TECHNICAL MANUAL

UNIT, INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT MAINTENANCE MANUAL

DRILLING SYSTEM, WELL, ROTARY, TRUCK MOUNTED, AIR TRANSPORTABLE, 600 FEET CAPACITY MODEL LP-12 NSN 3820-01-246-4276

This technical manual is an authentication of the manufacturer's commercial literature and does not conform with the format and content requirements normally associated with Army technical manuals. This technical manual does, however, contain all essential information required to operate and maintain the equipment.

HEADQUARTERS, DEPARTMENTOF THE ARMY
8 MAY 1989

CHANGE
No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C.4 October 1989

UNIT, INTERMEDIATE DIRECT SUPPORT AND
INTERMEDIATE GENERAL SUPPORT MAINTENANCE MANUAL

DRILLING SYSTEM, WELL, ROTARY
TRUCK MOUNTED, AIR TRANSPORTABLE,
600 FEET CAPACITY
MODEL LP-165F299
NSN 3820-01-246-4276

Approved for public release; distribution is unlimited.

TM 5-3820-256-24-4, 8 May 1989 is changed as follows.

1. Title is changed as shown above.

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General. United States Army
Chief of Staff

Official:
WILLIAM J. MEEHAN, II
Brigadier General United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-25A, Unit, Direct Support and General Support Maintenance requirements for Drilling Machine, Well, Combination Rotary/Percussion, Semitrailer Mounted Diesel, 1500 Ft. Model CF-15-S

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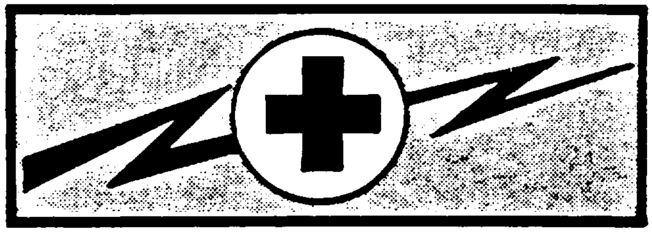
WARNING



MI 131637

ELECTRIC POWER LINES CAN KILL

Never raise mast or crane, or operate drill unit with less than 25 feet working clearance to any electrical power line.

Do not touch live electrical parts.

Check for buried utility lines before drilling.

WARNING

Crane and drilling operations have inherent hazards that cannot be mechanically safe guarded. Operator and maintenance personnel are required to wear hard hats and safety shoes.

Compressed air used for cleaning can create airborne particles that may enter the eyes. Pressure will not exceed 30 psig. Eye protection required.

Never operate engine in enclosed areas. Exhaust gases, particularly carbon monoxide, may build up. These gases are harmful and potentially lethal.

Cleaning solvent (PD-680, Type II) is toxic to skin, eyes and respiratory tract. Skin and eye protection required. Avoid repeated or prolonged contact. Good general ventilation is normally adequate.

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag and airborne particles. Protection equipment consisting of welding goggles with proper tinted lenses, apron or jacket, and welder's boots required. Good general ventilation is normally adequate.

Exercise care when using sharp or pointed tools to prevent injury to personnel.

Personnel will be trained in safe climbing practices. Climbing devices will be used on mast at all times. Safety climbing devices will be inspected prior to each use to insure good working order. For Artificial Respiration, refer to FM 21-11.

WARNING

NOISE HAZARD

exist for all personnel within 15 Feet of an operating drilling unit. Personnel must wear approved ear protection equipment. Failure to do so may result in impairment or loss of hearing.

INTRODUCTION

1. SCOPE

This manual covers the 600 Feet Capacity Well Drilling System, Model LP-12, NSN 3820-01-246-4276.This manual consists of six volumes.

2. DRILLING SYSTEM

The Drilling System consists of three main components; a well drilling machine; a support vehicle (rig tender); and a well completion kit.Government furnished (GFE) incorporated as part of the system include a trailer mounted power unit and 3,000 gallon, collapsible, fabric water tank.

3. DRILLING MACHINE - VOLUME 1

The drilling machine is a truck mounted rotary well drilling machine consisting of a 32 foot mast, three drum drawworks assembly, rotary table, mud pump and air compressor. The components of the drilling machine are powered by the truck engine.

4. SUPPORT VEHICLE - VOLUME 2

The support vehicle is a truck mounted vehicle consisting of a 1,000 gallon water tank, hydraulically driven water pump, an electric fuel pump and fuel dispensing nozzle, a welder-generator assembly, and an electro-hydraulic crane. The support vehicle also provides a storage area for transport of drill pipe, collars, hand tools, operating and accessory equipment for the drilling machine, and the well completion equipment.

5. TRUCKS - VOLUMES 3, 4 and 5

The drilling machine and support vehicle are mounted on truck chassis of the same model. The drilling machine truck has a special design low profile cab. The truck is a diesel engine powered, 6x6 vehicle with a transfer case to transfer engine power to truck mounted components.

6. WELL COMPLETION - VOLUME 6

The well completion kit consists of equipment necessary for completion of a 600-ft. water well.

7. OPERATION INSTRUCTIONS

Refer to TM5-3820-256-10 for Operation, Preventive Maintenance and Lubrication of the Well Drilling System.

8. REPAIR PARTS

For repair parts refer to TM5-3820-256-24P, Repair Parts and Special Tools List.

9. APPENDIXES - VOLUME 6

Maintenance Allocation Chart is contained in Appendix A; Torque Requirements are contained in Appendix B.

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GENERAL INFORMATION

CONTENTS

GENERAL

LINE SETTING TICKET

Each vehicle is provided with a Line Setting Ticket or code sheet which lists identification code numbers of component units used to build the vehicle.

One copy of the line setting ticket is included in the literature provided with the vehicle. When replacement parts are required, take this copy with you to positively identify vehicle components to be sure of getting the correct parts.

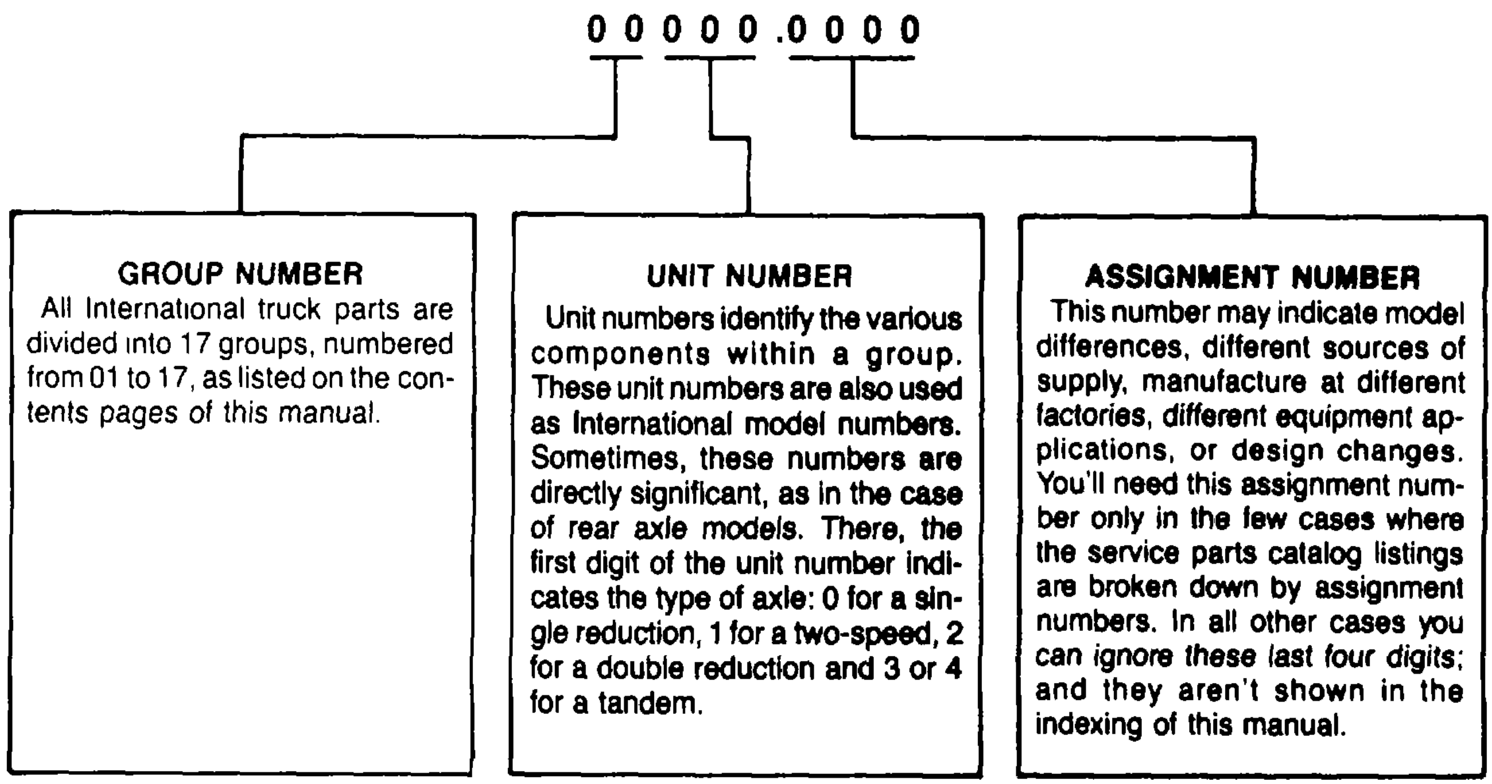
BE SURE TO RETURN LINE SETTING TICKET TO VEHICLE AFTER OBTAINING PARTS.

A second copy of the Line Setting Ticket is permanently attached to the vehicle. (Location will vary with vehicle model.) **THIS TICKET MUST NOT BE REMOVED.**

COMPONENTS CODES

Codes are the basics for identifying the components used on an International Truck. They are used by sales personnel ordering the truck by manufacturing to build that order and by parts personnel to service the truck. Many of the index items in this manual are identified by codes or International models so it is important to understand them.

The code structure is as follows:

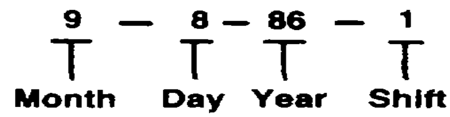


CHASSIS BUILD DATE

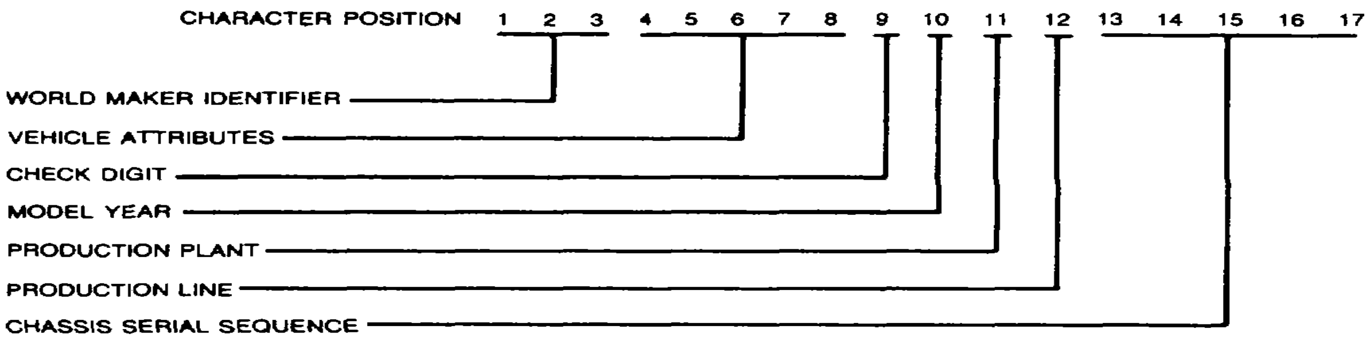
Since 1974 the Chassis Build Date has been stamped on the capacity plate for each truck in the section called Date Mfg. This information is used to identify parts difference due to design change. The Chassis Build Date is sometimes required since trucks are not always built in Chassis Number sequence.

Chassis Build Date is also stamped on all Line Setting Ticket copies, except the reduced size version attached to the cab.

The number as stamped on the capacity plate is structured as follows:



VEHICLE IDENTIFICATION NUMBER (VIN) STRUCTURE — 1986



POSITIONS 1-3 WMI

1HT = U.S. PRODUCED TRUCK
1HV = U.S. PRODUCED BUS
1HS = U.S. PRODUCED TRACTOR
2HT = CANADA PROD. TRUCK
2HV = CANADA PROD. BUS
2HS = CANADA PROD. TRACTOR

POSITIONS 4-7 VEHICLE ATTRIBUTES

SEE PAGE 7 FOR THESE IDENTIFICATION ATTRIBUTES

POSITION 8 ATTRIBUTES

VEHICLES BUILT BEFORE AUG. 22, 1983

ENGINE & BRAKE SYSTEM IF TRUCK OR BUS

0 = GAS ENGINE & AIR BRAKES IN ATTRIBUTE CODES AG190 & DG210
0 = HEAVY DUTY DIESEL & AIR BRAKES IN ATTRIBUTE CODES CG250 & CG260
2 = GAS ENGINE & AIR BRAKES
3 = SMALL DIESEL & AIR BRAKES
5 = MID-RANGE DIESEL & AIR BRAKES
7 = HEAVY DUTY DIESEL & AIR BRAKES
B = GAS ENGINE & HYD. BRAKES
C = SMALL DIESEL & HYD BRAKES
E = MID-RANGE DIESEL & HYD. BRAKES
G = HEAVY DUTY DIESEL & HYD. BRAKES

POSITION 8 ATTRIBUTES (Cont'd.)

VEHICLES BUILT AUG 22, 1983 AND LATER

GVW RANGE & BRAKE SYSTEM

GVW RANGE	BRAKE SYSTEM AIR	BRAKE SYSTEM HYD
0 TO 6000	A	B
6001 TO 10000	C	D
10001 TO 14000	E	F
14001 TO 16000	G	H
16001 TO 19500	J	K
19501 TO 26000	L	M
26001 TO 33000	N	P
33001 TO 55000	R	S
55001 TO 110000	T	U

POSITION 9 CHECK DIGIT

CALCULATED FROM OTHER 16 POSITIONS (PER FMVSS115)

POSITION 10 MODEL YEAR

F = 1985
G = 1986
H = 1987

POSITION 11 PRODUCTION PLANT

C = CHATHAM, ONTARIO
H = SPRINGFIELD, OHIO
Y = FLORENCE, KENTUCKY

POSITION 12 PRODUCTION LINE

A OR B (THIS PLANT)

POSITION 13-17 CHASSIS SERIAL SEQUENCE

(THIS MODEL YEAR, THIS PLANT, THIS LINE)

ATT = Attributes

ATTRIBUTES FOR POSITIONS 4-5 OF VIN STRUCTURE

S-SERIES 1600-1900		
ATT	MODEL NAME	MODEL DESCRIPTION
Straight Truck 97.5" BBC		
LA	1654	4x2 Cab Dsl 68" ABC
LC	1754	4x2 Cab Dsl 68" ABC
LD	1954	4x2 Cab Dsl 68" ABC
LF	1854 4x4	4x4 Cab Dsl 68" ABC
LG	G-1904	Glider Chassis
LH	G-1954	Glider Chassis
Straight Truck 100.5" BBC		
LK	F-1954 6x4	6x4 Cab Dsl 68" ABC
LL	F-1954 6x6	6x6 Cab Dsl 68" ABC
FBC Bus		
LN	1753	4x2 FBC Dsl
LP	1853	4x2 FBC Dsl
Fwd Cntl Chassis		
JA	1853FC	4x2 Fwd Cntl — SB Axle-Dsl
Tractor 97.5" BBC		
LR	1955	4x2 Cab Dsl 68" ABC

S-SERIES RHD		
ATT	MODEL NAME	MODEL DESCRIPTION
Straight Truck 97.5" BBC		
LY	1754 RHD	4x2 Cab 68" ABC Dsl Rhd
Straight Truck 100.5" BBC		
LZ	F-1954 6x4 RHD	6x4 Cab 68" ABC Dsl Rhd

S-SERIES 2100-2600		
ATT	MODEL NAME	MODEL DESCRIPTION
Tractor 91.3" BBC		
LT	2155	4x2 Cab Dsl 83" ABC
Tractor 92" BBC		
ZA	2275	4x2 Cab Dh Dsl 63" ABC
ZB	F-2275 6x4	6x4 Cab Hd Dsl 63" ABC
ZC	G-2275	Glider Chassis
ZD	2375	4x2 Cab Hd Dsl 63" ABC
ZE	F-2375 6x4	6x4 Cab Hd Dsl 63" ABC
JZ	G-2375	Glider Chassis
Car Hauler 92" BBC		
ZF	2276	4x2 Cab Hd Dsl 63" ABC
ZG	F-2276 6x4	6x4 Cab Hd Dsl 63" ABC
Tractor 112" BBC		
ZH	2575	4x2 Cab Hd Dsl 78" ABC
ZJ	F-2575 6x4	6x4 Cab Hd Dsl 78" ABC
ZK	G-2575	Glider Chassis
Severe Service 112" BBC		
ZL	2554	4x2 Cab Dsl 78" ABC
ZM	2574	4x2 Cab Dhd Sl 78" ABC
ZN	F-2554 6x4	6x4 Cab Dsl 78" ABC
ZP	F-2574 6x4	6x4 Cab Hd Dsl 78" ABC
ZR	G-2504	Glider Chassis
ZS	2654	4x2 Cab Dsl 64" ABC
ZT	2674	4x2 Cab Hd Dsl 64" ABC
ZU	F-2654 6x4	6x4 Cab Dsl 64" ABC
ZV	F-2674 6x4	6x4 Cab Hd Dsl 64" ABC
ZW	G-2604	Glider Chassis

