.

If clearance is more or less than specified, readjust as follows:

Manual Adjustment Type

a. Rotate engine flywheel until adjusting ring lock is exposed. Remove adjusting ring lock bolt and pry lock free of adjusting ring (Figure 5). Use caution when prying lock from adjusting ring as it is spring loaded.

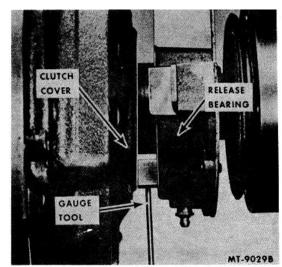


Fig. 4 Checking Release Bearing Adjustment Without Clutch Brake (Dana Angle Spring Clutch)

- b. Release clutch by blocking pedal in depressed position.
- c. Use a large screwdriver to turn clutch adjusting ring. Turn adjusting ring counterclockwise to move release bearing toward flywheel; turn adjusting ring clockwise to move bearing housing away from flywheel. Rotation or movement of each notch will move release bearing housing approximately .5 mm (.020"). Thus, three (3) notches moved means about 1.6 mm (1/16") release bearing movement.

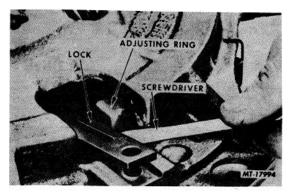


Fig. 5 Removing Adjusting Ring Lock (Dana Angle Spring Clutch) (Manual Adjustment Type)

- Re-engage clutch and recheck clearance.
 A tolerance of plus or minus .8 mm (1/32") is allowable.
- e. When specified release bearing clearance is obtained, install lock plate with bolt and washer. Be sure to reinstall correct lock bolt. A longer bolt will prevent clutch release.

Self-Adjuster Type

- a. Rotate engine until adjuster assembly is exposed.
- b. Remove right hand bolt from adjuster assembly and loosen left hand bolt one turn (see Figure 6).

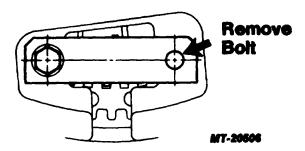
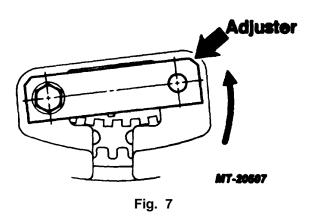


Fig. 6

 Rotate adjuster upward. This will disengage worm gear from adjusting ring to allow manual adjustment. Hold adjuster disengaged and tighten left bolt (see Figure 7).



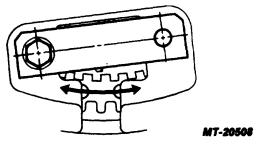


Fig. 8

d. Release clutch by blocking pedal in depressed position.

Rotate adjusting ring to obtain specified release bearing clearance (see Figure 8). Rotate adjusting ring clockwise to move bearing housing away from flywheel or counterclockwise to move bearing housing toward flywheel.

Re-engage clutch and recheck release bearing clearance. Readjust as needed.

Loosen left hand bolt and rotate adjuster downward to engage worm gear with adjusting ring teeth (see Figure 9). Adjusting ring may have to be rotated slightly to allow worm gear to mesh.

Make sure adjuster actuator arm is engaged in hole in release sleeve retainer.

h. Install right hand bolt and tighten both bolts to 41-47 N. m (30-35 ft. lb.). (See Figure 10).

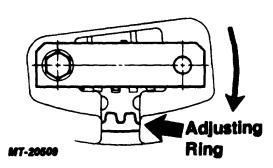


Fig. 9

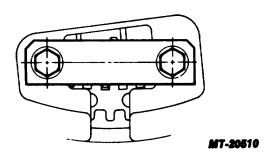


Fig. 10

 After adjusting clutch (Step 2), adjust clutch linkage to obtain specified release shaft yoke (fork) to release bearing housing clearance (Figure 11) as outlined below. This adjustment will provide specified pedal free travel.

<u>Vehicles With Adjusting Yoke at Front End of Lower</u> (Horizontal) Control Rod:

- a. Loosen lower (horizontal) clutch control rod adjusting yoke lock nut.
- Remove cotter pin and clevis pin and disconnect lower control rod from relay shaft inner lever.
- c. Insert a 7 mm (.28") spacer gauge between clutch pedal shank and pedal return stop. (Spacer gauge can be made locally).

IMPORTANT

Use 8.8 mm (.34") spacer gauge on vehicles having pedal return spring connected to upper (vertical) clutch control rod.

- Pull lower control rod forward until release shaft yoke (fork) contacts release bearing housing.
- e. Holding rod in forward position (per "d" above), adjust control rod yoke until clevis pin can be freely inserted through yoke and relay shaft lever.
- f. Tighten control rod yoke lock nut and install new cotter pin.
- g. Remove pedal spacer gauge.

<u>Vehicles With Adjusting Yoke at Rear End of Lower</u> (Horizontal) Control Rod:

- a. Loosen lower (horizontal) clutch control rod adjusting yoke lock nut.
- b. Remove cotter pin and clevis pin and disconnect lower control rod from release shaft lever.
- c. Insert a 7 mm (.28") spacer gauge between clutch pedal shank and pedal return stop. (Spacer gauge can be made locally).

IMPORTANT

Use 8.8 mm (.34") spacer gauge on vehicles having pedal return spring connected to upper (vertical) clutch control rod.

- d. Pull release shaft lever forward until release shaft yoke (fork) contacts release bearing housing.
- e. Holding lever rod in forward position (per "d" above), adjust control rod yoke until clevis pin can be freely inserted through yoke and release shaft lever.
- f. Tighten control rod yoke lock nut and install new cotter pin.
- g. Remove pedal spacer gauge.
- 4. Reinstall clutch housing inspection cover.
- Operate clutch pedal and check clutch release and clutch brake application. Clutch should fully release and clutch brake (where equipped) should apply before clutch pedal contacts floor panel.

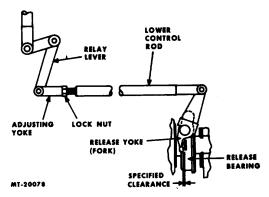


Fig. 11 Release Bearing-to-Release Shaft Yoke Clearance (Pull Type Clutch)

For Lipe LP, LPA Clutches:

1. Remove clutch housing inspection cover and check release bearing clearance as follows:

<u>Vehicles with clutch brake</u>: Check clearance between release bearing housing and clutch brake disc (Figure 12).

<u>Vehicles without clutch brake</u>: Check clearance between release bearing housing and transmission front bearing cap (Figure 12).

Gauge tools can be made locally by welding a piece of stock material to a rod (handle). Refer to SPECIFICATIONS for specified clearance dimensions.

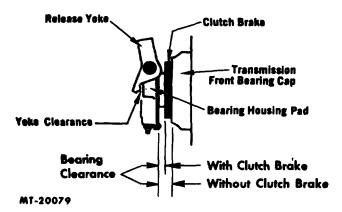


Fig. 12 Release Bearing Clearance (Lipe LP, LPA Clutches)

2. If clearance is more or less than specified, readjust as follows:

Manual Adjustment (LP) Type

- a. Hold or block clutch pedal down (clutch disengaged).
- b. Loosen release sleeve lock nut (Figure 13). This can be accomplished by use of

- a spanner wrench or a punch and a hammer.
- c. Release clutch pedal (engage clutch).
- d. Rotate sleeve adjusting nut (Figure 13) to obtain specified clearance between release bearing housing and clutch brake disc or transmission front bearing cap.
 Keep a light tension on release yoke or
 - Keep a light tension on release yoke or clutch pedal while turning sleeve adjusting nut. This will keep release spider snugly against release levers and prevent a false clearance reading.
 - Depress clutch pedal a few times and recheck release bearing clearance; readjust if needed.
- e. Hold or block clutch pedal down (clutch disengaged) and tighten release sleeve lock nut.

IMPORTANT

Always disengage clutch while lock nut is being loosened or tightened, but always have clutch engaged when turning release sleeve to obtain proper clearance.

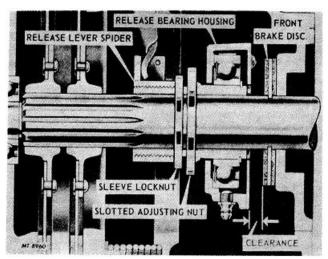


Fig. 13 Release Bearing Adjustment (Lipe LP Clutch) (Manual Adjustment Type)

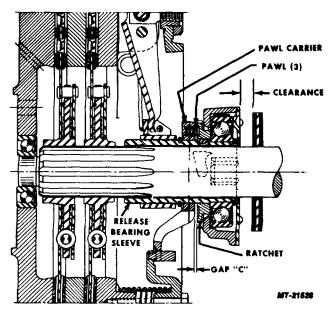


Fig. 14 Release Bearing Adjustment (Lipe LPA Clutch) (Self-Adjuster Type)

Self-Adjuster (LPA) Type

IMPORTANT

Incorrect release bearing clearance may indicate that self-adjuster mechanism is not functioning. Readjust clearance as outlined below and then recheck clearance after a period of service. If clearance is again out of specified limits, clutch should be removed for service of self-adjuster.

If release bearing clearance (Step 1) exceeds specified dimension, establish proper clearance by turning adjusting ratchet (Figure 14) counterclockwise (as viewed from rear of vehicle) using a soft drift and a small hammer.

CAUTION

Do <u>not</u> attempt to turn ratchet in a clockwise rotation without releasing ratchet pawls with a pawl block tool as instructed below.

If release bearing clearance (Step 1) is less than specified dimension, establish proper clearance as follows:

a. Insert pawl block tool SE-2745 (Figure 15) between pawl carrier and ratchet (Gap "C", Figure 14). Rotate position of tool until all three (3) pawls are released.

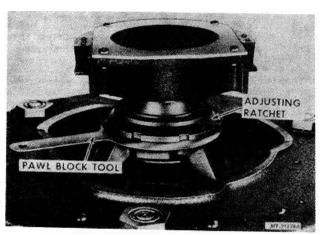


Fig. 15 Pawl Block Tool in Position. (Clutch Removed from Vehicle for Illustration)

- Using a soft drift and small hammer, turn adjusting ratchet clockwise (as viewed from rear of vehicle) until specified clearance is obtained.
- c. Remove pawl block tool.

 After adjusting clutch (Step 2), adjust clutch linkage to obtain specified release shaft yoke (fork) to release bearing housing clearance (Figure 11) as outlined below. This adjustment will provide specified pedal free travel.

<u>Vehicles With Adjusting Yoke at Front End of Lower</u> (Horizontal) Control Rod:

- a. Loosen lower (horizontal) clutch control rod adjusting yoke lock nut.
- b. Remove cotter pin and clevis pin and disconnect lower control rod from relay shaft inner lever.
- c. Insert a 7 mm (.28") spacer gauge between clutch pedal shank and pedal return stop. (Spacer gauge can be made locally).

IMPORTANT

Use 8.8 mm (.34") spacer gauge on vehicles having pedal return spring connected to upper (vertical) clutch control rod.

- Pull lower control rod forward until release shaft yoke (fork) contacts release bearing housing.
- e. Holding rod in forward position (per "d" above), adjust control rod yoke until clevis pin can be freely inserted through yoke and relay shaft lever.
- f. Tighten control rod yoke lock nut and install new cotter pin.
- g. Remove pedal spacer gauge.

<u>Vehicles With Adjusting Yoke at Rear End of Lower</u> (Horizontal) Control Rod:

- a. Loosen lower (horizontal) clutch control rod adjusting yoke lock nut.
- Remove cotter pin and clevis pin and disconnect lower control rod from release shaft lever.
- c. Insert a 7 mm (.28") spacer gauge between clutch pedal shank and pedal

return stop. (Spacer gauge can be made locally).

IMPORTANT

Use 8.8 mm (.34") spacer gauge on vehicles having pedal return spring connected to upper (vertical) clutch control rod.

- d. Pull release shaft lever forward until release shaft yoke (fork) contacts release bearing housing.
- e. Holding lever in forward position (per "d" above), adjust control rod yoke until clevis pin can be freely inserted through yoke and release shaft lever.
- f. Tighten control rod yoke lock nut and install new cotter pin.
- g. Remove pedal spacer gauge.
- Operate clutch pedal and check clutch release and clutch brake application. Clutch should fully release and clutch brake (where equipped) should apply before clutch pedal contacts floor panel.

CLUTCH PEDAL SHAFT BUSHING REPLACEMENT

(Refer to Figure 16)

- 1. Disconnect clutch pedal return spring.
- 2. Disconnect clutch pedal from upper clutch rod by removing cotter pin and clevis pin.
- 3. Disconnect brake pedal return spring (where used).
- 4. Disconnect brake pedal from brake cylinder rod (where used).
- 5. Remove pedal shaft bolt lock nut.
- Remove pedal shaft bolt, clutch pedal (with bushings), brake pedal (with bushings) or pedal spacer and spacer tube from steering column support bracket.
- 7. Discard old bushings. Inspect spacer tube and bore(s) of pedal(s) for wear. Replace if worn or damaged. Replace clevis pin(s), if worn.