ENGINE CODE ATTRIBUTES — POSITIONS 6-7 OF VIN STRUCTURE

ATT	CODE	ATT	CODE	ATT	CODE	ATT	CODE	ATT	CODE	ATT	CODE
DG	12093	GE	12178	HS	12218	KH	12268	TG	12470	VT	12538
DH	12094	GF	12179	HT	12219	KL	12271	TV	12482	VV	12540
DK	12096	GG	12180	HU	12220	KZ	12283	TW	12483	VW	12541
DT	12103	GP	12187	HW	12222	K2	12284	TY	12485	VY	12543
DU	12104	GS	12189	HX	12223	K3	12285	T3	12488	VZ	12544
DV	12105	GH	12181	HY	12224	K4	12286	T4	12489	V2	12545
DW	12106	GJ	12182	JM	12243	K6	12288	T5	12490	V4	12547
D4	12112	GK	12183	JN	12244	LB	12291	T6	12491	WE	12555
D5	12113	GL	12184	JS	12247	LT	12306	UB	12494	WG	12557
EC	12118	GR	12188	JU	12249	LW	12309	UC	12495	WK	12560
ED	12119	GT	12190	JV	12250	LY	12311	UD	12496	WM	12562
EH	12123	GU	12191	JW	12251	L2	12313	UG	12499	WN	12563
EJ	12124	GV	12192	JX	12252	L5	12316	UL	12503	WP	12564
EY	12137	GX	12194	JY	12253	L6	12317	UP	12506	WR	12565
EZ	12138	GZ	12196	J3	12256	L7	12318	UR	12507	WX	12571
FH	12152	G2	12197	J4	12257	MA	12319	UX	12513	W3	12575
FR	12159	HB	12204	J5	12258	RC	12408	UY	12514	W4	12576
FU	12162	HD	12206	J6	12259	RN	12418	U2	12516	W6	12578
FZ	12167	HE	12207	J7	12260	RP	12419	U5	12519	XA	12580
GB	12175	HG	12209	KA	12261	R2	12429	U7	12521	XF	12585
GC	12176	HP	12216	KB	12262	SH	12442	VA	12522		
GD	12177	HR	12217	KC	12263	S3	12459	VG	12528		

WORK SAFELY - FOLLOW THESE RULES

Proper service techniques and repair procedures are necessary for reliable and safe operation of all vehicles as well as the safety of the personnel performing the work. This service manual provides normal and effective methods for accomplishing repair and service work. With the many variations In procedures and techniques, and the skill level of the Individual doing the work, the service manual cannot anticipate all variations and furnish cautions and directions.

The following list contains some general precautions the technician should follow when servicing the vehicle, to avoid the possibility of personal injury or property damage:

1. Always use safety stands In conjunction with hydraulic jacks or hoists. Do not rely on the Jack or hoist to carry the load as they could fall.

2. Always wear safety glasses when using a hammer, chisel or other tools that may cause chips to fly.

3. Keep work area organized and clean. Wipe up oil or spills of any kind. Keep tools and parts off the floor. Eliminate situations which could result in slip-and-fall personal injury accidents.

4. Use a safety catch on all hoist hooks to reduce the possibility that a load could slip off the hook.

5. When using an acetylene torch, always wear welding goggles and gloves. Keep a properly charged fire extinguisher within easy reach. Be sure the acetylene and oxygen tanks are separated by a metal shield and are chained to the cart. Do not weld or heat areas near fuel tanks or fuel lines and utilize proper shielding around hydraulic tanks or hydraulic lines.

6. Always use a cab prop bar and/or other means to hold a tilt cab In the raised position. Never rely on the vehicle hydraulic system to hold the cab in a raised position. If the cab were to come down, It could cause serious or fatal Injuries.

7. When re-assembling subassemblies, parts, hoses, hydraulic lines, fuel lines, wiring, etc., be sure they are positioned properly for alignment and clearance with related parts to their original setting and/or position.

8. Electrical storage batteries give off highly flammable hydrogen gas when charging and continue to do so for some time after receiving a steady charge. Do not under any circumstances allow an electric spark or an open flame near the battery. Do not lay any tools across battery terminals as this may result In a spark or short circuit which may cause an explosion. Be careful to avoid spilling any electrolyte on hands or clothing. Use protective clothing and goggles when working on or filling batteries with acid.

9. Be sure the Ignition switch is always in the OFF position, unless otherwise required by the procedure. Disconnect the battery ground cable when servicing the electrical system to avoid electrical burns and damage to the vehicle.

10. Always set the parking brake when working on a vehicle. Leave the transmission gear selector in NEUTRAL with the parking brake applied (engine ON or OFF) unless Instructed otherwise for a specific operation. Place wood blocks (4"x4" or larger) against the front and rear surfaces of the tires to provide additional restraint from inadvertent vehicle movement.

11. Hydraulic fluid escaping under pressure can have enough force to penetrate the skin. Hydraulic fluid may also infect a minor cut or opening In the skin. If injured by escaping fluids, see a doctor at once. Serious infection or reaction can result If medical treatment is not given immediately.

12. Do not attempt to repair or tighten hydraulic hoses that are under pressure or when the engine is running. Cycle all hydraulic control valves to relieve all pressure before disconnecting lines or performing other work on hydraulic systems. Make sure all connections are tight and hoses and lines are in good condition before applying pressure to the system. To locate a leak under pressure, use a small piece of cardboard or wood. Never use hands.

13. When refueling, keep the hose and nozzle in contact with the metal of the fuel tank to avoid the possibility of an electric spark Igniting the fuel. Do not overfill the fuel tank - overflow creates fire hazard. Do not smoke when refueling. Never refuel when the engine Is running.

14. Always use a protective cage when inflating tires. Do not exceed recommended tire pressures. On tubeless tires, do not Inflate over 30 psi to seat the tire bead. Always check tire and rim diameter to be sure they are Identical. Never attempt to mount a tire on a rim where the tire and rim are of different sizes.

15. Use pullers to remove bearings, bushings, gears, cylinder sleeves, etc. when applicable. Use hammers, punches and chisels only when absolutely necessary. Then, be sure to wear safety glasses.

16. Never use trouble lights or electric powered tools that have cut and/or damaged cords or plugs. Be sure all electric tools are properly grounded.

17. Be careful when using compressed air to dry parts. Use approved air blow guns, do not exceed 30 psi, wear safety glasses or goggles and use proper shielding to protect everyone In the work area.

18. Do not wear rings, wrist watches or loose fitting clothing when working on vehicles. They could catch on moving parts causing serious Injury.

19. Excessive or repeated skin contact with sealants or solvents may cause skin Irritation. In case of skin contact, remove sealant or solvent promptly by washing with soap and water.

20. Never operate engine in closed areas. Exhaust gases, particularly carbon monoxide, may build up. These gases are harmful and potentially lethal.

21. On vehicles equipped with a locking differential, never run the engine with the transmission in gear and a driven wheel still on the ground. The wheel still on the ground could cause the vehicle to move.

22. Keep hands clear of all moving parts.

IMPORTANT

The above is only a partial list of safe work rules. Common sense and good judgment are always necessary to avoid personal injury accidents.

STANDARD TORQUE DATA FOR NUTS AND BOLTS
IMPORTANT

Your vehicle may utilize parts which are metric dimensions along with the conventional English system.

In some Instances, fasteners In metric are almost Identical in dimension to the English Inch system; therefore, any new part must be of the same measurement and strength as that replaced. Numbers on the heads of metric bolts and on surfaces of metric nuts Indicate their strength. English bolts use radial lines for this Identification, while most English nuts do not have strength markings.

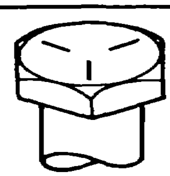
Mismatched or Incorrect fasteners can result In vehicle damage, malfunction or possibly personal Injury. Whenever possible, fasteners removed from a specific location should be re-used In that same location. If this Is not possible, new fasteners selected must match those replaced.

The torque values listed herein are to be used as a general guide only. Refer to the appropriate Service Manual section for the proper torque values. For torque values not listed in the Service Manual, the torque values below are applicable.

Recommended torque for all Standard Application Nuts and Bolts, provided:

A. Use only for through bolt and nut applications.
B. Bolts and nuts must be same SAE grade.
C. Applies only to phosphate and oil finish and plain steel bolts and nuts (see note).
D. All thread surfaces are clean and lubricated with SAE-30 engine oil only.
E. Joints are rigid, that is, no gaskets or compressible materials are used.
F. Washers, if used, must be hardened.

NOTE: Does not apply to cadmium plated or zinc coated bolts and nuts.



SAE Grade 5 bolts are identified by 3 radial lines.

SAE Grade 8 bolts are identified by 6 radial lines.

Size (in.)	Grade 5		Grade 8		Flange Head	
	Ft. Lb.	N•m	Ft. Lb.	N•m	Ft. Lb.	N•m
1/4	90-110*	10-12	115-140*	13-16	—	—
5/16	155-190*	18-22	215-265*	24-30	—	—
3/8	21-27	29-37	30-38	41-52	—	—
7/16	34-42	46-57	50-60	68-81	—	—
1/2	50-60	68-81	70-85	95-115	100-120	136-163
9/16	75-90	102-122	105-125	142-170	130-160	176-217
5/8	105-125	142-169	145-175	197-237	200-240	271-325
3/4	175-215	237-291	250-300	339-407	300-370	407-502
7/8	290-350	393-474	400-500	543-678	—	—
1	425-525	576-711	625-750	847-1017	—	—

FRAME

CONTENTS

FRAME

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

GENERAL

Since the frame is depended upon to keep the major components of a vehicle in their relative positions, it is highly important that the frame be kept in good condition at all times.

ALIGNMENT
METHOD OF CHECKING

A satisfactory method of checking the frame and axle alignment, particularly when a body and cab is on a chassis, is to mark on a level floor all points at which measurements are to be taken. Tack or tape pieces of paper to the floor directly under each point of measurement on the chassis as indicated by the letter "K" in Figs. 1 and 2. Use a plumb bob since the points of measurement must be accurately marked in relation to the frame in order to obtain a satisfactory alignment check.

After each measurement point has been carefully marked on the floor, proceed as follows:

1. Locate center line of chassis by measuring front and rear end widths, using marks on floor. If frame widths check, draw center line on floor, full length of chassis. If frame widths do not check, lay out center line as follows:

2. Center line can be drawn through the inter-section of any one pair of equal diagonals (A-A, B-B, C-C, D-D) and center point of one end of frame or through points of intersection of any two pairs of equal diagonals.

3. Measure distance from center line to opposite points marked over entire length of frame. Measurements should not vary more than 1/8" at any point.

4. Measure diagonals (A-A, B-B, C-C, D-D) will indicate point where misalignment occurs. If diagonals in each pair check within 1/8", that part of frame included between points of measurement may be considered in satisfactory align-ment. These diagonals should intersect within 1/8" of center line.

AXLE ALIGNMENT WITH FRAME

After determining that the frame is properly aligned, the axle alignment with the frame should be checked by comparing diagonals.

Dimensions for side elevation of frame should be checked at the points indicated and should not vary more than 1/8".

REPAIR AND REINFORCEMENTS
NON HEAT TREATED FRAMES

Cutting

Whenever it is necessary to cut the frame, the side rail should be cut at an angle of 45 degrees. This method distributes the cut and weld over a greater area than a cut made at right angles with the rail.

Reinforcing

Reinforcements can be made with flat, channel or angle stock. Because of difficulties encountered when inserting channel reinforcements into frame side rails, the use of angle reinforcements is acceptable. Whenever possible, the reinforcement should extend from the front axle to slightly beyond the rear spring front mounting bracket as shown in Fig. 3. This procedure, of course, may be impractical because of the position of attached units and existing crossmembers. The reinforcement thickness should not exceed that of the side rail to be reinforced.

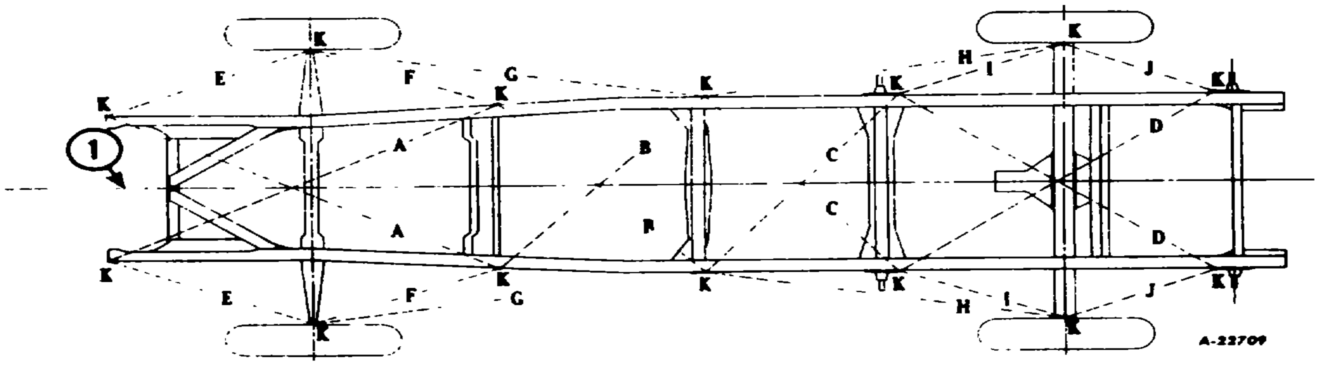


Fig. 1

1. Center Line of Chassis

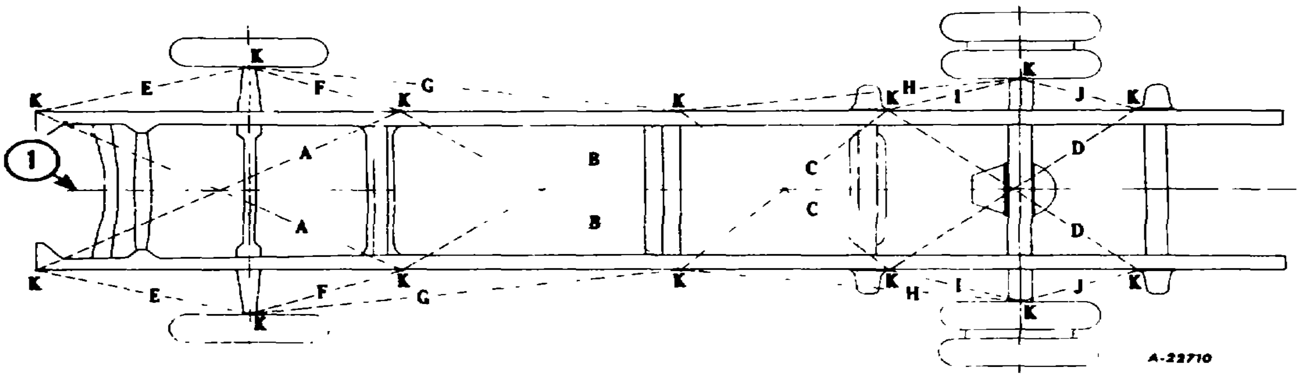


Fig. 2

1. Center Line of Chassis

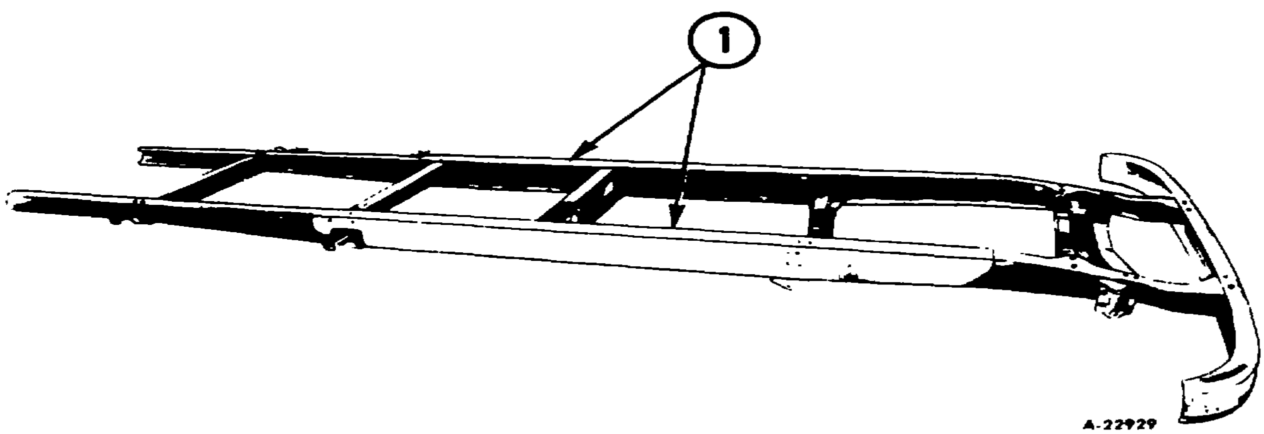


Fig. 3

1. Inverted "L" Type Frame Reinforcement

Riveting

Hot rivets are acceptable, as they can be more easily driven with hand tools. Cold rivets should only be used where tools of sufficient power to properly set the rivets are provided.