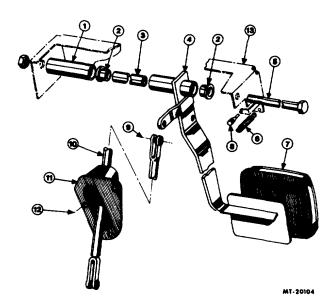


Fig. 16 Clutch Pedal Shaft Details

Legend for Figure 16

Key Description

- 1 SPACER, Pedal (W/Air Brakes) PEDAL, Brake (W/Hyd. Brakes)
- 2 BUSHING (2)
- 3 TUBE, Spacer
- 4 PEDAL, Clutch
- 5 BOLT, Pedal Shaft NUT, Lock
- 6 SPRING, Return
- 7 PAD, Pedal
- 8 BUMPER, Pedal Stop
- 9 PIN, Clevis (3/8 x 1.0625) PIN, Cotter (3/32 x 1.25)
- 10 ROD, Clutch, Upper
- 11 SEAL, Clutch Rod RETAINER, Sea
- 12 SCREW (3)
- 13 BRACKET, Steering Column Support
- 8. Lubricate inside and outside diameters of new bushings with a light coat of grease. Use IH 251H EP grease or an equivalent NLGI #2 multi-purpose lithium grease.
- 9. Position spacer tube and bushings in bore(s) of pedal(s).
- 10. Position clutch pedal (with bushings), brake pedal (with bushings) or pedal spacer and

spacer tube into steering column support bracket and install pedal shaft bolt and lock nut.

- Tighten pedal shaft lock nut to specified torque (see BOLT TORQUE CHART). Be sure pedal(s) pivot(s) freely after tightening lock nut.
- Connect brake pedal to brake cylinder rod (where used). Adjust brake pedal free travel if necessary.
- 13. Connect brake pedal return spring (where used).
- 14. Connect clutch pedal to upper clutch rod and install new cotter pin. Lubricate clevis pin with a light coat of grease.
- 15. Connect clutch pedal return spring.
- Check clutch control adjustments and readjust as needed (see ADJUSTMENT).

RELAY SHAFT BUSHING REPLACEMENT

2200 SERIES VEHICLES (Refer to Figure 17)

- 1. Disconnect upper and lower clutch rods from relay shaft levers by removing cotter pins and clevis pins.
- Remove relay shaft lock nuts, lock washers and flat washers. Remove relay shaft levers from relay shaft.

IMPORTANT

Mark relay shaft levers to assure correct location at reassembly.

- 3. Remove relay shaft and bushings from cab longitudinal sill ("sled runner").
- 4. Discard old bushings. Inspect relay shaft and replace if worn or damaged. Replace clutch rod clevis pins, if worn.
- Lubricate inside and outside diameters of new bushings with grease. Use IH 251H EP grease or equivalent NLGI #2 multi-purpose lithium grease.
- 6. Position relay shaft and bushings in cab longitudinal sill.
- 7. Install relay shaft levers, flat washers, lock washers and lock nuts on relay shaft.
- Tighten relay shaft lever lock nuts to specified torque (see BOLT TORQUE CHART). Be sure relay shaft rotates freely after tightening lock nuts.

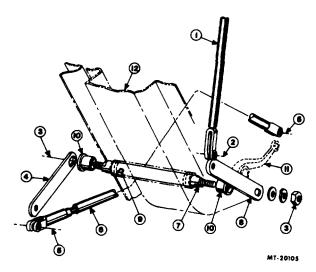


Fig. 17 Relay Shaft Details (2200 Series Vehicles)

Legend for Figure 17

Key Description

- 1 ROD, Clutch, Upper
- 2 PIN, Clevis (3/8 x 1.0625) PIN, Cotter (3/32 x 1.25)
- 3 NUT (2) WASHER, Lock (2) WASHER, Flat (2)
- 4 LEVER, Lower Rod
- 5 PIN, Clevis (1/2 x 1.36) (2) PIN, Cotter (1/8 x 1.75) (2)
- 6 ROD, Clutch, Lower
- 7 SHAFT, Relay
- 8 LEVER, Upper Rod
- 9 FITTING, Lubrication
- 10 BUSHING (2)
- 11 LEVER, Release Shaft
- 12 SILL, Cab
- 9. Connect upper and lower clutch rods to relay shaft levers and install new cotter pins. Lubricate clevis pins with a light coat of grease.

- 10. Lubricate clutch relay shaft through lubrication fitting (see Step 5 for grease specification).
- 11. Check clutch control adjustments and readjust as needed (see ADJUSTMENT).

VEHICLES EXCEPT 2200 SERIES (Refer to Figure 18)

- 1. Disconnect upper and lower clutch rods from relay levers by removing cotter pins and clevis pins.
- Remove relay shaft bolts, lock washers and flat washers.
- 3. Remove relay shaft and remove relay lever (bellcrank) assembly and bushings.
- 4. Discard old bushings. Inspect relay shaft and relay lever (bellcrank) assembly and replace if worn or damaged. Replace clutch rod clevis pins, if worn.
- Lubricate inside and outside diameters of new bushings with grease. Use IH 251H EP grease or an equivalent NLGI #2 multipurpose lithium grease.
- 6. Position bushings in relay lever (bellcrank) assembly.
- 7. Position relay lever (bellcrank) assembly between cab longitudinal sill and relay shaft bracket. Install relay shaft.
- 8. Install flat washers, lock washers and relay shaft bolts. Tighten bolts to specified torque (see BOLT TORQUE CHART). Be sure relay lever assembly pivots freely after tightening bolts.
- 9. Connect upper and lower clutch rods to relay levers and install new cotter pins. Lubricate clevis pins with a light coat of grease.
- 10. Lubricate relay lever assembly through lubrication fitting (see Step 5 for grease specification).
- 11. Check clutch control adjustments and readjust as needed (see ADJUSTMENT).

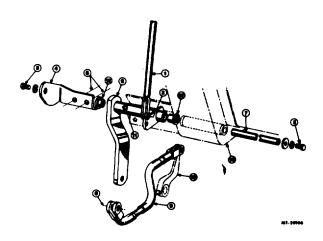


Fig. 18 Relay Shaft Details (Vehicles Except 2200 Series) (Typical)

Legend for Figure 18

- Key Description
 - 1 ROD, Clutch, Upper
 - 2 PIN, Clevis (3/8 x 1.0625) PIN, Cotter (3/32 x 1.25)
 - 3 BOLT (2) WASHER, Lock (2) WASHER, Flat (2)
 - 4 BRACKET, Relay Shaft
 - 5 BOLT (2) WASHER, Lock (2)
 - 6 ASSEMBLY, Relay Lever (Bellcrank)
 - 7 SHAFT, Relay
 - 8 PIN, Clevis (1/2 x 1.36) PIN, Cotter (1/8 x 1.75)
 - 9 ROD, Clutch, Lower
- 10 LEVER, Release Shaft
- 11 FITTING, Lubrication
- 12 BUSHING, (2)
- 13 SILL, Cab

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TROUBLE SHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE
Clutch won't release:	 Improper adjustments. Driven disc hub binding on main drive gear splines. Faulty clutch assembly.
Clutch dragging:	 See causes for "Clutch won't release." Dirt or foreign material in clutch. Oil or grease on driven disc linings. Misalignment. Broken driven disc linings. Warped or damaged driven disc, pressure plate or flywheel.
Clutch slipping:	 Improper adjustment. Oil or grease on driven disc linings. Worn driven disc linings. Weak or broken clutch pressure plate springs.
"Grabby" clutch:	 Oil or grease on driven disc linings. Incorrect type of lining material. Clutch assembly loose or out of parallel with flywheel face. Bent main drive gear shaft. Loose engine mounting bolts. Loss of tension in driven disc cushioning springs (where used).
Noisy clutch:	 Insufficient pedal free travel. Improper adjustment. Worn or damaged release bearing. Clutch assembly loose on flywheel. Faulty clutch assembly. Bent main drive gear shaft.
Premature clutch wear:	 Abusive driving habits. Improper adjustment. Incorrect type or improperly installed driven disc facings. Weak or broken clutch pressure plate springs. Warped clutch pressure plate.

BOLT TORQUE CHART

		Specified Torque
<u>Location</u>	Bolt Size	Newton-meters (Pound-Feet)
Pedal Shaft Bolt	1/2 - 13	102 - 115 (75 - 85)
Relay Shaft Lever Nuts	7/16 - 14	46 - 56 (34 - 42)
(2200 Series Vehicles)		, ,
Relay Shaft Bolts	1/2 - 13	68 - 81 (50 - 60)
(Vehicles Except 2200 Series)		
Lower Control Rod Adjustment Yoke		
Lock Nut	1/2 - 20	68 - 81 (50 - 60)
Relay Shaft Bracket Mounting Bolts	3/8 - 16	28 - 36 (21 - 27)
•	5/16 - 18	18 - 22 (13 - 16)

SPECIFICATIONS

CLUTCH TYPE	RELEASE BEARING CLEARANCE	CLUTCH PEDAL FREE TRAVEL
Push Type	3 mm (1/8") between release bearing and clutch fingers.	32 mm (1-1/4")
Pull Type 356 mm (14-Inch) Single Plate	Clutch Internal Adjustment: With Clutch Brake	(1-1/4)
Codes: 11347-11349 11348-11350 Pull Type 356 mm (14-Inch), 394 mm (15.5-Inch) Two Plate	13 mm (1/2")* between release bearing housing and clutch brake disc. Without Clutch Brake 19 t 3 mm (3/4 + 1/8") between release bearing housing and transmission front bearing cap.	32 mm (1-1/4")
Codes: 11145-11351 11346-11352 11252	External (Linkage) Adjustment: 3 mm (1/8)**	
Pull Type 356 mm (14-Inch) Single Plate	Clutch Internal Adjustment: With Clutch Brake	
Codes: 11359 11360 Pull Type 356 mm (14-Inch), 394 mm (15.5-Inch) Two Plate	13 mm (1/2") between release bearing housing and clutch brake disc. Without Clutch Brake	32 mm (1-1/4")
Codes: 11239-11353 11249-11354 11250 11155 11254	14 mm (9/16") between release bearing housing and clutch cover. or 19 ± 3 mm (3/4 + 1/8") between release bearing housing and transmission front bearing cap. External (Linkage) Adjustment:	
	3 mm (1/8)**	

^{* 11-14} mm (7/16 - 9/16-Inch) permissible on self adjuster type.

^{**} Between release shaft yoke (fork) and release bearing housing.



CLUTCH

CLUTCH CONTROL

(HYDRAULIC)

S-SERIES

1853 FC

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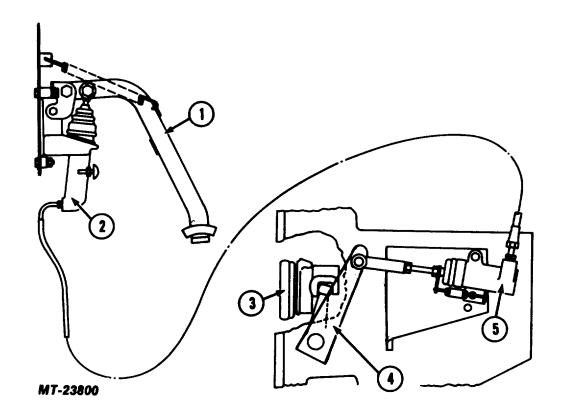


Fig. 1 Clutch Control System

- 1. Clutch Pedal
- 2. Master Cylinder
- Release Bearing

DESCRIPTION

The hydraulic clutch control system incorporates a pedal operated master cylinder which transmits hydraulic fluid to a slave cylinder mounted on the vehicle's transmission. Slave cylinder piston and push rod movement transmitted through the release shaft lever, release shaft and release fork moves the release bearing to release and apply the clutch.

Because of various engine, clutch and transmission combinations slave cylinder location and mounting differ between individual vehicles. However, system operation is similar.

The clutch itself is conventional and functions the same as in mechanically actuated installations.

- 4. Release Shaft Lever
- 5. Slave Cylinder

OPERATION

Depressing the clutch pedal moves the master cylinder piston displacing hydraulic fluid through tubing and flexible hose to the slave cylinder. Hydraulic fluid entering the slave cylinder displaces the slave cylinder piston moving the release bearing against the clutch release fingers. As the pedal is further depressed, greater pressure is built up in the slave cylinder to overcome clutch spring pressure and disengage the clutch.

When foot pressure on the clutch pedal is released, retracting springs return the slave cylinder piston, release shaft, release fork and release bearing and the clutch will re-engage. As slave cylinder piston is returned to its released position, it forces the hydraulic fluid back through the connecting hose and tubing to the master cylinder..

LUBRICATION

Clutch release bearing and release shaft should be lubricated at the intervals specified in the vehicle operator's manual and at the time of clutch or clutch control service.

For lubricant types, refer to LUBRICATION section, CTS-2412 of the Truck Service Manual.

MAINTENANCE

The following maintenance operations should be performed on the clutch control system at the time of vehicle chassis lubrication.

 Check hydraulic fluid level in clutch master cylinder. Keep filled to 13 mm (1/2 inch) from top of filler opening (Figure 2). Use "Super Heavy Duty" hydraulic brake fluid meeting or exceeding "DOT-3" specifications.

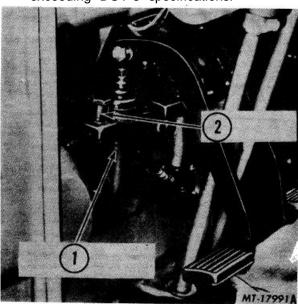


Fig. 2 Master Cylinder Filler Location
1. Master Cylinder 2. Filler Cap

- Inspect master and slave cylinders and connecting piping for hydraulic fluid leakage. Make any necessary repairs.
- Check clutch pedal free travel. If free travel is less than 32 mm (1.25") make adjustments. (See ADJUSTMENT)

At least once each year and in the event of clutch service, clutch control system should be inspected for worn or damaged parts. Any parts showing evidence of wear or damage should be replaced. When installing new parts, clutch control system should be lubricated and readjusted.

ADJUSTMENT

To assure correct clutch operation and long service life of clutch components, the clutch control system must be kept in proper adjustment.

Clutch control adjustments are: (1) clutch pedal adjustment and (2) release bearing clearance adjustment. These adjustments must be made periodically to compensate for wear of clutch facings (as indicated by reduction of clutch pedal free travel) and at the time of clutch or clutch control system service.