Rivets should be from 50% to 100% as heavy in diameter as the total thickness of the plates to be riveted.

Welding

Electric arc-welding is recommended for all frame welding.

The reinforcements should be welded to the frame after the reinforcements are riveted. All unused holes should be filled with welding material. The welding rod should be substantially the same material as that used in the frame.

Preparation Of Frame For Repair

Before welding the reinforcement to the cracked section of the frame side rail, certain preparations are necessary to insure strength and stableness of repair. To prevent further spreading of the crack, a hole should be drilled at the starting point of the crack, Fig. 4. Widen the crack its full length, using two hacksaw blades together. Groove or bevel both sides of the crack to permit the weld to penetrate to the surface and establish a solid contact between the reinforcement and the frame side rail. Grooving can be accomplished by grinding or with a cape chisel.

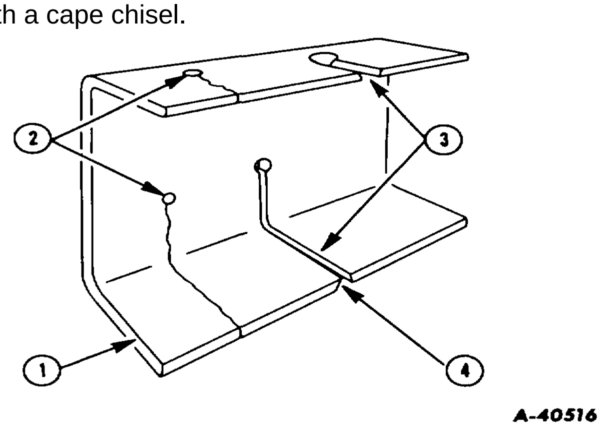


Fig. 4 Showing Method of Drilling Frame Rail to Stop Progress of crack

1. Frame Rail
2. Drill Hole
3. Widen Crack
4. Bevel Edges

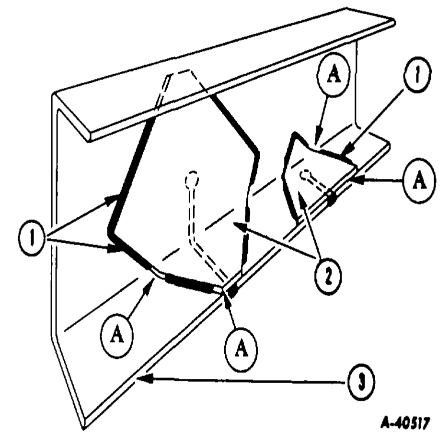


Fig. 5 Suggested Types of Reinforcement Plates and Method of Attaching to Frame Roll

1. Weld
2. Reinforcement Plate
3. Frame Rail

> IMPORTANT
>
> Do not weld into the corners of the frame or along the edges of the frame side rail flanges "A", Fig. 5. Welding at these points tends to weaken the frame and encourage development of new cracks.

Use only the shielded-arc method for all frame welding. Heat generated during welding is localized and burning of material is minimized whenever this method is used, (Fig. 6). Additional advantages are that the finished weld can be ground, filed, and drilled as necessary.

With the reinforcement positioned in the frame side rail, follow the welding patterns shown in Fig. 5 as closely as possible.

> IMPORTANT
>
> In addition to the specific recommendations given in these paragraphs, always remember the following general rules of welding "good housekeeping".

1. Surface areas and edges to be joined must be clean and free from oil or grease.

2. Always avoid craters, notching, and undercutting.

3. Peen new welds to relieve stresses caused by shrinkage.

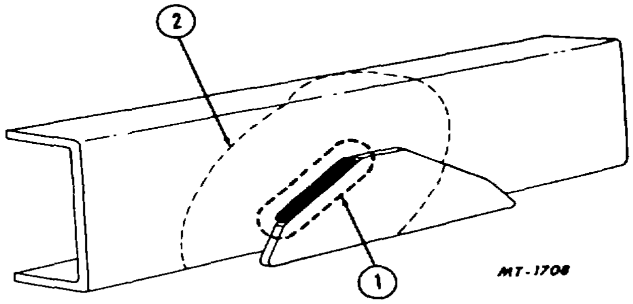


Fig. 6 Weld Sample Showing Lower Heat Dissipation Possible With Shielded Arc-Welding

1. Limited Heat Dissipation From Arc-Weld (Preferred)

2. Wide Heat Dissipation From Gas Weld Positioning of Frame Reinforcements

Positioning of Frame Reinforcements

Whenever practical, the welding of frame reinforcements should be confined to the web of the side rail rather than the flanges. This procedure provides the strongest possible assembly.

Avoid at all times welds made square with the side rail, either on webs or flanges. When welds are made at an angle of at least 30 degrees from square, there is less possibility of setting up dangerous stress concentrations in the rail. Physical tests of the strength of various welds have shown that a weld made at an angle of at least 30 degrees from the direction of strain will retain the original physical properties of the complete rail section.

Frame Straightening

Use of heat is not recommended when straightening frames. Heat weakens the structural characteristics of frame members and all straightening should be done cold. Frame members (except aluminum) which are bent or buckled sufficiently to show cracks or weak-ness after straightening, should be replaced or reinforced.

BOLT SPECIFICATIONS AND TORQUES

While most IH frames are of riveted construction, there are some frames which are assembled with bolts and nuts. Bolting, though more costly does provide a time saving advantage when replacing crossmembers or frame attaching parts.

IMPORTANT

If bolting is used for altering or adding to the frame, the following must be observed.

Bolts to be used for installing fifth wheels must be 5/8" diameter high strength material such as I.H. type 8 (SAE grade 8) bolts. Type 8 bolts can be identified by the six radial lines on the head of the bolt. Nuts must be of corresponding type.

The torque value for tightening these bolts is 200-240 ft. lbs. (271-325 N-m) and is based on new bolts and nuts lubricated with engine oil. If frame components are aluminum, flat washers must be used next to the aluminum whether under head, nut or both.

Proper tightening of bolts and nuts is most important, since the strength of the joint depends on the maximum clamping force between the members.

FRONT AXLE

CONTENTS

02

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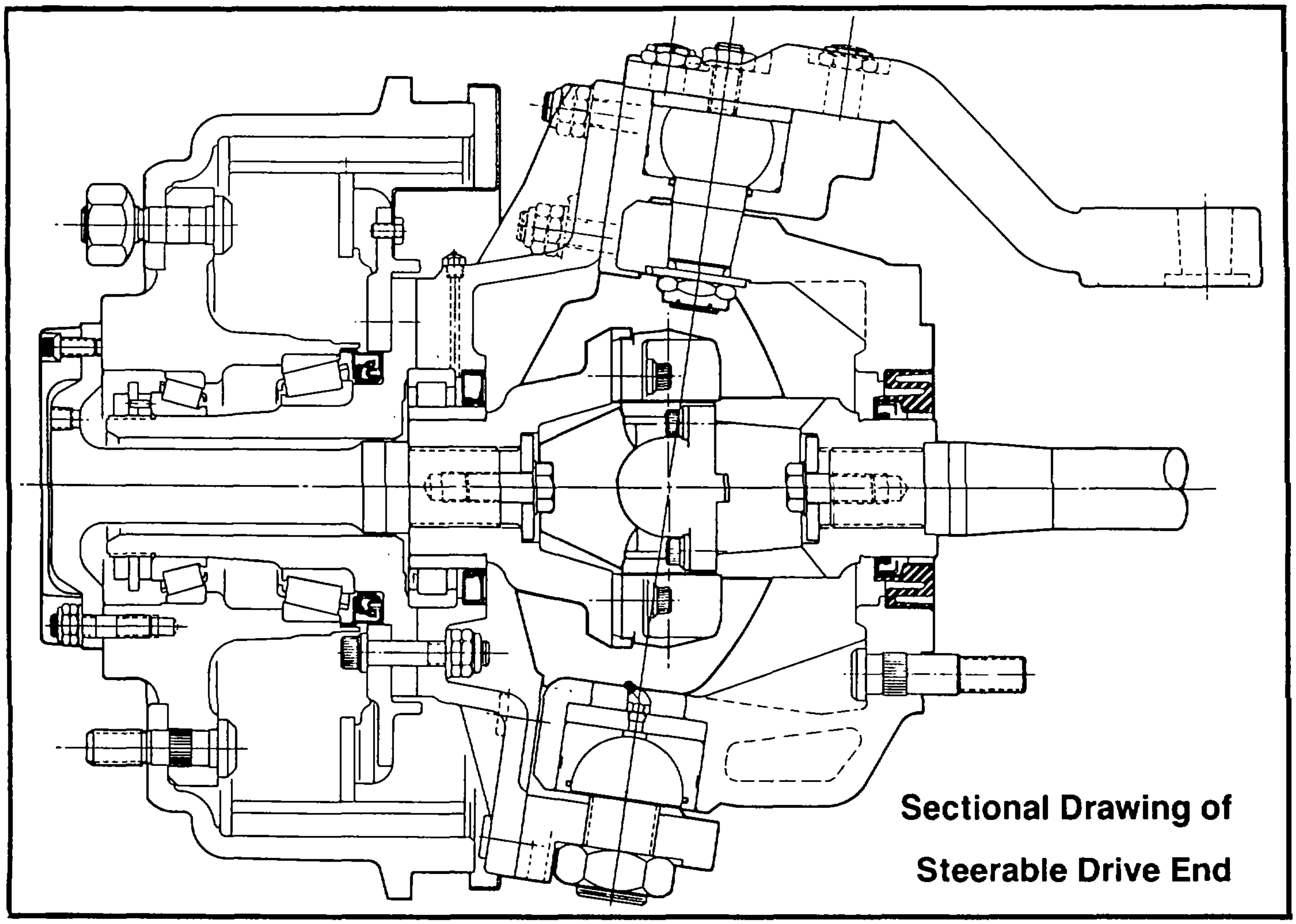
I. DESCRIPTION & OPERATION



A. General Description

The Fabco Steerable Drive Axle consists of four major assemblies. The axle housing is the structural backbone. Steerable drive ends are attached to each end of the housing. A differential carrier assembly bolts into the center of the housing. A steering connecting tie rod joins between the right and left steerable drive ends. A steering arm is provided (usually on the left steerable drive end) for connection into a vehicle's steering system. It may be equipped with right hand or dual steering arms.

B. Operation

Driving forces are put into the axle at the pinion yoke on the differential carrier; they pass through the differential to the inner axle shafts and the inner drive yoke of the universal joint; they then pass into the outer drive yoke and the outer axle shaft which connects to the wheel hub and rotates the wheel.

When steered, the outer section of each steerable drive end turns about the kingpin centerline. The universal joint, centered on the kingpin centerline, allows driving forces to turn with the steered wheel ends.

The axle is equipped with air or hydraulic brakes. The brake shoes expand to contact conventional brake drums.

C. Operating Instructions

In conditions where the vehicle rear wheels might spin, such as sand, loose dirt, mud, snow, ice or ascending grades, the front drive axle can be shifted into operation for improved traction. Engagement can be made at any vehicle speed, unless the rear wheels are spinning. Engagement is best accomplished while the engine is pulling lightly.

Recommended Lubricants

LUBRICANT	ABOVE 320	BELOW 32°
Gear Oil	MIL-L-2105 B	MIL-L-2105 B
	SAE 140	SAE 90
	MIL-L-2105 C	MIL-L-2105 C
	80W-140	80W-90
Chassis Grease	MIL-G-10294	MIL-G-10294
Wheel Bearing Grease	NLGI Grade #2	NLGI Grade #2
Wheel Bearing Oil	Use same as recommended for differential	

A. Wheel Bearings

Wheel bearings require cleaning, inspection, packing with grease or an oil change at each brake re-line. Wheel bearings should be lubricated in accordance with the vehicle manufacturers recommendations. They may either be grease packed or oil lubricated. A 1/4" pipe plug (see fig. 2) is located under the hub cap in the outer axle shaft flange. Oil filled wheel hubs should be filled to the level of this plug when it is in a position on the axle horizontal centerline. Grease packed bearings require that the section of the wheel hub between the bearing cups be filled to the level of the inner diameter of the bearing cups.

The outer axle shaft inner bearing should also be packed with grease, if the hubs are not lubricated with oil. With the outer shaft out for access to the wheel bearings, disconnect the joint from the inner and outer drive yokes, and push the outer drive yoke from the bearing and seal. The bearing rollers are now accessible and may be packed by hand. Do not use anything to apply grease that would cut the seal. If oil lubricated, the bearing will receive its supply from the wheel bearing reservoir, and repacking is not required. See Section IV-B and Section VI-D, H and I for disassembly and reassembly of hubs and outer axle shaft.

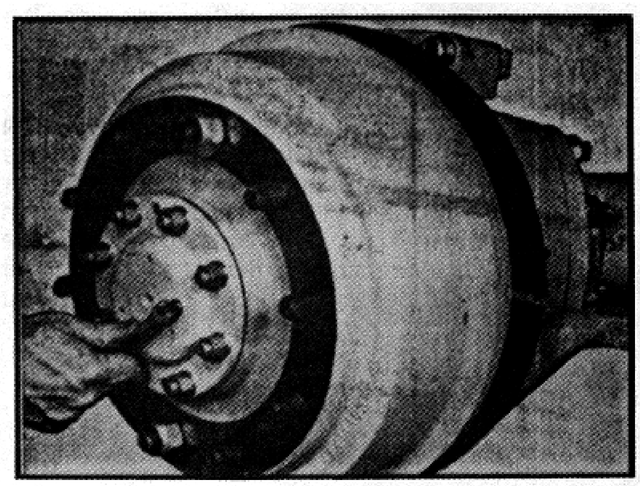


Fig. 2

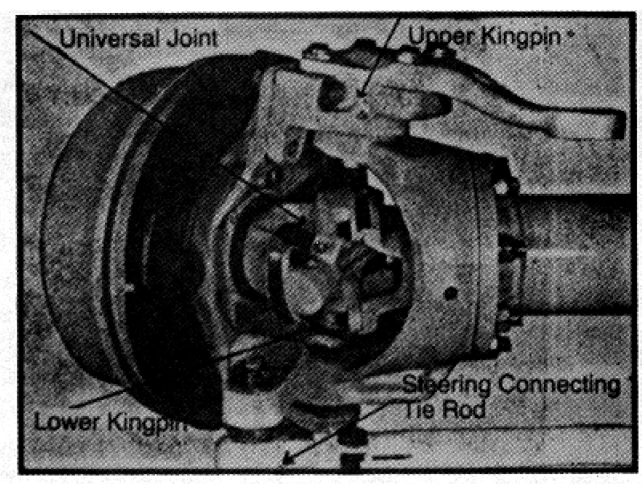


Fig. 3

B. Universal Joints

Universal joints should be lubricated at each chassis lubrication (approximately 1,000 mile intervals). Vehicles operated with the joints submerged must be lubricated at more frequent intervals. Apply until seepage is detected around each of the rubber cap seals. If all seals do not release lubricant, move the cross laterally in all four directions, then pull down on the bearing cap opposite the side that did not release. Apply lubricant until a flow appears.

C. Kingpin Bearings

Kingpin bearings should be lubricated at each chassis lubrication (approximately 1,000 mile intervals). To ensure thorough lubrication, the front axle should be raised slightly to relieve weight. The lower kingpin lube fitting is located in the lower kingpin bearing plate and is accessible in the top surface of the lower arm of the suspension yoke (See fig. 3). The upper kingpin fitting is either on the front or rear of the upper kingpin bracket (See fig. 3).

D. Differential Carrier

Differential carrier should have the lubricant changed at the same intervals as the rear axle on the vehicle or at 10,000 mile intervals. Drain while lubricant is warm. Clean the magnetic drain plug when it is removed. Remove the fill plug to ensure quicker drainage. Allow housing to drain completely. Install the drain plug and fill the housing with the appropriate gear oil to the bottom of the fill plug hole. Check for leaks. SAE 140 gear oil (meeting Mil-L-2105B) is appropriate for most operating conditions. Follow the vehicle manufacturers recommendations for the rear axle and apply them to the front axle under other conditions.

E. Steering Tie Rod Ball Joints

Steering tie rod ball joints should be lubricated every 1,000 miles with chassis lubricant (See fig. 3). Check the steering system at each lubrication. Inspect for loose, bent or otherwise damaged components. Careful attention to such details is a vital safety factor.

III. AXLE ADJUSTMENT

A. General

Adjustments may be necessary after an accident, in response to and to correct steering problems, tire wear problems or as a part of the reassembly process after a thorough inspection.

B. Wheel Bearing Adjustment

1. Raise the front of the vehicle with a jack and secure vehicle with jackstands of suitable capacity.

2. Remove front wheels from vehicle.

3. Remove the brake drum. (Disc style wheels only.)

4. With the end turned to full steering lock remove the bolt and washer retaining the outer drive yoke. (See fig. 14).
5. Remove the nuts from the outer axle shaft drive studs.
6. The flange should be loose enough to remove by hand. If not, use suitable bolts in the extractor holes to remove the outer axle shaft. (See fig. 15)

Note: If oil is used for wheel bearing lubrication, care should be exercised to protect brake linings, etc.