IMPORTANT

Before making adjustments, make sure master cylinder is filled with fluid and that hydraulic system is free of entrapped air.

CLUTCH PEDAL ADJUSTMENT

The pedal stop setting (distance from tip of pedal stop to dash panel, Figure 3) determines total pedal travel. It is adjusted by screwing pedal stop bolt in or out of master cylinder body.

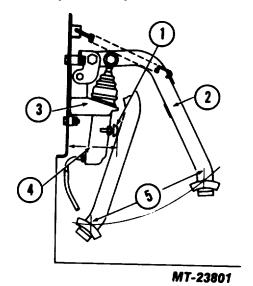


Fig. 3 Clutch Pedal Adjustment

- 1. Pedal Stop
- 2. Clutch Pedal
- 3. Master Cylinder
- 4. Pedal Stop Setting
- 5. Pedal Travel

Check for specified pedal stop setting. If necessary, loosen pedal stop lock nut and turn pedal stop bolt to obtain specified setting. (See SPECIFICATIONS)

IMPORTANT

Pedal stop must limit pedal travel before master cylinder piston "bottoms" in cylinder bore.

Make sure that clutch pedal return spring fully returns master cylinder push rod so that master cylinder piston uncovers fluid compensating port in cylinder bore.

If piston does not return sufficiently to open compensating port, the following may occur.

- System remains pressurized (fluid cannot return to reservoir). This would result in no release bearing clearance and possible clutch slippage due to clutch being held partially disengaged.
- b. Insufficient fluid in system (fluid cannot enter system from reservoir). This could cause poor clutch release due to inadequate slave cylinder travel and possible entry of air into system past slave cylinder piston cups.

Clutch pedal free travel is determined by clutch release bearing clearance. Correct adjustment of release bearing will provide proper pedal free travel.

RELEASE BEARING CLEARANCE ADJUSTMENT PUSH TYPE CLUTCH

Release bearing-to-clutch finger clearance adjustment is made at the slave cylinder push rod yoke as outlined below.

(Refer to Figure 4).

1. Be sure clutch pedal is adjusted correctly.

(See CLUTCHPEDAL ADJUSTMENT)

- 2. Disconnect slave cylinder return spring.
- Loosen slave cylinder yoke lock nut. Remove cotter pin and yoke pin and disconnect yoke from clutch release shaft lever.
- Rotate yoke to lengthen slave cylinder push rod until release bearing contacts clutch fingers with yoke pin in place and slave cylinder piston "bottomed."

Back off yoke (shorten push rod) five turns to obtain specified release bearing-to-clutch finger clearance.

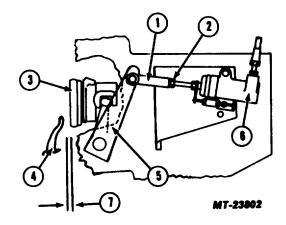


Fig. 4 Release Bearing Clearance Adjustment, Typical (Push Type Clutch)

- 1. Yoke
- Lock Nut
- 3. Release Bearing
- 4. Clutch Finger
- 5. Release Shaft Lever
- 6. Slave Cylinder
- 7. Specified Clearance
- 6. Install yoke pin and cotter pin. Tighten yoke lock nut.
- 7. Connect slave cylinder return spring.

IMPORTANT

Make sure slave cylinder return spring is capable of fully retracting slave cylinder ("bottoming" piston) to assure that release bearing-to-clutch finger clearance is obtained. If spring is weak or missing or if release linkage is binding, release bearing will not be pulled away from release fingers resulting in bearing and finger wear problems.

Some vehicles have a release bearing return spring located within the clutch housing.

PULL TYPE CLUTCH

Two types of adjustments <u>must</u> be made: (1) clutch internal (release bearing) adjustment and (2) external (slave cylinder yoke) adjustment.

IMPORTANT

Do not change external (slave cylinder yoke) adjustment without checking the internal adjustment first. Changing the external adjustment will not compensate for an improperly adjusted clutch.

The following procedures cover both internal and external adjustments.

For Lipe LP, LPA Clutches:

- Be sure clutch pedal is adjusted correctly. (See CLUTCH PEDAL ADJUSTMENT)
- 2. Remove clutch housing inspection cover and check release bearing clearance as follows:

<u>Vehicles with clutch brake</u>: Check clearance between release bearing housing and clutch between brake disc (Figure 5).

<u>Vehicles without clutch brake</u>: Check clearance release bearing housing and transmission front bearing cap (Figure 5).

Gauge tool can be made locally by welding a piece of stock material to a rod (handle). Refer to SPECIFICATIONS for specified clearance dimensions.

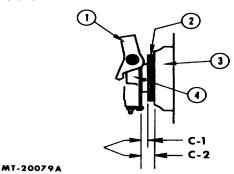


Fig. 5 Release Bearing Clearance (Lipe LP, LPA Clutches)

1. Release Yoke

C-1.Clearance

2. Clutch Brake

(With Clutch Brake)

3. Transmission

C-2.Clearance

4. Release Bearing

Front Bearing Cap

(Without Clutch

Housing

Brake)

3. If clearance is more or less than specified, readjust as follows:

Manual Adjustment (LP) Type

- a. Hold or block clutch pedal down (clutch disengaged).
- b. Loosen release sleeve lock nut (Figure 6). This can be accomplished by use of a spanner wrench or a punch and a hammer.
- c. Release clutch pedal (engage clutch).
- d. Rotate sleeve adjusting nut (Figure 6) to obtain specified clearance between release bearing housing and clutch brake disc or transmission front bearing cap.

Keep light tension on release yoke or clutch pedal while turning sleeve adjusting nut. This will keep release spider snugly against release levers and prevent a false clearance reading. Depress clutch pedal a few times and recheck release bearing clearance; readjust if needed.

e. Hold or block clutch pedal down (clutch disengaged) and tighten release sleeve lock nut.

IMPORTANT

Always disengage clutch while lock nut is being loosened or tightened, but always have clutch engaged when turning release sleeve to obtain proper clearance.

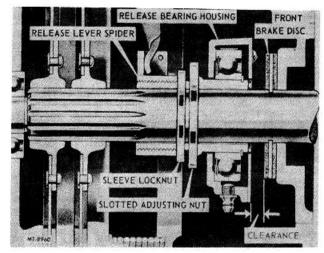


Fig. 6 Release Bearing Adjustment (Lipe LP Clutch) (Manual Adjustment Type)

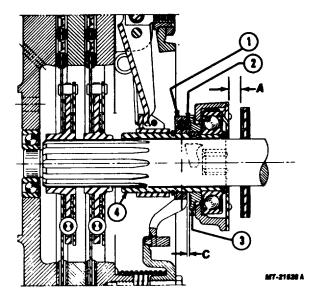


Fig. 7 Release Bearing Adjustment (Lipe LPA Clutch) (Self-Adjuster Type)

- 1. Pawl Carrier
- 2. Pawl (3)
- 3. Ratchet
- 4. Release Bearing Sleeve
- A. Specified Clearance
- C. Gap "C"

Self-Adjuster (LPA) Type

IMPORTANT

Incorrect release bearing clearance may indicate that self-adjuster mechanism is not functioning. Readjust clearance as outlined below and then recheck clearance after a period of service. If clearance is again out of specified limits, clutch should be removed for service of self-adjuster.