7. Remove the wheel bearing lock nut (See fig. 4) and lockwasher from spindle. Loosen wheel bearing adjustment nut.

8. Tighten wheel bearing adjusting nut while turning the hub, back off 1/2 turn and then tighten to 50 ft. lbs. torque. (See fig. 4) Back off 1/4 turn. Install the wheel bearing lockwasher with tang in the spindle keyway and one side or the other toward the bearing locknut in such a way as to fit over the dowel.

   Install the outer locknut and torque to specification. With the locknut properly tightened, end play should be between .001 and .010 and the wheel hub should rotate freely.

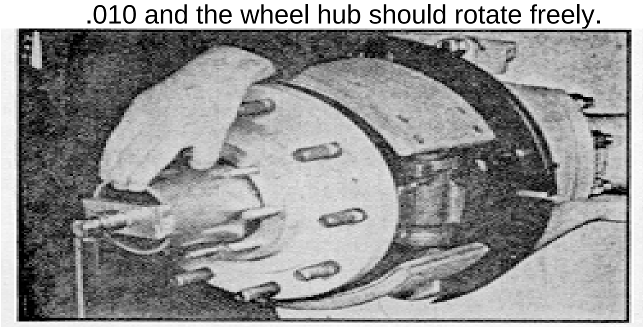


Fig. 4

9. Apply a bead of liquid sealant to outer axle shaft flange. See Service Bulletin 738 407, Page 22.

10. Insert the outer axle shaft into the spindle bore, rotate and align the shaft splines with the outer drive yoke splines, rotate the shaft and yoke to align the shaft flange with the drive studs.

    Back up drive yoke with suitable weight. Tap axle shaft flange end to drive the shaft into the drive yoke. Assemble the drive yoke retaining washer with a new sealing washer, and the bolt to the end of the axle shaft. See fig. 39, page 19. Tighten to specified torque.
11. Push axially on the outer drive yoke and check for positive clearance under the axle shaft for flange. The clearance should be at least .015inch. (See fig. 40, page 19).

12. Install axle shaft drive stud nuts. Tighten to Specified torque.

13. If wheel bearings are oil lubricated, refer to Section II, A to refill.

C. Kingpin Adjustment

1. The front of the vehicle should be raised and properly supported. Front wheels should be off the axle.
2. The lower kingpin jam nut should be loose or loosened and the lower kingpin ball stud backed down all the way.

3. Raise the wheel hub, spindle yoke and kingpin bracket assemblies with a hydraulic jack located under the drum. On units with an upper kingpin adjusting screw projecting through the upper kingpin cap or steering arm, adjust the screw to raise the aforementioned parts. Raise unit until the upward movement is resisted by the bottom of the upper kingpin bearing coming into contact with the lower spherical surface of the upper kingpin ball stud.

4. Put a stack of feeler gauges between the lower kingpin bracket and the suspension yoke. The feeler gauges should fill the gap snugly.

5. Turn the lower kingpin ball stud upward until the stack of feeler gauges loosen (See fig. 5).

6. Back off the lower kingpin ball stud one quarter turn (900).
7. Tighten the jam nut to the correct torque while restraining the lower kingpin ball stud from turning. On units with an upper kingpin adjusting screw, back off the screw 1/4 turn. Restrain screw while tightening locknut.

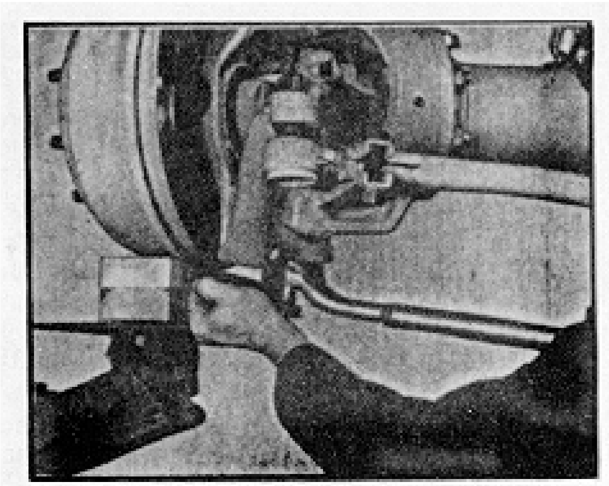


Fig. 5

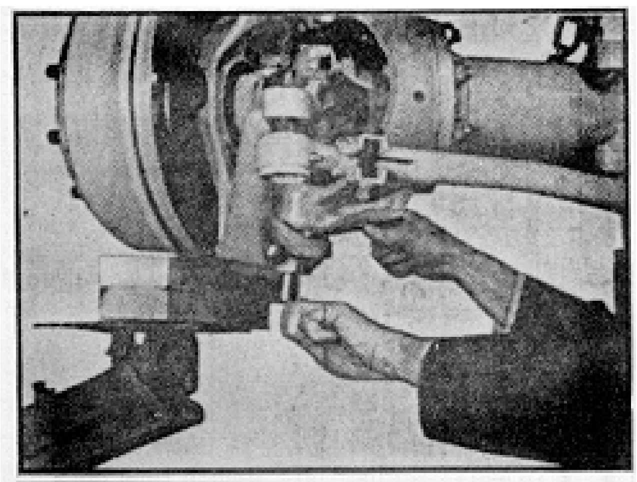


Fig. 6

8. Remove the jack or hoist supporting the brake drum. Using a pry bar under the upper kingpin bracket, 1/32 to 3/32 play may be observed on a new assembly. After loading, up to 1/8 play is acceptable. More than this requires inspection for wear or distortion.

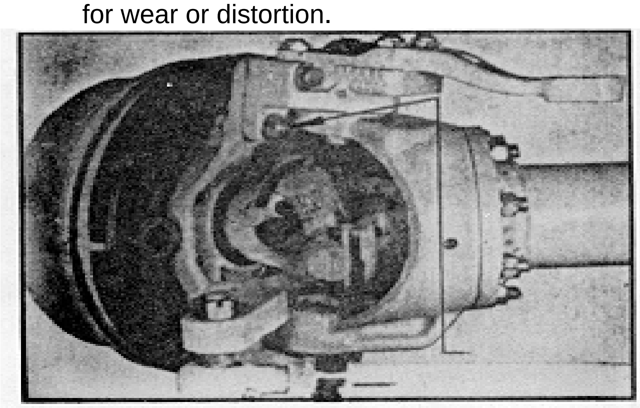


Fig. 7

9. The kingpins should be readjusted after any loosening or removal and reassembly of the upper or lower kingpin brackets, replacement of kingpin bushings, etc.

D. Steering Stop Adjustment

1. Adjust the tie rod. See section III-G.

2. Steering stop adjustment is made at the factory, needs no further action unless a major part such as the suspension yoke, spindle yoke, kingpin bracket or the like has been replaced.

3. The steering stop is the lower rear, upper kingpin bracket mounting bolt (See fig. 7). Adjustment is made by the installation of a number of washers under this bolt's head (See fig. 8). The purpose of the stop is to protect the universal joint and the brake chamber from hitting another part in a full turn of the steering.

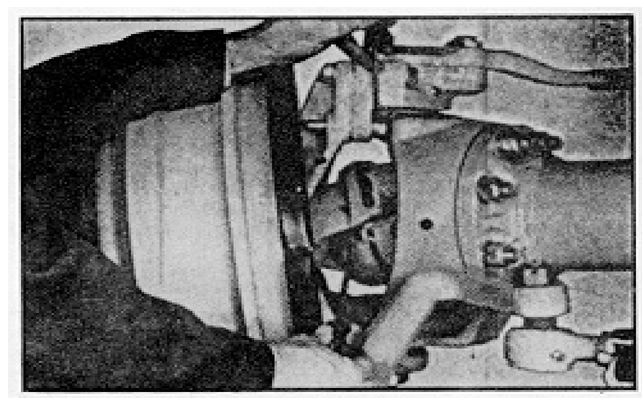


Fig. 8

4. Turn the steering to put the axle first in the full left turn condition. (See fig. 9). The head of the stop bolt should stop the turn before any of the rotating parts in the left hand steerable drive end interferes with another part. The brake chamber on the right end should not hit the suspension yoke. Turn the steering to the right and check the corresponding conditions (See figs. 8 and 10).

NOTE: POWER STEERING STOPS IN THE VEHICLE STEERING GEAR SHOULD NOT ALLOW THE APPLICATION OF POWER TO THE STEERING WHEN THE STEERABLE DRIVE END IS IN THE FULL TURN CONDITION.

III. AXLE ADJUSTMENT

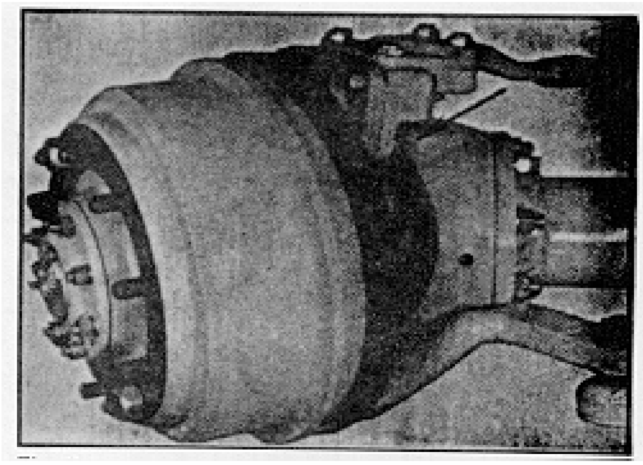


Fig. 9

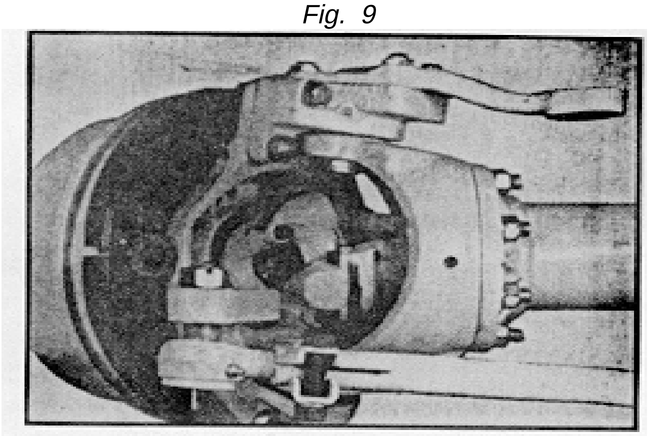


Fig. 10

E. Camber Adjustment

1. Refer to this section, part B, steps 1 and 2.

2. Adjustment is made by the addition or subtraction of shims.

3. Loosen the four bolts at the upper kingpin bracket, loosening the bracket from the spindle yoke. Remove only the top two bolts.
4. Remove or install shims as necessary to achieve the desired camber. (See figs. 11 and 12.)

5. Typical setting is I/2° positive, accomplished by factory installation of a shim between the upper kingpin bracket and the spindle yoke. Consult a tire specialist for specific recommendations.

6. Re-install bolts and tighten to the specific torque. (See fig. 13.)

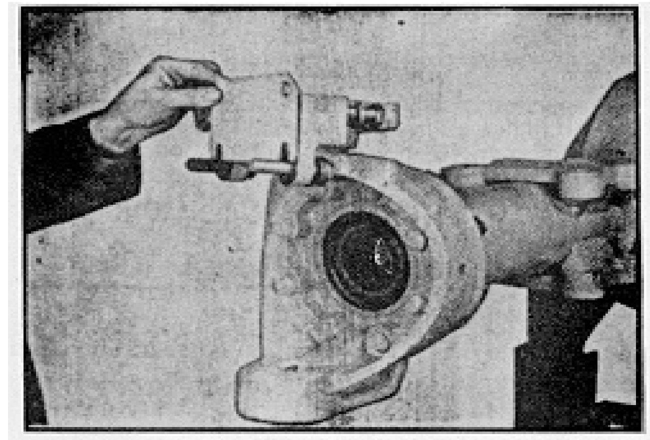


Fig. 11

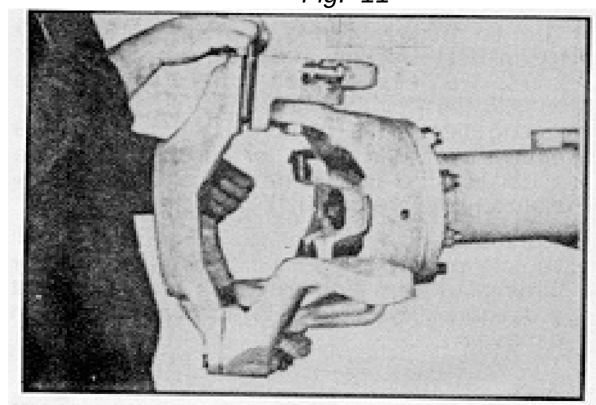


Fig. 12

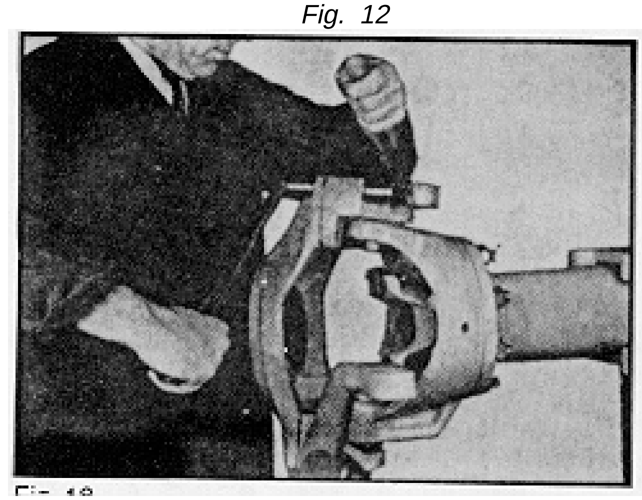


Fig. 13

7. Readjust the kingpin, referring to this section, Part C.

F. Adjustment Caster is set by the vehicle manufacturer and can be adjusted only by shims between the axle spring seat and the spring. Changing the caster will change the pinion angle and may affect the operation of the front drive shaft.

G. Toe-In Adjustment

1. Jack up the front of the vehicle.
2. Rotate tire and scribe a line completely around tire with a crayon held to center of tire.
3. jack.
4. tie rod clamp bolts.
5. distance between scribed lines on front and back of tires.
6. Turn tie rod tube with a pipe wrench to adjust toe-in. Set tie rod length until front measurement. is 0 to 1/8" less than rear measurement.If the.) vehicle has a full-time front drive system (proportioning differential), alignment should be 0-1/8 more in front than in rear, for toe-out. Consult tire specialist for a specific recommendation if specialized tires are used.
7. Tighten tie rod clamp bolts to correct torque. Roll vehicle forward at least a distance equal to four turns of wheels and re-check toe-in. Repeat procedure if necessary to achieve final toe-in dimension.

H.Adjustment

Brake adjustment is made automatically. Make the initial adjustment by driving the air braked vehicle 015" and .030". (Refer to the brake service manual for forward and applying the brakes. Continue additional information

IV. STEERABLE DRIVE END DISASSEMBLY

A. General Precautions for Disassembly

IMPORTANT: READ THIS SECTION BEFORE STARTING THE DISASSEMBLY PR OCEDURES

1. Follow each procedure closely in each section, making use of both text and pictures.

2. The outside of the unit should be carefully cleaned before starting the disassembly. If steam cleaning, ensure that breather and air fittings are covered to prevent water from entering assembly.

3. Cleanliness - Provide a clean place to work. It is important that no dirt or foreign material enters the unit during repairs.

4. Refer to the Exploded Views located in the parts section as a guide to disassembly.

5. Assemblies - When disassembling the various assemblies, lay all parts on a clean bench in the same sequence as removed. This procedure will simplify reassembly and reduce the possibility of losing parts.

6. Bearings - Carefully wash and relubricate all bearings as removed and protectively wrap until ready for use. Remove bearings with pullers designed for this purpose, or in manner which will not damage those bearings that will be reused.

7. When necessary to apply a force to remove a part, use of a puller or press would be preferred. However, sometimes it may be necessary to use a soft hammer or bar.

B. Hub, Drum and Wheel Bearing Disassembly

1. Raise the front of the vehicle with a jack and secure vehicle with jackstands of suitable capacity.
2. Remove front wheels from vehicle.

3. Remove the brake drum. (Disc wheel style hubs only).

4. With the end turned to full steering lock remove the bolt and washer retaining the outer drive yoke. (See fig. 14).

5. Remove the nuts from the outer axle shaft drive studs.

6. The flange should be loose enough to remove by hand. If not, use suitable bolts in the extractor holes to remove the outer axle shaft. (See fig. 15).

   Note: If oil is used for wheel bearing lubrication, care should be exercised to protect brake linings, etc.