If release bearing clearance (Step 2) exceeds specified dimension, establish proper clearance by turning adjusting ratchet (Figure 7) counterclockwise (as viewed from rear of vehicle) using a soft drift and a small hammer.

CAUTION

Do not attempt to turn ratchet in a clockwise rotation without releasing ratchet pawls with a pawl block tool as instructed below.

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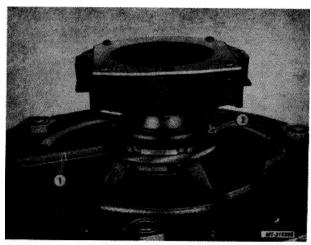


Fig. 8 Pawl Block Tool in Position. (Clutch Removed from Vehicle for Illustration)

1. Pawl Block Tool

2. Adjusting Ratchet

If release bearing clearance (Step 2) is less than specified dimension, establish proper clearance as follows:

- a. Insert pawl block tool SE-2745 (Figure 8) between paul carrier and ratchet (Gap "C", Figure 7). Rotate position of tool until all three (3), pawls are released.
- Using a soft drift and small hammer, turn adjusting ratchet clockwise (as viewed from rear of vehicle) until specified clearance is obtained.
- c. Remove pawl block tool.
- 4. Using 3.2 mm (1/8") rod as gauge, check clearance between release shaft fork and contact pads of release bearing housing (Figure 9).
- If necessary, disconnect slave cylinder yoke from clutch release shaft lever and adjust yoke (lengthen or shorten slave cylinder push rod) to obtain specified clearance between release shaft fork and

release bearing housing with yoke pin in place and slave cylinder piston "bottomed."

Install yoke pin and cotter pin and tighten yoke lock nut.

IMPORTANT

Make sure slave cylinder return spring is capable of fully retracting slave cylinder ("bottoming" piston) to assure that release shaft fork-torelease bearing housing clearance is obtained.

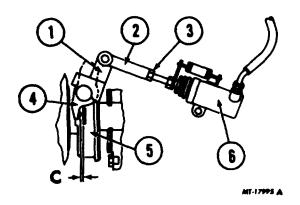


Fig. 9 Slave Cylinder Yoke Adjustment (Pull Type Clutch)

- 1. Release Lever
- 2. Yoke
- 3. Lock Nut
- 4. Fork

- 5. Release Bearing
- 6. Slave Cylinder
- C. Specified Clearance
- 7. Install clutch housing inspection cover.
- 8. Operate clutch pedal and check clutch release and clutch brake (where equipped) operation.

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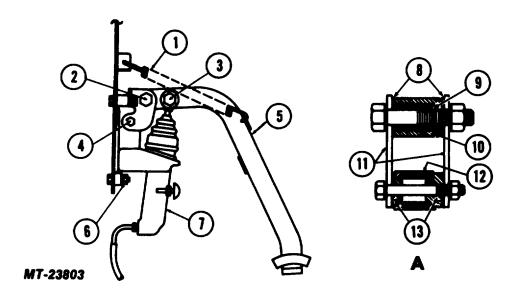


Fig. 10 Master Cylinder Mounting Details

- 1. Pedal Return Spring
- 2. Pedal Shaft Bolt
- 3. Shoulder Bolt
- 4. Shaft Bracket Mounting Bolt
- 5. Clutch Pedal
- 6. Cylinder Mounting Bolt (4)
- 7. Master Cylinder

- 8. Bushing (2)
 - 9. Shaft
- 10. Pedal
- 11. Brackets
- 12. Cylinder Body
- 13. Spacers
- A. Sectional View of Pedal Mounting

MASTER CYLINDER SERVICE

REMOVAL

- Disconnect clutch pedal return spring from clutch pedal.
- Disconnect hydraulic fluid pipe from master cylinder.
 - Place small drain pan beneath master cylinder to catch hydraulic fluid.
- 3. Remove the four master cylinder mounting bolts (Figure 10).
- Remove master cylinder (with clutch pedal) assembly from dash panel.

DISASSEMBLY

(Refer to Figure 10 for Steps 1, 2 and 3).

- 1. Remove clutch pedal-to-push rod shoulder bolt.
- Remove clutch pedal shaft bolt. Loosen pedal shaft bracket mounting bolt and remove clutch pedal, pedal shaft and bushings.

Remove pedal shaft bracket mounting bolt and remove pedal shaft brackets and spacers from master cylinder.

IMPORTANT Observe locations of thick and thin spacers to assure correct reassembly.

(Refer to Figure 11 for Steps 4 thru 7).

- Remove filler cap and gasket.
- 5. Remove push rod boot.
- Using snap ring pliers, remove retainer snap ring from cylinder bore.

IMPORTANT Do not damage cylinder bore when removing snap ring.

7. Remove push rod, piston (with secondary cup), primary cup, filler block and spring from master cylinder.

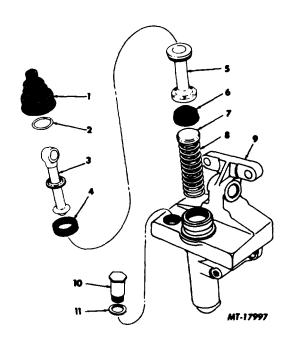


Fig. 11 Exploded View of Master Cylinder

- 1. Boot 7. Block, Cup Filler
- 2. Snap Ring 8. Spring
- 3. Push Rod4. Cup, Secondary9. Body10. Filler Cap
- 5. Piston 11. Gasket
- 6. Cup, Primary

CLEANING AND INSPECTION

- 1. Discard rubber parts (piston cups and boot). Replace with new parts at reassembly.
 - 2. Clean cylinder body and piston by immersing in a good grade of denatured alcohol or clean hydraulic brake fluid. Use soft bristle brush to remove foreign matter.

IMPORTANT

Cylinder and piston must not be cleaned in gasoline, kerosene or mineral oil solvents.

- 3. Blow out all passages with compressed air.
- Inspect piston and cylinder bore for corrosion and pitting. Bore should be clean and smooth. If damage is evident, replace parts.
- 5. Dry parts with compressed air and protect from contamination by dust and dirt.
- 6. Inspect clutch pedal shaft, pedal shaft bushings and pedal-to-push rod shoulder bolt and replace if worn or damaged.

REASSEMBLY

(Refer to Figures 11, 12 for Steps 1 thru 8).