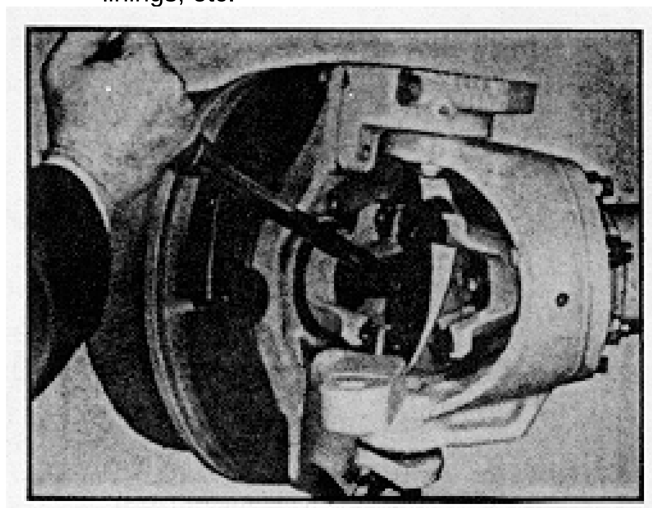


Fig. 14

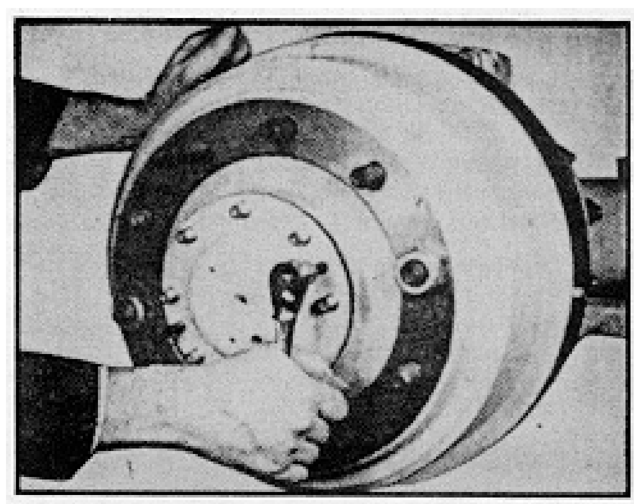


Fig. 15

7. Remove the wheel bearing lock nut (See fig. 16) and lockwasher from spindle. Loosen wheel bearing adjusting nut.
8. Rock hub lightly to loosen the outer wheel bearing cone. Remove the cone and protect it from dirt. If wheel bearings are oil lubricated, some oil may fall on the brake shoe when the hub is removed in the next step, unless suitable protection is used.

9. Lift the hub (or hub and drum assembly) off the spindle (See fig. 17) using care to avoid damage to the bearing surfaces and to the threads. Wipe off any oil that may have reached the brake shoe before it reaches the lining.
10. Do not remove the axle shaft studs unless replacing them.
11. Remove the hub seal from the hub and discard.
12. Remove the inner wheel bearing cone and protect it from dirt.
13. Cover the spindle with a clean shop rag to protect it from damage.
14. Press wheel bearing cups from hub, if replacement is necessary.

THIS IS THE LIMIT OF WHAT MAY BE CALLED ROUTINE DISASSEMBLY. IT ALLOWS ACCESS TO THE BRAKES FOR RELINING AND TO THE WHEEL BEARINGS FOR REPACKING. DISASSEMBLY BEYOND THIS POINT MIGHT BE REQUIRED TO REPLACE DAMAGED OR BROKEN PARTS.

C. Brake and Wheel Spindle Disassembly

1. 12-point capscrews retain the brake assembly and the spindle to the spindle yoke (See fig. 1 8). Make provisions for supporting the brake assembly in a place that will protect the brake hose or disconnect the brake hose. Remove the brake assembly after removing the capscrews.
2. Hold the spindle (See fig. 19), tap it with a soft hammer and it should separate from the spindle yoke.
3. Remove outer drive yoke from spindle yoke.

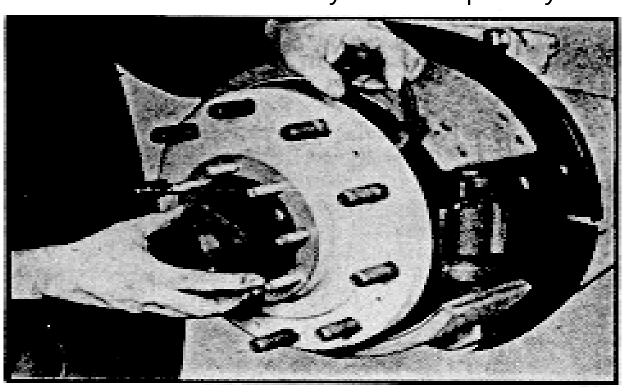


Fig. 16

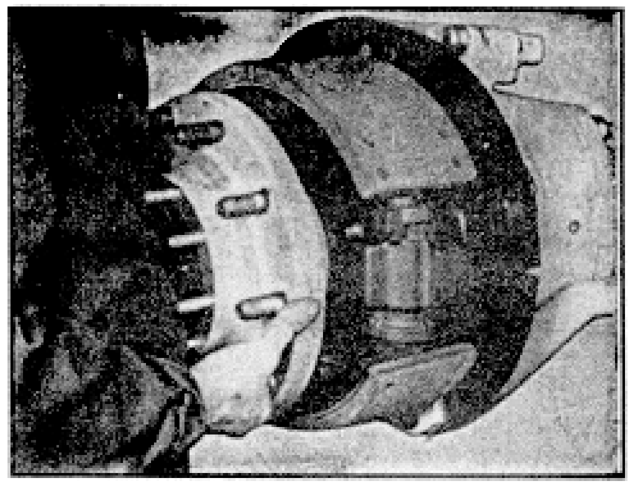


Fig. 17

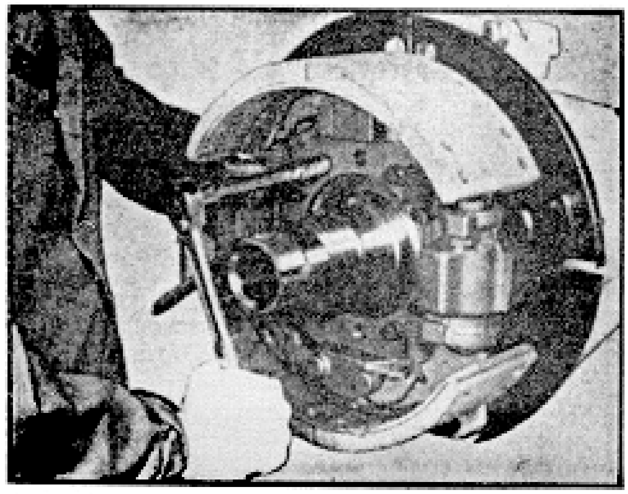


Fig. 18

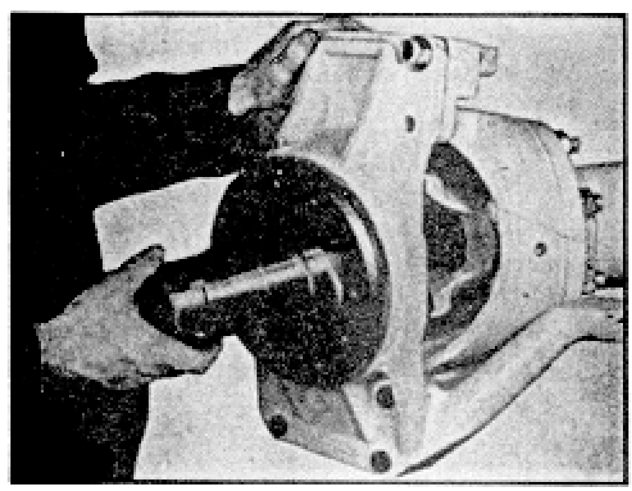


Fig. 19

D. Spindle Yoke Removal

1. Perform steps B and C, page 9 and page 10.

2. Disconnect the steering rod by removing the cotter pin, castle nut and then while prying between the tie rod end and the tie rod arm, sharply strike the side of the tie rod arm radially to the tie rod end tapered stud. Disconnect the brake hose.

3. Remove four capscrews (See fig. 20)that retain the universal joint cross and bearing to the outer drive yoke.

4. Support the spindle yoke while removing the four capscrews at the upper kingpin bracket. (See fig. 13.)

5. Lower the spindle yoke and at the same time rotate the top outward. (See fig. 21.) This should allow the lower kingpin ball to come out of its socket in the suspension yoke. The spindle yoke can then be moved away from the axle.

E. Removal of the Outboard Section of the Steerable Drive End

NOTE: After following this procedure, the outboard section of the end may be disassembled on the bench by following IV.B, C and D.

1. Perform Items 1 and 2 of Step B, Page 9.

2. Rotate the brake drum to position the outer drive yoke horizontally.

3.Unbolt the universal joint cross and bearing from the outer drive yoke. (See fig. 20.) 4. Attach the outboard section of the steerable drive end to a transmission jack that is equipped to handle the assembly. (See figs. 22 and 23.)

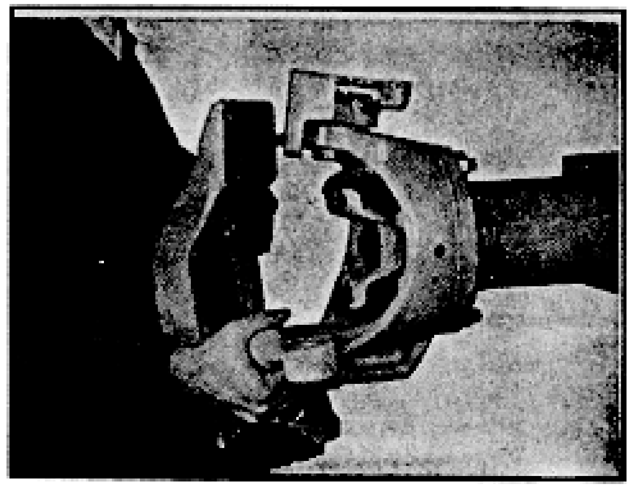


Fig. 21

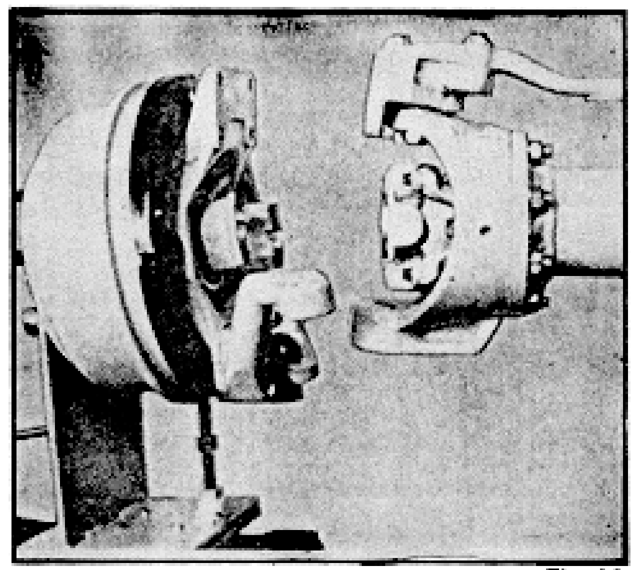


Fig. 22

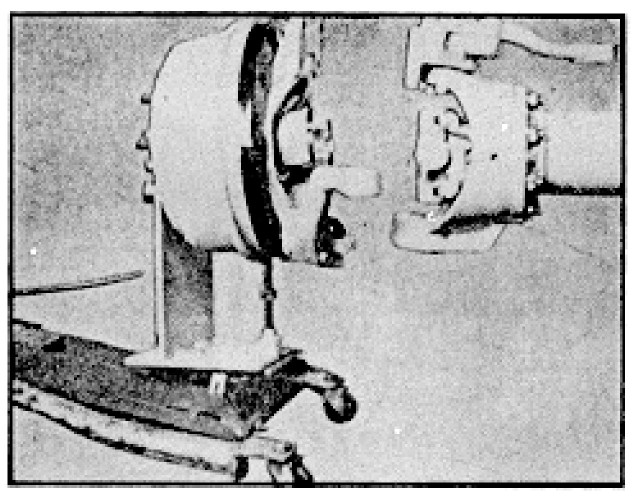


Fig. 23

5. Disconnect the steering tie rod by removing the cotter pin, castle nut and then, while prying between the tie rod end and the tie rod arm, sharply strike the side of the tie rod arm radially to the tie rod end tapered stud.

6. Disconnect the brake hose.

7. Remove the four bolts that hold the upper kingpin bracket to the spindle yoke.

8. Lower the transmission jack about two inches and roll the outer section of the steerable drive end away from the axle.

F. Inner Axle Shaft Removal

1. Perform only step E above and then pull the axle shaft and universal joint from the axle housing. (See fig. 24.)

2. Or after steps B, C, and D, pull the axle shaft and universal joint from the axle.

G. Lower Kingpin Bracket and Kingpin Removal

1. The lower kingpin ball stud and the lower kingpin bearing are exposed for inspection after steps B, C, and D or after step E alone. (See fig. 25.) Back off lower kingpin lock nut. Remove four nuts and washers retaining the lower kingpin bracket and tie rod arm to the spindle yoke. The bracket may now be removed.

2. A tool for rotating and holding the lower kingpin ball stud may be made by welding a nut onto a capscrew the head of which fits the socket in the end of the lower kingpin ball stud. A standard socket or wrench can then be used on the nut to turn the capscrew and kingpin stud. An allen wrench may be used.

3. Screw the kingpin stud from the bracket.

H. Lower Kingpin Bearing Removal

After Section IV-E, and only if the bearing is being replaced, drive the bearing out of the suspension yoke by pushing on the lower kingpin disc.

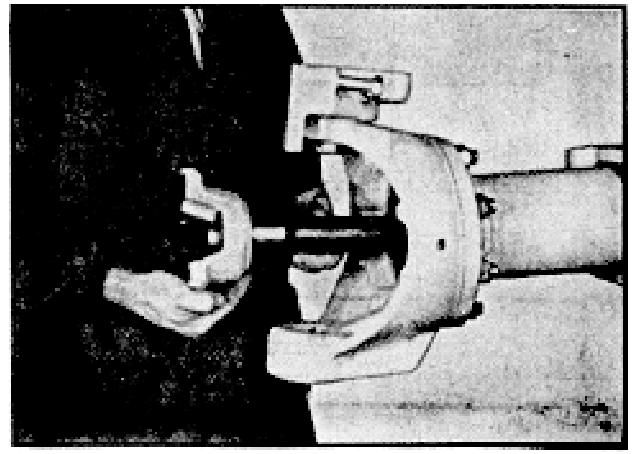


Fig. 24

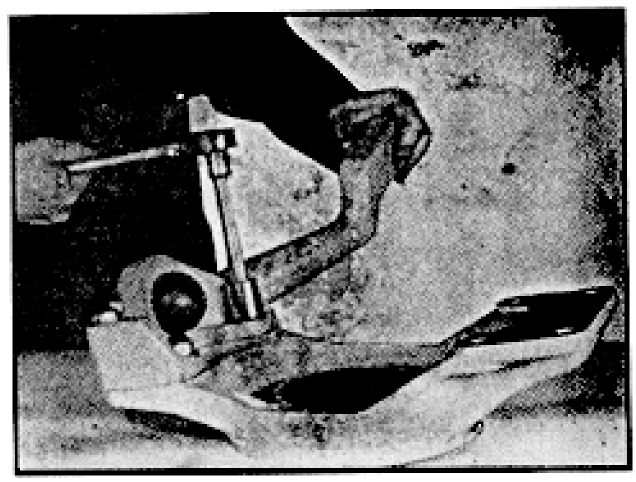


Fig. 25

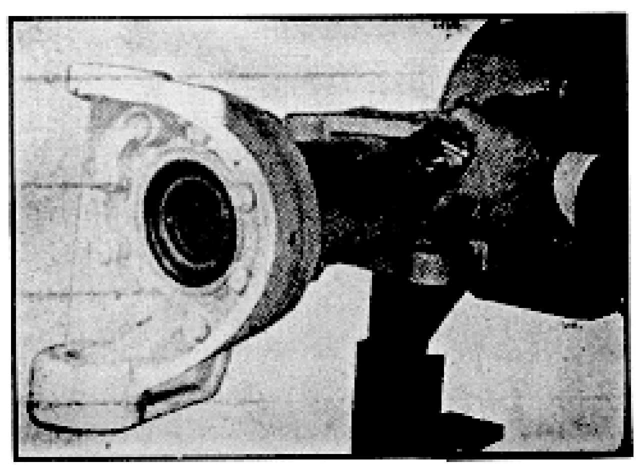


Fig. 26

IV. STEERABLE DRIVE END DISASSEMBLY

I. Upper Kingpin Removal

After Section IV-E, remove locknut from the bottom of the upper kingpin. Use a jack or jack screw to pry between the stud and the lower portion of the suspension yoke to force the ball stud from its tapered hole.

J. Steering Arm Removal

1. Disconnect brake line connection that may be attached to the steering arm.

2. Disconnect the steering drag link if so desired by applying a force between the drag link end and the steering arm and then striking the steering arm radially to the tapered ball connection. Avoid driving on the end of the tapered ball, or nut screwed thereon, as this will generally severely damage the end of the tapered ball before the parts separate.

3. Remove the four locknuts from the steering arm studs and remove arm.

K. Upper Kingpin Bearing Removal

1. Remove only if replacing with a new part.

2. After removing the upper kingpin bracket from the steerable drive end assembly, melt the bearing by applying heat from a propane type torch directly to the bearing.

L. Inner Axle Seal Removal

1. Do not remove the seal unless it is to be replaced by a new seal assembly.

2. The suspension yoke must be off the axle housing before the seal assembly can be removed. After IV-F, proceed as follows:

3. Remove suspension yoke from the axle housing by removing eight locknuts and hardened washers. (See fig. 26.)

4. Drive the seal from the suspension yoke with a suitable drift.

M. Outer Axle Seal Removal

After IV-D or E, use a standard puller to remove the seal.

N. Outer Drive Yoke Roller Bearing Removal

With the spindle removed (section IV-D) and after removing the seal (section IV-M), the bearing can be pushed from the spindle yoke.

0. Universal Joint Disassembly

The universal joint may be disassembled without any other disassembly or after step IV-D, or IV-E.

Remove eight capscrews that attach the bearing assembly to drive yokes. (See fig. 20). Remove the cross and bearing. (See the capscrews from the center of the drive yokes and remove the drive yokes. The outer drive yoke may require some prying before it comes off the outer axle shaft. The inner yoke and shaft should be from the axle and separated on the bench.

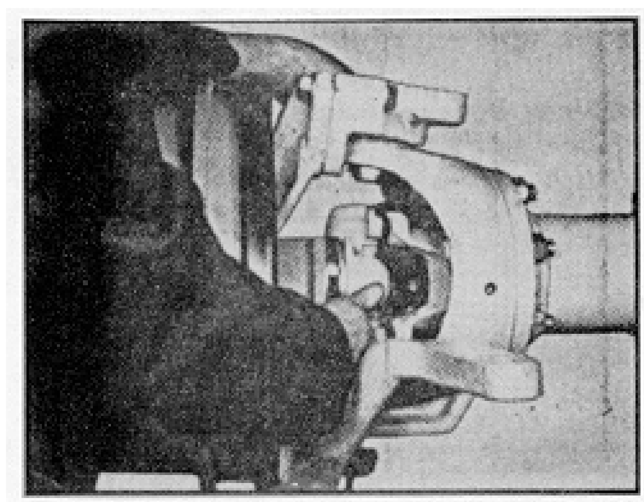


Fig. 27

V. CLEANING AND INSPECTION

A. Choice of Cleaning Methods

1. Steam may be used for external cleaning of completely assembled units. Care must be taken to ensure that water is kept out of the assembly by tightly closing breather caps and other openings.

2. Rough parts such as housings, which are too large to conveniently clean with solvents, may be immersed in hot solution tank containing a mild alkaline solution. Parts cleaned in hot solution tanks must be rinsed thoroughly to prevent damage by traces of alkaline material.

3. Parts with ground or polished surfaces, such as bearings and shafts, should be cleaned with emulsion cleaners or petroleum solvents. Alkaline hot solution tanks may damage the machined surfaces and such cleaning methods should be avoided.

B. Drying and Corrosion Inhibition

Soft, clean shop towels should be used to dry parts after cleaning. Compressed air may be used to clean accessible areas of large parts such as the housing. Bearings should not be spun dry with compressed air, as the lack of lubrication may cause damage to the mating surfaces.

Dry parts should be immediately coated with a light oil or corrosion inhibitor to prevent corrosion damage. Parts which are to be stored should also be wrapped in heavy waxed paper.

C. Inspection

Prior to reassembly, parts which are to be reused must be carefully inspected for signs of wear or damage. Replacement of such parts can prevent costly downtime at a future date.

All bearing surfaces, including ball bearing assemblies and roller bearing cups and cones, should be examined for pitting, wear, or overheating. Shafts may be nicked and marred, or may have damaged threads. Parts which show any signs of damage should be repaired or replaced.

VI. STEERABLE DRIVE END ASSEMBLY

A. General Precautions for Reassembly

IMPORTANT: READ THIS SECTION BEFORE STARTING THE REASSEMBLY PROCEDURES.

1. Gaskets Use liquid sealant per Service Bulletin 738 407, Page 22.

2. Differential Mounting Bolts To prevent oil leakage, use Permatex form-a-gasket #2 pliable setting sealant or equal on all threads. See torque rating chart for recommended torque, Section VIII.

3. Assembly Refer to the parts section as a guide to reassembly.

4. Initial Lubrication Coat all splines and seals with Lubriplate during installation to provide initial lubrication, preventing scoring and galling.

5. Bearings Use of flanged-end bearing drivers is recommended for the installation of bearings. These drivers apply force to inner or outer races of bearing, preventing damage and maintaining alignment with shaft and bore.

6. Seals Use a flanged type guide or driver to install seals. Use of a soft hammer or a soft drift can be made if care is exercised.

B. After Partial Disassembly

Reassembly after partial disassembly should generally reverse the disassembly procedure.

C. Suspension Yoke Assembly

1. Press eight studs into the suspension yoke.

2. Apply liquid sealant or gasket cement to the outer edge of the inner drive yoke seal assembly. (See fig. 28). Press inner drive yoke seal assembly into suspension yoke with an installation tool. (See fig. 29 and 30). Remove excess sealant.

3. Insert the lower kingpin disc with the large end of the lube fitting tapered hole toward the top of the suspension yoke. Press the lower kingpin bearing into place in an arbor press or use a push plate and a C-clamp. Do not use the kingpin ball stud to press in the bearing. Lightly lubricate the bearing and install the o-ring.

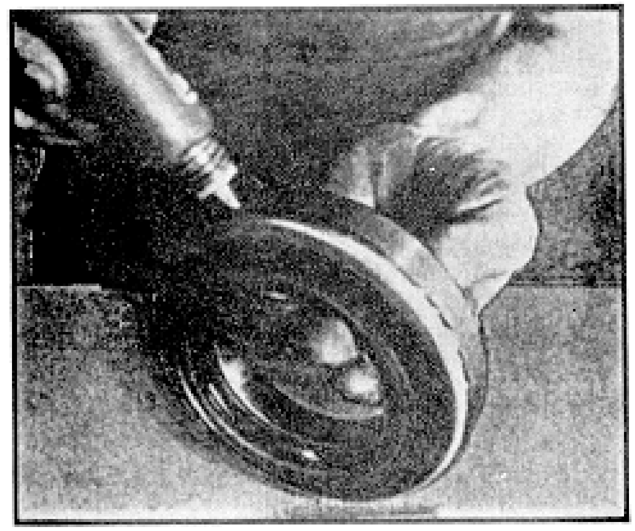


Fig. 28

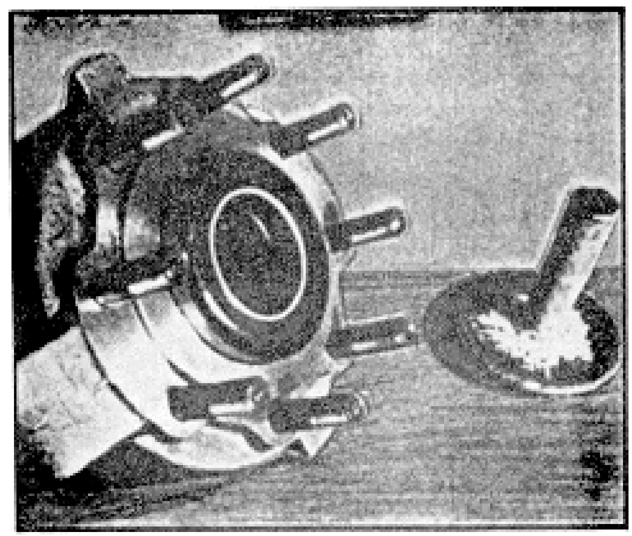


Fig. 29

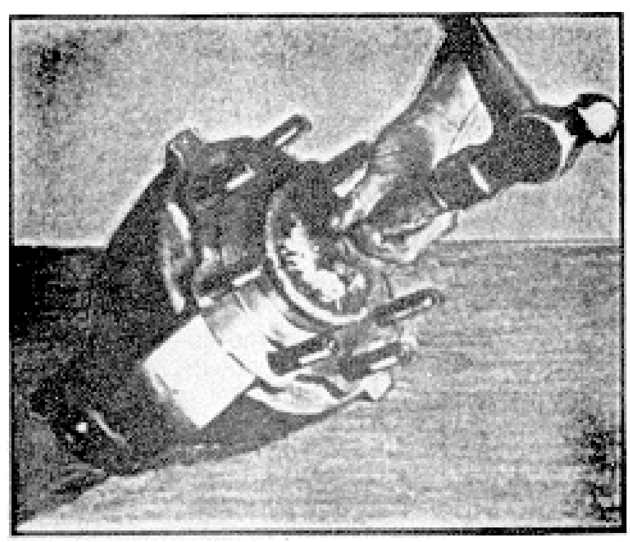


Fig. 30

VI. STEERABLE DRIVE END ASSEMBLY

4. Apply a bead of liquid sealant to the axle housing flange. See Service Bulletin 738 407, Page 22. Install the suspension yoke with hardened washers and locknuts. Tighten to specified torque.

5. Install a new o-ring and a new upper kingpin bearing (if needed) into the upper kingpin bracket. Apply a light coat of lubricant to the inside of the socket and to the ball section of the upper kingpin ball stud. Insert the ball stud through the bearing and bracket and into the tapered hole in the suspension yoke. Install the plain washer and the locknut. Tighten to the specified torque.

6. Assemble the inner axle yoke spacer ring on the inner axle shaft against the shoulder behind the spline. Install the inner drive yoke, (without the pressed-on bearing race) onto the spline.

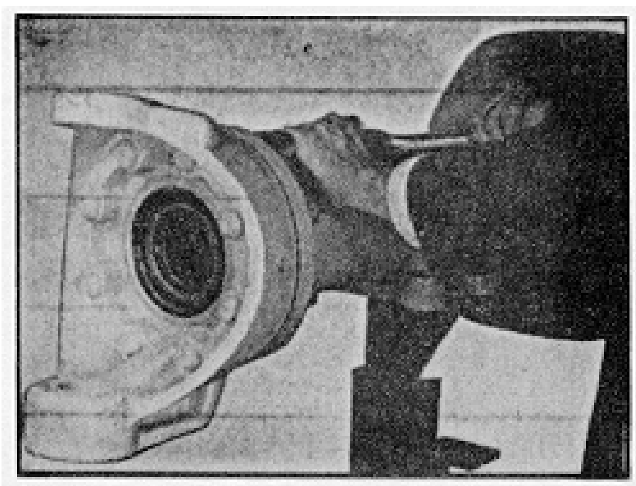


Fig. 31

7. Install the short (1-3/4 long) bolt into a new seal ing washer, through the retaining washer, and into the shaft end, tightening to specified torque.

8. Apply lubricant to the inner drive yoke hub area. Insert the proper inner drive yoke shaft assembly through the suspension yoke. (See fig. 24). CAUTION MUST BE TAKEN TO AVOID DAMAGING THE INNER DRIVE YOKE SEAL ASSEMBLY. Rotate the inner drive yoke shaft assembly until it engages the side gears on the differential assembly, continue to slide the shaft inward until it engages the seal assembly. Care should be exercised to prevent damage to the primary seal lip and to insure the drive yoke hub is seated in the bronze bearing portion of the seal without distorting the large rubber diaphragm section of the floating seal.

Fig. 32

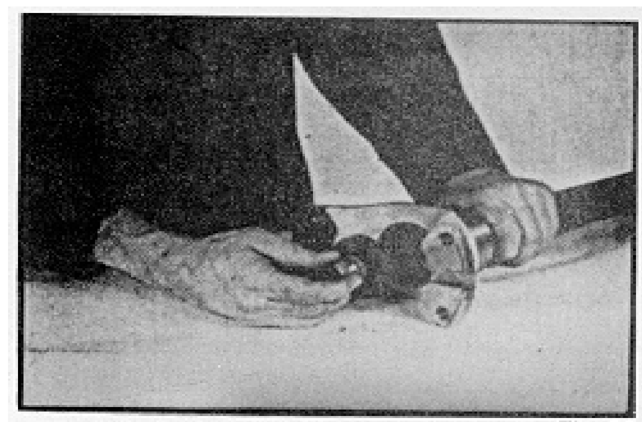


Fig. 33

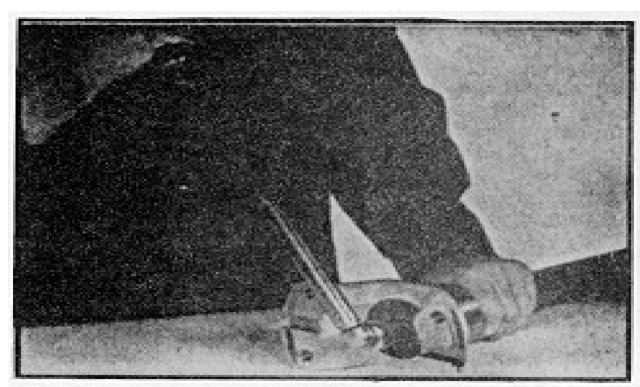


Fig. 34

D. Spindle Yoke Assembly

1. Pack the roller bearing with the proper lubricant and press into place in the spindle yoke. (See fig. 35.)
2. Coat the outside circumference of the outerdrive yoke seal with liquid sealant. Press the seal into place in the spindle yoke. (See fig. 36).
3. Rest the spindle yoke with its inboard side down. Install the lower kingpin mounting studs.

E. Lower Kingpin Bracket Installation

1. Screw the lower kingpin ball stud into the lower kingpin until it just bottoms. Start the lower kingpin ball stud jam nut onto the stud.
2. The lower kingpin brackets with integral tie rod arms are handed. The left arm goes on the left steerable drive end and will position the tie rod to the rear when installed on the axle.

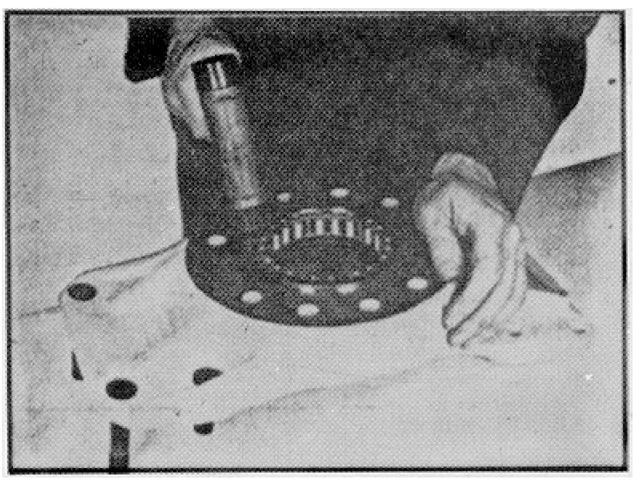


Fig. 35

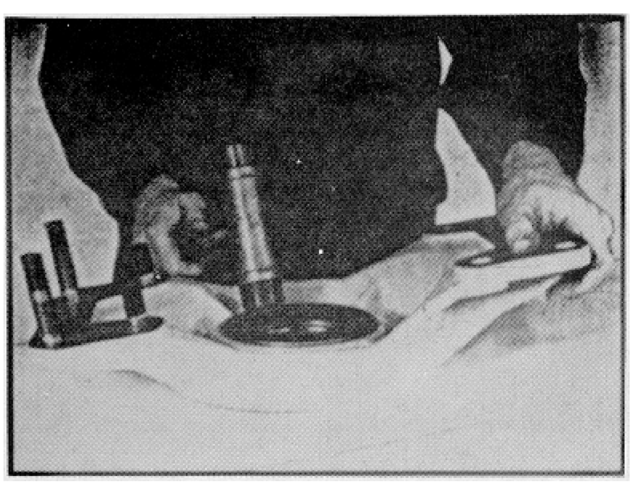


Fig. 36

3. Position the proper bracket on the studs or bolts, whichever is used., projecting through the spindle yoke. Install the hardened washers and locknuts. Tighten to the specified torque. (See fig. 25).

F. Spindle Yoke to Suspension Yoke Assembly

1. With the spindle yoke upright , position the outer drive yoke horizontally. If the spindle yoke assembly includes the brakes and wheel hub it should be attached to and supported by a suitable jack or hoist. Position the lower kingpin ball (well lubricated) under the lower kingpin socket in the suspension yoke. (See fig. 21). The spindle yoke assembly must be tilted outward at the top slightly to allow the ball stud to enter its socket.

2. Raise the spindle yoke assembly until the ball stud enters the socket. Align the upper kingpin mounting holes with the corresponding holes in the spindle yoke.

3. Install only three bolts. (See fig. 13). The lower rear bolt is the steering stop bolt. Washers under the fourth bolts head will limit the maximum turn angle on the steerable drive end. The bolts should pass through the camber adjusting shim or shims. (See fig. 13). The same number of washers and the same shims should be reused in a reassembly of parts that have previously been together. Also refer to Section IIIIl-D and E. Tighten locknuts to specifications.

G. Brake Assembly Installation

1. Apply a bead of liquid sealant to the spindle flange or the spindle yoke. See Service Bulletin 738 407, Page 22. Position the spindle on the spindle yoke piloting on the roller bearing outer race, aligning the bolt holes, and orienting the wheel bearing adjusting lock-washer keyway to face upwards. Position the brake assembly on the spindle flange pilot, aligning the bolt holes, orienting the actuator or wedge chamber on the horizontal centerline at the front.