- Lubricate secondary cup with clean brake fluid. Place cup in groove at push rod end of piston. Lip of cup must face opposite end of piston (Figure 12).
- 2. Assemble primary cup filler block to spring. Lubricate primary cup with clean brake fluid and place on filler block. Lip of cup must face toward spring (Figure 12).
- Lubricate cylinder bore with clean brake fluid. Install spring, filler block and primary cup into cylinder bore being careful not to damage primary cup.
- 4. Lubricate piston and secondary cup with clean brake fluid. Install piston (with secondary cup) into cylinder bore being careful not to damage secondary cup.
- 5. Install push rod and install snap ring in groove of cylinder bore.

IMPORTANT Do not damage cylinder bore when

installing snap ring.

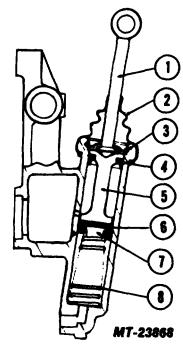


Fig. 12 Sectional View of Master Cylinder

- 1. Push Rod
- 2. Boot
- 3. Snap Ring
- 4. Cup, Secondary
- 5. Piston
- 6. Cup, Primary
- 7. Block, Filler
- 8. Spring

- 6. Install push rod boot.
- 7. Install pedal stop and lock nut, if removed at disassembly.
- Install filler cap and gasket. (Refer to Figure 10 for Steps 9 thru 13).
- Assemble pedal shaft brackets, spacers and shaft bracket mounting bolt to master cylinder body. Do not tighten bolt.
- Lubricate inside and outside diameters of pedal shaft bushings with a light coat of grease. Use IH 251H EP grease or an equivalent NLGI #2 multi-purpose lithium grease. Position bushings and shaft into bore of clutch pedal.
- 11. Position clutch pedal (with shaft and bushings) between pedal shaft brackets on master cylinder body and install pedal shaft bolt.
- 12. Lubricate contact surfaces of shoulder bolt with a light coat of grease (see Step 10). Install shoulder bolt.
- Tighten pedal shaft bracket mounting bolt, pedal shaft bolt and shoulder bolt to specified torque. (See BOLT TORQUE CHART)

INSTALLATION

- Position master cylinder (with clutch pedal) assembly on dash panel and install bolts and lock nuts. Tighten lock nuts to specified torque. (See BOLT TORQUE CHART)
- Connect clutch pedal return spring to clutch pedal. Make sure return spring fully retracts master cylinder.
- 3. Connect hydraulic fluid pipe to master cylinder.
- 4. Fill master cylinder and bleed hydraulic system. (See BLEEDING HYDRAULIC SYSTEM)
- 5. Check clutch control adjustments and readjust as needed. (See ADJUSTMENT)

SLAVE CYLINDER SERVICE

REMOVAL

- Disconnect slave cylinder return spring (where used).
- Disconnect slave cylinder yoke from clutch release shaft lever by removing cotter pin and

- yoke pin.
- 3. Disconnect hydraulic fluid pipe from slave cylinder.
- 4. Remove slave cylinder mounting bolts and spacers (where used).
- 5. Remove slave cylinder (with push rod and yoke) assembly from mounting bracket.

DISASSEMBLY

(Refer to Figure 13)

- 1. Remove boot and push rod (with yoke) from cylinder body.
- 2. Remove snap ring from groove in cylinder bore.

IMPORTANT

Do not damage cylinder bore when removing snap ring.

- 3. Remove piston (with cups) from cylinder bore.
- 4. Remove bleeder valve from cylinder body.

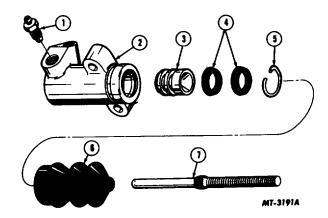


Fig. 13 Exploded View of Slave Cylinder

- 1. Bleeder Valve
- 2. Body
- 3. Piston
- 4. Piston Cups
- 5. Snap Ring
- 6. Boot
- 7. Push Rod

CLEANING AND INSPECTION

- Discard rubber parts (piston cups and boot).
 Replace with new parts at reassembly.
- Clean metal parts by immersing in a good grade of denatured alcohol or clean hydraulic brake fluid. Use soft bristle brush to remove foreign matter.

IMPORTANT

Cylinder and piston must not be cleaned in gasoline, kerosene or mineral oil solvents.

- 3. Inspect piston and cylinder bore for corrosion and pitting. Bore should be clean and smooth. If damage is evident, replace parts.
- 4. Dry parts with compressed air and protect from contamination by dust and dirt.

REASSEMBLY

- 1. Lubricate piston cups with clean brake fluid. Place cups in grooves of piston. Lips of cups must face opposite of push rod end of piston.
- 2. Lubricate cylinder bore with clean brake fluid. Install piston (with cups) into cylinder bore being careful not to damage cups.
- 3. Install snap ring in groove of cylinder bore.

IMPORTANT CAUTION

Do not damage cylinder bore when installing snap ring.

- 4. Install bleeder valve.
- 5. Install boot and push rod.

INSTALLATION

- Position slave cylinder and spacers (where used) on mounting bracket and install mounting bolts, nuts and lock washers, Tighten mounting bolts to specified torque. (See BOLT TORQUE CHART)
- Connect slave cylinder yoke to clutch release shaft lever. Adjust yoke to obtain specified release bearing-to-clutch finger clearance with slave cylinder piston completely "bottomed." (See ADJUSTMENT)
- 3. Connect slave cylinder return spring (where

- used). Make sure return spring fully retracts slave cylinder.
- 4. Connect hydraulic fluid pipe to slave cylinder.
- Fill master cylinder and bleed hydraulic system. (See BLEEDING HYDRAULIC SYSTEM)
- 6. Check clutch control adjustments and readjust as needed. (See ADJUSTMENT)

BLEEDING HYDRAULIC SYSTEM

The bleeding operation must be performed to purge air from the hydraulic system whenever cylinders have been serviced or fluid lines have been disconnected.

PRESSURE BLEEDING

Pressure bleeding is preferred. This can be accomplished by use of SE-1197 Pressure Brake Bleeder or equivalent.

- Fill and charge bleeder per manufacturer's instructions. Use "Super Heavy Duty" hydraulic brake fluid meeting or exceeding "DOT-3" specifications.
- 2. Clean area around master cylinder filler opening. Remove filler cap and gasket.
- 3. Using adapter fittings, connect bleeder to master cylinder filler opening. Open valve on bleeder to fill and pressurize hydraulic system.
- Attach bleeder tube (length of hose) to slave cylinder bleeder valve. Allow opposite end of bleeder tube to enter a clean container, such as a pint jar, one-third filled with clean hydraulic fluid.

NOTE

End of tube must be kept below surface of fluid in container.