2. Install the bolts from the brake spider side, using hardened washers and locknuts on the inside of the spindle yoke. Torque to specification

H. Wheel Hub Assembly

1. Assemble the wheel bearing cups and the outer axle shaft drive studs to the wheel hub.

2. On disc style wheel hubs:
   Press wheel studs into place. Left thread studs go into the left hand hub, right hand thread studs into the right hub.

   On cast spoke style hubs:

   Assemble the brake drum to the cast spoke hub and secure with bolts, washers, and nuts. Tighten bolts to correct torque. Install the rim studs to cast spoke hub.

3. Pack the inner wheel bearing cone with the proper lubricant and insert into the wheel hub.

4. Coat the outside circumference of the wheel hub seal with liquid sealant and press into the hub.

5. Pack the cavity between the inner and outer wheel bearing to level of the small diameter of the bearing cups.

6. On disc style drum:

   Adjust the brakes to match closely, but still clear the brake drum.

   On cast spoke hubs:

   Adjust the brakes to match the brake drum by using a brake shoe adjusting gauge. Measure the I.D. of the drum and adjust the brakes to match the gauge reading. The gauge is available from the McMaster-Carr Supply Co., Los Angles.

7. Position the wheel hub or cast spoke hub and drum carefully over the spindle, brake and spindle yoke assembly. (See fig. 17). Rotate the hub while positioning over spindle.

8. Pack the outer wheel bearing and install over the spindle.

9. Install the wheel bearing adjusting nut with dowel, if used, dowel facing outward (or up). (See fig. 16).

10. Adjust the wheel bearings per III-B.

I. Outer Drive Yoke and Outer Drive Axle Shaft Assembly

1. The outer drive yoke should be complete with a bearing race pressed on its hub. This race should not have been removed at disassembly unless either the yoke or race were replaced by new parts.

2. Lubricate the seal and bearing surface of the outer drive yoke and put the yoke in place in the bearing and seal that is in spindle yoke. (See fig. 37).

3. Apply a bead of liquid sealant to the outer axle shaft flange. See Service Bulletin 738 407, Page 22.

4. Install the yoke spacer ring onto the outer axle shaft splines. Insert the shaft into the spindle bore, rotate and align the splines with the drive yoke splines, rotate the shaft and yoke to align the flange holes with the drive studs. (See fig. 38). Insert the long (2 inch) yoke retaining bolt through a new sealing washer, through the retaining washer and into the threaded hole in the shaft end. (See fig. 39). Tighten to specified torque.

5. Push axially on the outer drive yoke and check for positive clearance under the axle shaft flange. The clearance should be at least .015-inch. (See fig. 40).

6. Install the locknuts to retain the axle shaft. Tighten to specified torque.

7. On oil lubricated wheel bearing, turn wheel hub to position the oil plug hole in the outer axle shaft horizontally. (See fig. 41). Fill hub with specified oil, install plug.

8. Install the hub cap.

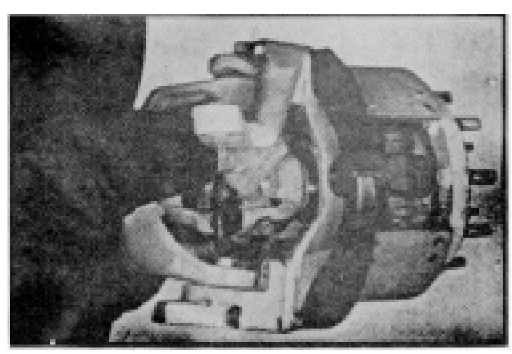


Fig. 37

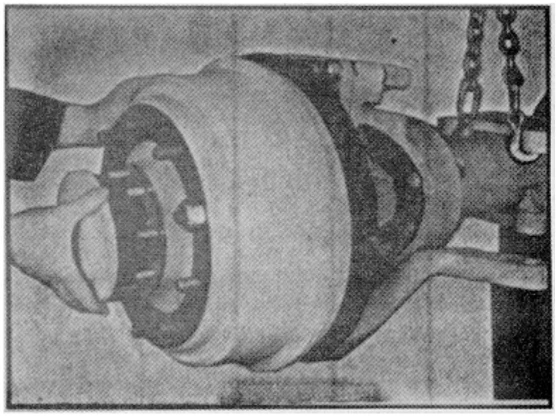


Fig. 38

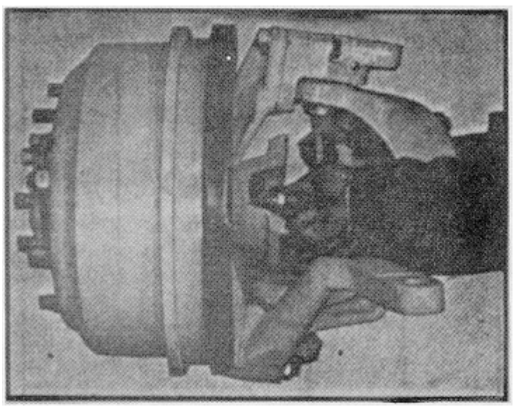


Fig. 39

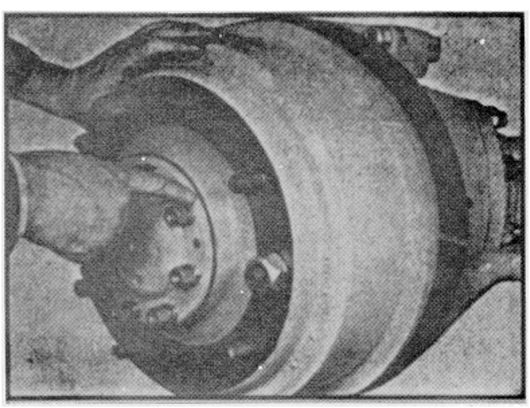


Fig. 40

J. Universal Joint Assembly

Install the universal joint cross and bearing assembly with two bolts in each of the bearing caps. (See figs. 27 and 20). Rotate the wheel hub to rotate the universal joint while the end is turned against the steering stop and check for positive clearance. (See fig. 9).

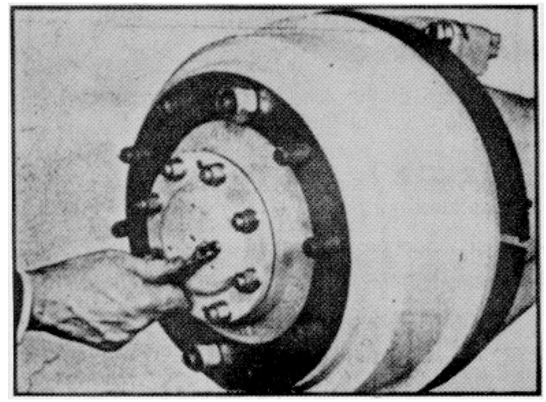


Fig. 41

K. Brake Actuator Chamber Installation

If not already on the assembly, add the brake actuator chamber. Assemble a collet nut on the actuator chamber tube so that the tapered part of the nut will fit into actuator. Screw the actuator chamber into the actuator until the tube is tight against the wedge stop washer. Tighten the collet nut securely (150 ft. lbs. torque).

L. Steering Arm Assembly

Install the steering arm and upper kingpin bearing cap. Note that the short studs are used on the outboard end when installing the steering arm and the long studs on the inboard end. Use flexloc nuts on the studs. The cap is held in place with bolts and lockwashers.

M. Tie Rod Assembly

Install the steering connecting tie rod. Tighten the castle nuts to the specified torque and use new cotter pins.

N. Final Assembly

1. Make adjustments as described in Section III.

2. Lubricate and add lubricants as described in Section II.

3. Install wheels and tires. Torque wheel nuts to specifications.

4. Lower the vehicle to the ground and road test.

VII. DIFFERENTIAL CARRIER

A. Removal of Differential Carrier from Axle

All service of the differential carrier assembly requires removal of the assembly from the axle housing.

1. Remove the drain plugs and drain lubricant from axle housing.
2. Disconnect propeller shaft at pinion yoke.
3. Refer to Section IV-F, and remove both inner axle shafts.
4. Attach differential carrier to a suitable roller jack. (See fig. 42).
5. Remove capscrews and nuts holding differential carrier to axle housing.
6. Roll differential carrier away from the axle. (See fig. 43).

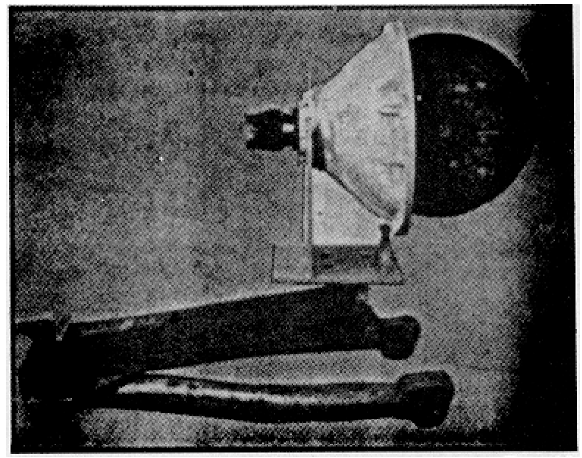


Fig. 42

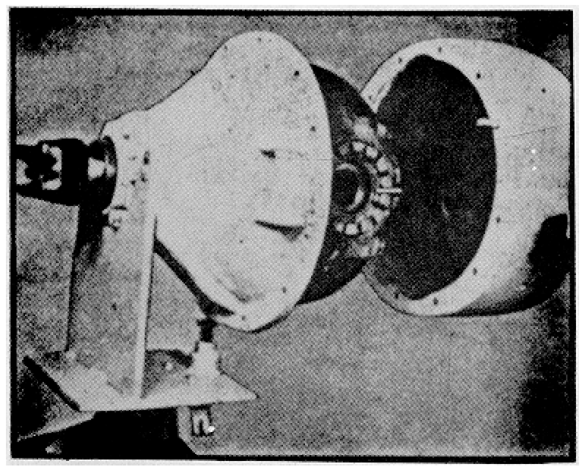


Fig. 43

B. Installation of Differential Carrier to Axle

1. Refer to the Differential Carrier Service Manual for detailed service procedures.
2. Apply a bead of liquid sealant to the differential mounting face. See Service Bulletin 738 407, page 22. Apply in the same manner as shown for the axle flanges, a bead and a ring around each bolt hole.
3. Position the differential carrier in the axle housing with a suitable roller jack, (See fig. 43), picking up two locating studs.
4. Install differential carrier capscrews and stud nuts. Tighten to the correct torque. Fig. 43
5. Connect the propeller shaft.
6. Assemble the Steerable Drive Ends as outlined in Section VI.
7. Install the drain plug and fill the axle to the bottom edge of the level hole with the appropriate lubricant.
8. Install the level plug.

TORQUE SPECIFICATIONS

	SIZE	LB-FT
Drive Pinion Nut	1-1/8 - 18	320 Min.
Differential Carrier	7/16	45-55
Suspension Yoke to Axle Housing	3/4-16	250
Upper Kingpin Ball Stud Nut	1-14	250
Drive Yoke to Axle Shaft	5/8-18	125
Spindle, Brake Spider to Spindle Yoke	9/1.6-18	150
Upper and Lower Kingpin Bracket Mtg	5/8-18	175
Wheel Bearing Adjusting Nut	See Text	
Wheel Bearing Locknut	3-12	250-400
Outer Axle Shaft Stud Nuts	1/2-20	125
Hubcap Bolts	3/8-16	50
Universal Joint Capscrews	1/2-20	120
Lower Kingpin Jam Nut	11/2-12	400
Steering Arm Mounting	3/4-16	200
Upper Kingpin Bracket Cap Bolts	3/4-10	75
Tie Rod Ball Stud Castle Nut	7/8-14	100
Tie Rod Clamp Bolt	5/8-18	75
Brake Drum Mounting (Cast Spoke Hubs)	3/4-16	300
Rim Clamp Nut (Cast Spoke Hubs)	3/4-10	210-260
Wheel Nuts (Std. Ball Seat Mtd.)	3/4-16	450-500

Torque values given should be within a range of ± 10% of values shown.
Values shown are for dry, non-lubricated threads. Since back-off torque is proportional to tightening torque, it is generally best to have dry threads.

SERVICE BULLETIN

Kelsey-Hayes Company
Fabco Division

NO. 738 407

SUBJECT: FORMED-IN-PLACE-GASKETS FOR PRODUCTION AND SERVICE USE

AFFECTS: ALL FABCO AXLES

EFFECTIVE: JUNE 1985

I. Formed-In-Place-Gasket compound has been phased-in as the standard gasket material on all Fabco axles.

The paper gaskets will not (and should not) be used.

II. Service gaskets will not be available.

Fabco offers gasket compound as a service replacement.

SIZE	FABCO NO.	LOCTITE PRODUCT NO.
6 ml. tube	728 232 001	51517
50 ml. tube	728 232 002	51531
300 ml. tube	728 232 003	51574

A. The advantages of this material in place of cut gaskets are:

1. Eliminates gasket compression set.
2. Reduces or eliminates bolt loosening.
3. Improves structural integrity of the assembly.
4. Cures under pressure - does not require, absorption of moisture.
5. Spreads over the mating surfaces at assembly forming a film that effectively leaves the joined parts in metal-to-metal contact.
6. Provides a reliable seal.

B. This anerobic compound (Loctite 515) must be used in the following places:

1. Suspension yoke to axle housing (this is the same as steerable drive end to axle housing flange).
2. Spindle to spindle yoke (or torque plate).
3. Outer axle shaft (or drive flange) to wheel hub.

Kelsey-Hayes Company/Subsidiary of Fruehauf Corporation 249 671h St., Oakland, CA 94662 (415) 658-7070 TWX 910-366-7196

C. Loctite product 515 Gasket Eliminator is available through Industrial Bearing Suppliers.

III. The compound listed above may be used to mount the differential carrier to the axle housing or to assemble the differential carrier itself. The following materials may also be used to mount or assemble the differential carrier:

A. General Electric 1473 Silicone RTV "Silmate".

B. Dow 732 Si!icone RTV "Silastic".

C. Loctite 504 "Gasket Eliminator".

D. Loctite 510.

IV. Recommended Application Procedures:

A. Following the pattern shown in the attached sketches, apply the gasket compound in a 1/8" diameter bead. Encircle stud or cap screw holes completely. On axle models incorporating threaded puller holes, be sure to keep the bead of material inside the location of the hole.

C. Assemble the components without lateral movement and torque fasteners. Fastener torques should be checked within thirty minutes of assembly for compliance with service manual specifications which remain unchanged. It is important to check and, if necessary, re-torque fasteners within thirty minutes of assembly because they will tend to leak if retorqued after the gasket compound has cured.

D. After assembly, the axle can be filled with oil and used immediately if necessary. It is however, advisable to allow as much time as possible for the compound to cure fully. Axles employed in severe applications should not be operated for six to twelve hours, allowing more cure time for the sealant.

V. The following gaskets have been eliminated.

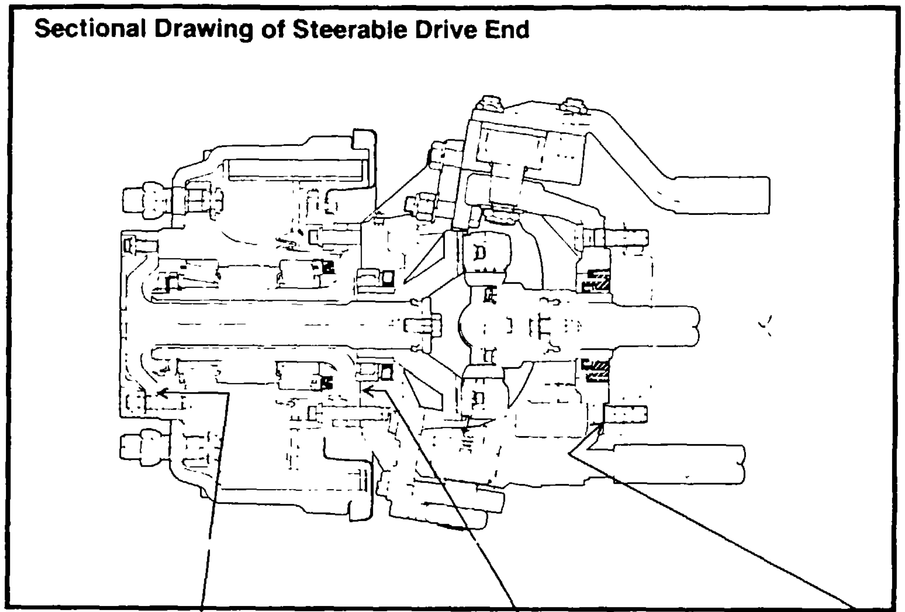
427 249	427 389
427 257	427 392
427 378	427 452
427 379	427 454
427 382	427 455
427 262	427 395

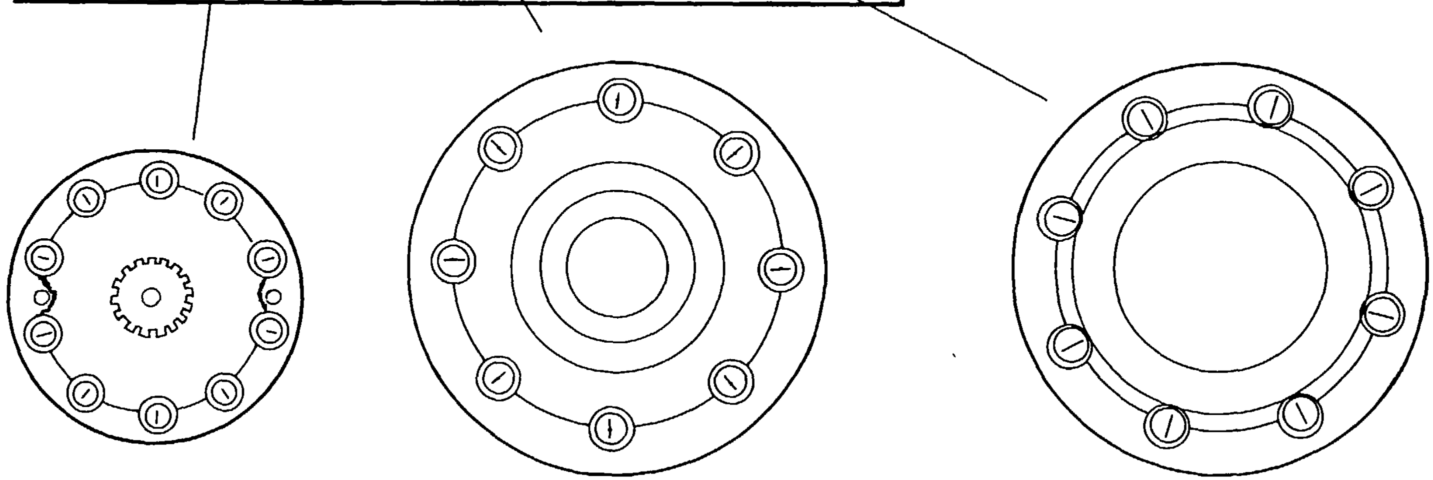
SERVICE BULLETIN
NO. 738 407

USE ONLY LOCTITE PRODUCT 515 GASKET ELIMINATOR

APPLY AS ILLUSTRATED 3/32 TO 1/8 DIAMETER BEAD.