- 5. Open slave cylinder bleeder valve and manually hold slave cylinder push rod in fully returned position (to assure that piston is "bottomed"). Observe flow of fluid from bleeder tube. When all air bubbles cease, close and tighten bleeder valve. Remove bleeder tube from bleeder valve.
- Disconnect bleeder from master cylinder. Add or remove fluid as needed to obtain specified level in master cylinder reservoir. (See MAINTENANCE)



MANUAL BLEEDING

Where pressure bleeding equipment is not available, hydraulic system can be bled manually as follows:

- 1. Fill master cylinder with fluid and install filler cap and gasket.
- Attach bleeder tube to slave cylinder bleeder valve. Place opposite end of tube in container one-third full of hydraulic fluid. (See Step 4 of PRESSURE BLEEDING)
- 3. Have an assistant operate clutch pedal to pressurize hydraulic system.
- 4. With assistant holding pressure with clutch pedal, open slave cylinder bleeder valve. Allow clutch pedal to travel its full stroke. Close bleeder valve. Do not allow clutch pedal to return before closing bleeder valve.
- 5. Repeat Steps 3 and 4 until solid fluid (without air bubbles) flows from bleeder tube. Tighten bleeder valve and remove bleeder tube.

CAUTION

Keep master cylinder reservoir filled with fluid. Rebleeding will be necessary if reservoir is emptied during bleeding operation.

 After bleeding is completed, refill master cylinder to specified level. (See MAINTENANCE)

CLUTCH PEDAL SHAFT BUSHING REPLACEMENT

The following procedure can be used to replace the clutch pedal shaft bushings, if needed, without disturbing the hydraulic system.

(Refer to Figure 10).

- Disconnect clutch pedal return spring from clutch pedal.
- 2. Remove clutch pedal-to-push rod shoulder bolt.
- 3. Remove clutch pedal shaft bolt. Loosen pedal shaft bracket mounting bolt and remove clutch pedal, pedal shaft and bushings.
- 4. Discard old bushings. Inspect pedal shaft and shoulder bolt and replace if worn or damaged.
- Lubricate inside and outside diameters of new bushings with a light coat of grease. Use IH 251H EP grease or an equivalent NLGI #2 multi-purpose lithium grease. Position bushings and shaft into bore of clutch pedal.
- Position clutch pedal (with shaft and bushings) between pedal shaft brackets and install pedal shaft bolt.
- 7. Lubricate contact surfaces of shoulder bolt with a light coat of grease (see Step 5). Install shoulder bolt.
- 8. Tighten pedal shaft bracket mounting bolt, pedal shaft bolt and shoulder bolt to specified torque. (See BOLT TORQUE CHART)
- 9. Connect clutch pedal return spring to clutch pedal.
- Check clutch control adjustments and readjust as needed. (See ADJUSTMENT)

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TROUBLE SHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE
Clutch will not release:	Low hydraulic fluid.
Cidion will not release.	Air in hydraulic system.
	3. Improper adjustments.
	 Master cylinder and/or slave cylinder piston cups worn or damaged.
	5. Driven disc hub binding on main drive gear splines.
	6. Faulty clutch assembly.
Clutch dragging:	See causes for "Clutch will not release:"
	Dirt or foreign material in clutch.
	Oil or grease on driven disc linings.
	4. Misalignment.
	Driven disc hub binding on main drive gear splines.
	Broken driven disc linings.
	Warped or damaged driven disc, pressure plate or flywheel.
Clutch slipping:	Improper adjustments.
	2. Weak or improperly installed master cylinder and/or slave cylinder return
	spring.
	3. Oil or grease on driven disc linings.
	4. Worn driven disc linings.
	5. Weak or broken clutch pressure plate springs.
'Grabby" clutch:	Oil or grease on driven disc linings.
	Incorrect type of lining material.
	3. Clutch assembly loose or out of parallel with flywheel face.
	4. Bent main drive gear shaft.
	5. Loose engine mounting bolts.
	Loss of tension in driven disc cushioning springs (where used).
Noisy clutch:	Insufficient pedal free travel.
	2. Improper adjustments.
	Worn or damaged release bearing.
	4. Clutch assembly loose on flywheel.
	5. Faulty clutch assembly.
	Bent main drive gear shaft.
Premature clutch wear:	Abusive driving habits.
	Improper adjustments.
	Incorrect type or improperly installed driven disc facings.
	Weak or broken clutch pressure plate springs.
	5. Warped clutch pressure plate.

BOLT TORQUE CHART

Location	Bolt Size	Specified Torque Newton-meters	Ft. Lbs.
Pedal Shaft Bolt	1/2-13	68-81	50-60
Pedal Shaft Bracket Mounting Bolt	5/16-18	17-20	13-15
Clutch Pedal-to-Push Rod Shoulder Bolt	7/16-14	41-47	30-35
Master Cylinder Mounting Stud Nuts	5/16-18	17-20	13-15
Slave Cylinder Mounting Bolts	3/8-16	28-36	21-27
Slave Cylinder Push Rod Yoke Lock Nut(s)	3/8-24	28-36	21-27

SPECIFICATIONS

PEDAL STOP SETTING	RELEASE BEARING CLEARANCE
104 mm (4.1 inches)	3.2 mm (1/8 inch) (Between release bearing and clutch fingers)
104 mm (4.1 inches)	Clutch Internal Adjustment:
	With Clutch Brake 13 mm (1/2")* between release bearing housing and clutch brake disc. Without Clutch Brake 19 + 3 mm (3/4 + 1/8") between release bearing housing and transmission front bearing cap. External (Slave Cylinder Yoke) Adjustment 3.2 mm (1/8 inch)**
	104 mm (4.1 inches)

^{* 11-14} mm (7/16-9/16 inch) permissible on self-adjuster type.
** Between release shaft yoke (fork) and release bearing housing.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR. General, United States Army Chief of Staff

Official:

R. L. DILWORTH

Brigadier General, United States Army The Adjutant General

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PREVIOUS EDITIONS ARE OBSOLETE. P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

The Metric System and Equivalents

Linear Measure

- 1 centimeter = 10 millimeters = .39 inch
- 1 decimeter = 10 centimeters = 3.94 inches
- 1 meter = 10 decimeters = 39.37 inches
- 1 dekameter = 10 meters = 32.8 feet
- 1 hectometer = 10 dekameters = 328.08 feet
- 1 kilometer = 10 hectometers = 3,280.8 feet

Weights

- 1 centigram = 10 milligrams = .15 grain
- 1 decigram = 10 centigrams = 1.54 grains
- 1 gram = 10 decigram = .035 ounce
- 1 decagram = 10 grams = .35 ounce
- 1 hectogram = 10 decagrams = 3.52 ounces
- 1 kilogram = 10 hectograms = 2.2 pounds
- 1 quintal = 100 kilograms = 220.46 pounds
- 1 metric ton = 10 quintals = 1.1 short tons

- Liquid Measure
- 1 centiliter = 10 milliters = .34 fl. ounce
- 1 deciliter = 10 centiliters = 3.38 fl. ounces
- 1 liter = 10 deciliters = 33.81 fl. ounces
- 1 dekaliter = 10 liters = 2.64 gallons
- 1 hectoliter = 10 dekaliters = 26.42 gallons
- 1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

- 1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
- 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
- 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
- 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
- 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

- 1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
- 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
- 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	То	Multiply by	To change	То	Multiply by
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit	5/9 (after	Celsius	°С
	temperature	subtracting 32)	temperature	

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