DIAGRAM ILLUSTRATES SDA-20 - SDA-9, 12, 16, 18 ARE SIMILAR.



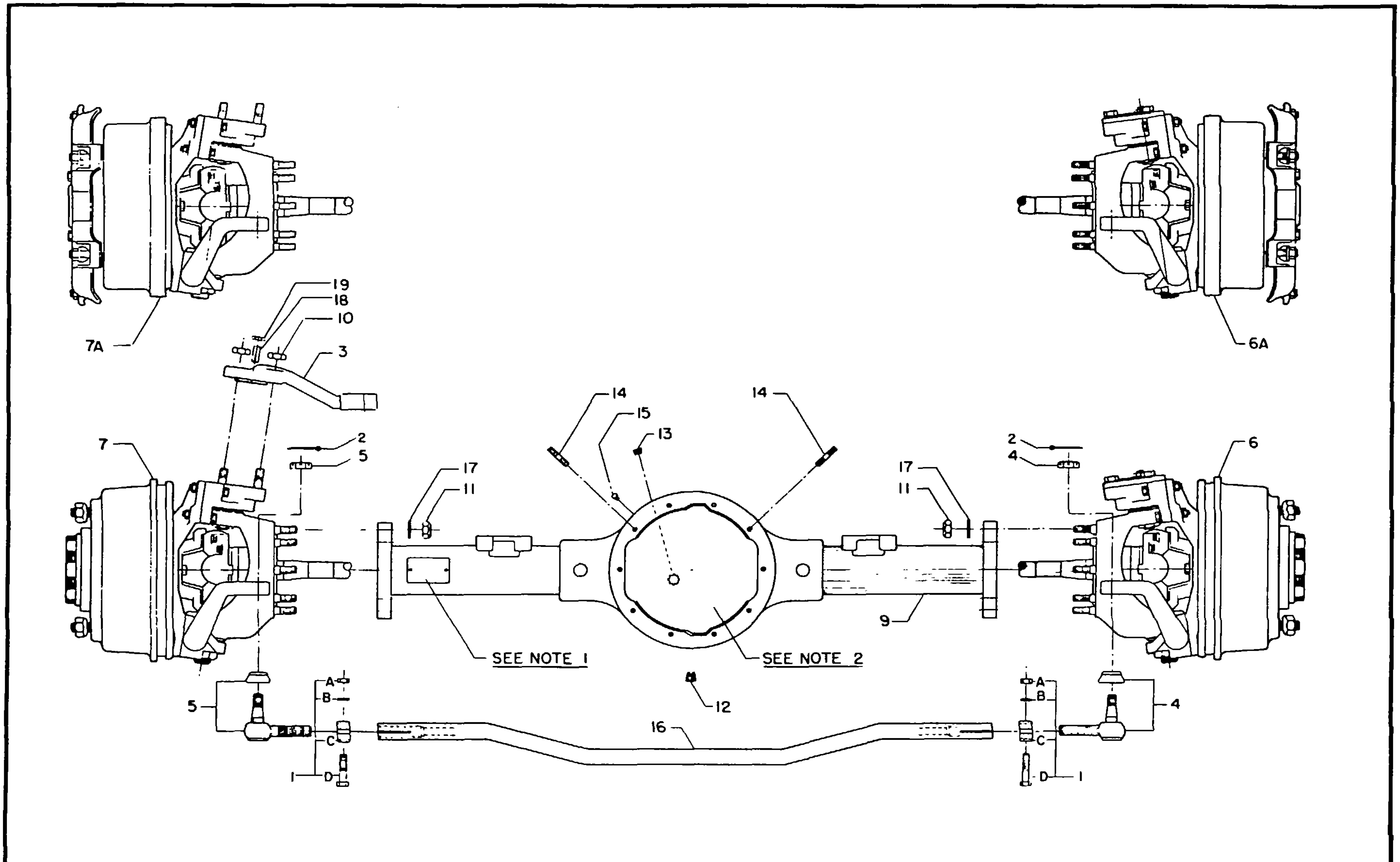


APPLY TO INBOARD SURFACE OF AXLE SHAFT FLANGE

APPLY TO INBOARD FACE OF SPINDLE FLANGE

APPLY TO OUTBOARD FACE OF AXLE HOUSING FLANGE

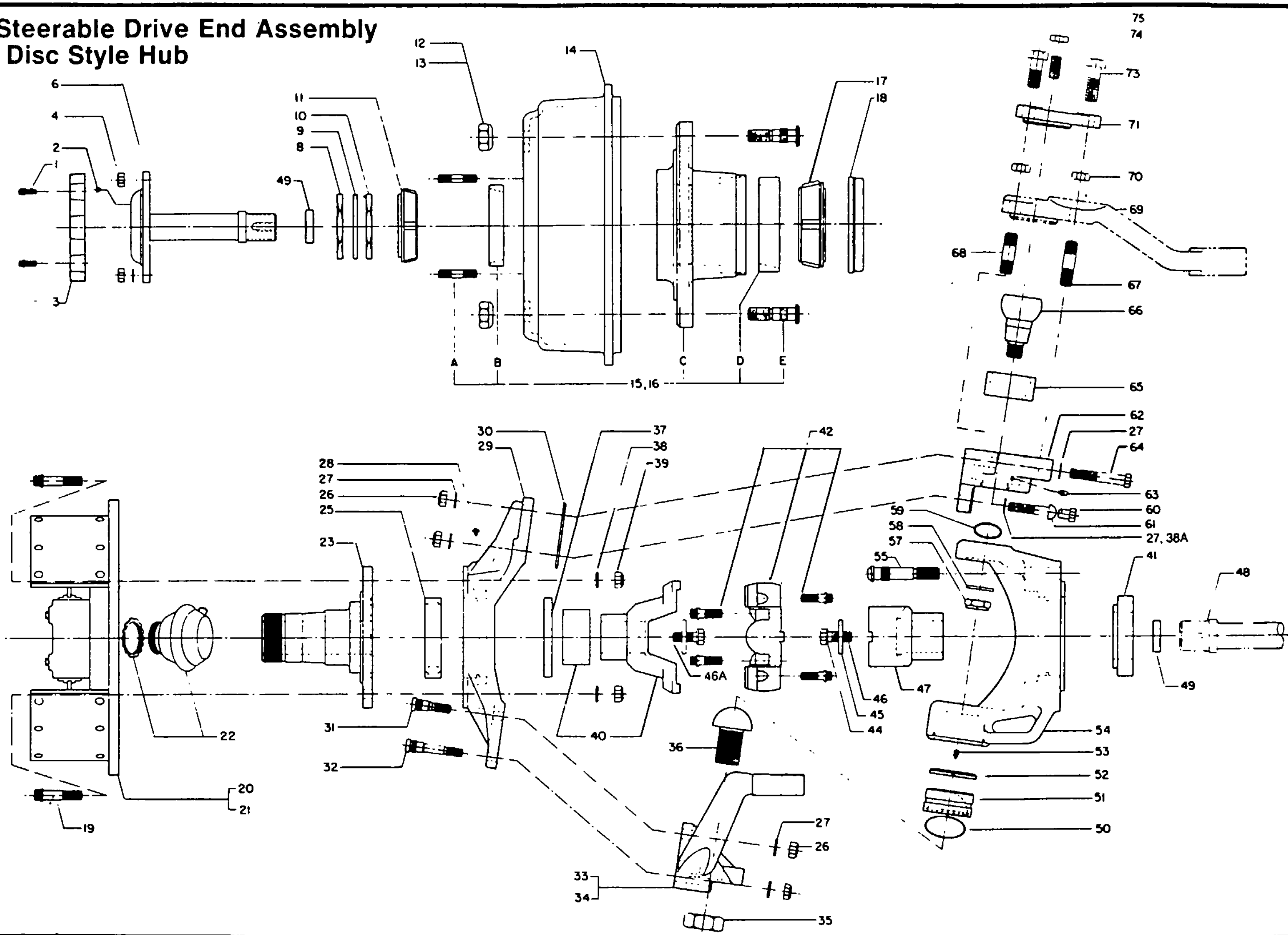
Steerable Drive Axle Assembly



Steerable Drive Axle Assembly

ITEM	DESCRIPTION	QUANITY PER AXLE
1	Clamp, Tie Rod, Consisting of:	2
A	Locknut, 5/8 - 18	
B	Lockwasher, 5/8	
C	Clamp	
D	Bolt, 5/8 - 18 x 2-3/4	
2	Pin, Cotter	2
3	Arm, Axle Steering	1
4	End, Right Tie rod	1
5	End, Left Tie rod	1
6	End, Right Steerable Drive, Disc Style	1
7	End, Left Steerable Drive, Disc Style	1
9	Housing, Axle	1
10	Nut, Steering Arm Mounting Lock	4
11	Nut, Steerable Drive End to Axle Housing Mounting Stud	16
12	Plug, Axle Housing Drain	1
13	Plug, Axle Housing Oil Level	1
14	Stud, Differential Carrier Mounting	2
15	Fitting, Axle Housing Vent	1
16	Tube, Tie Rod	1
17	Washer, Steerable Drive End Mounting Stud	16
18	Screw, Socket HD. Set, 5/8 - 18	2
19	Nut, Jam, 5/8 - 18	2

Steerable Drive End Assembly
Disc Style Hub

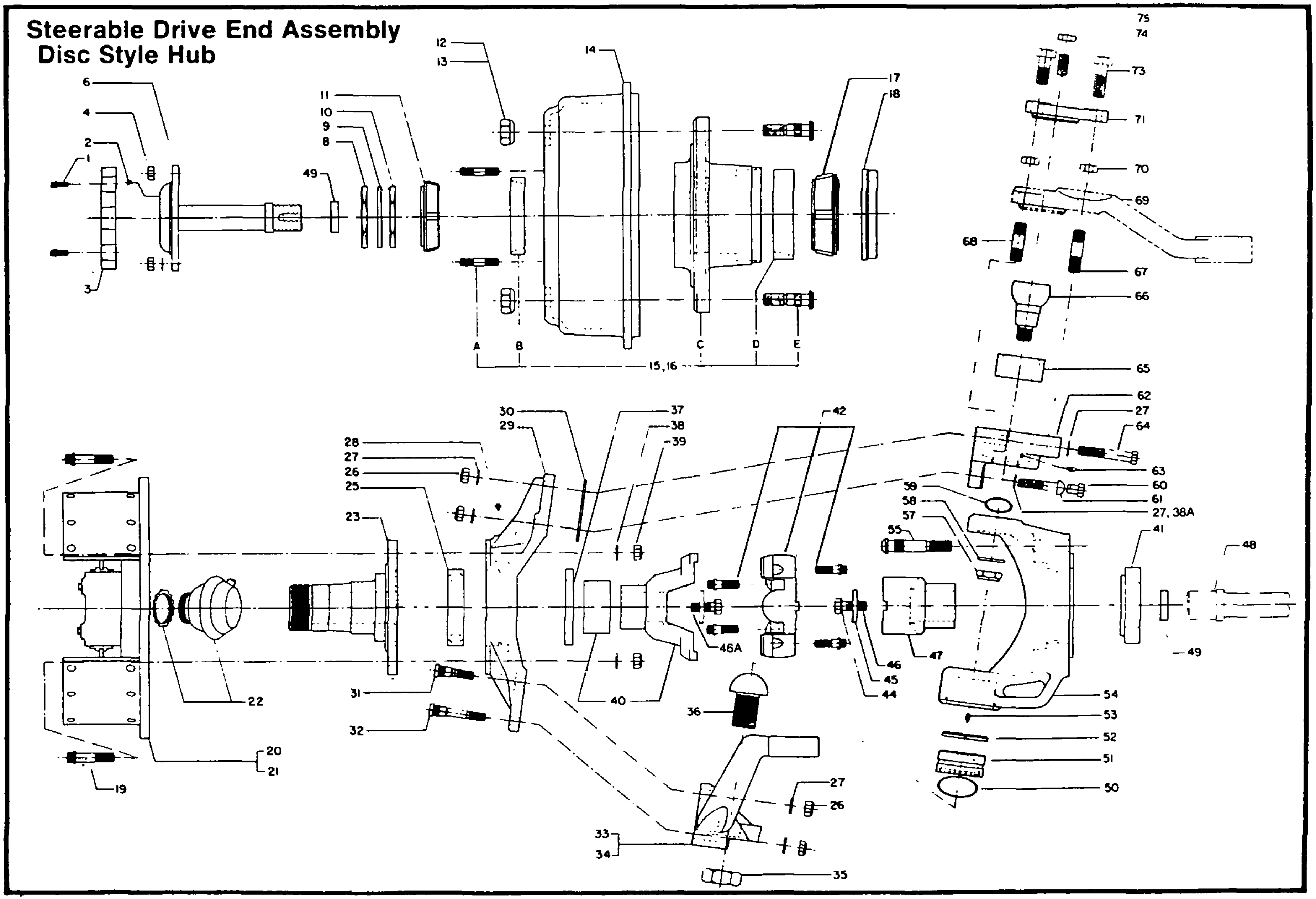


Steerable Drive End Assembly
(Disc Style Hub)

ITEM	DESCRIPTION	QUANITY PER AXLE END L.H.	R.H.
1	Capscrew, Hub Cap	2	2
2	Plug, Wheel Brg. Oil Level	1	1
3	Hub, Cap	1	1
4	Nut, Axle Shaft Drive Stud	8	8
6	Shaft, Outer Axle	1	1
8	Nut, Wheel Bearing Lock	1	1
9	Washer, Wheel Brg. Lock	1	1
10	Nut, Wheel Bearing Adjustment (with Dowell)	1	1
11	Bearing Cone, Outer Wheel	1	1
12	Nut, Left Hand Wheel	10	-
13	Nut, Right Hand Wheel	-	10
14	Drum, 15x5 Brake	1	1
	+Assembly, Left Hand Wheel Hub (Air Brakes Axles Only)		
15		1	-
	+Assembly, Right Hand Wheel Hub (Air Brake Axles Only)		
16		-	1
A	Stud, Outer Axle Shaft Drive	8	8
B	Bearing Cup, Outer Wheel	1	1
	Hub, Wheel (Air Brake Axles Only)		
C		1	1
D	Bearing Cup, Inner Wheel	1	1
	Stud, Left Hand Wheel	10	-
E	Stud, Right Hand Wheel	-	10

+ This Assembly contains Items A through E.

ITEM	DESCRIPTION	QUANITY PER AXLE END L.H.	R.H.
17	Bearing Cone, Inner Wheel	1	1
18	Seal, Wheel Hub	1	1
	Screw, Wheel Spindle Mtg., 3 1/2 lg.	8	8
19	Screw, Wheel Spindle Mtg., 4-3/8 lg.	2	2
20	Brake Assembly, Left Hand	1	-
21	Brake Assembly, Right Hand	-	1
22	Actuator & Lock Nut, Brake (Air Brake Axles Only)	1	1
23	Spindle, Wheel Bearing	1	1
25	Bearing, Outer Race and Roller Ass'y.	1	1
26	Nut, Lower & Upper Kingpin Bracket Mounting Lock	8	8
27	Washer, Kingpin Bracket Mtg.	12	12
28	Vent	1	1
29	Yoke, Spindle	1	1
30	Shim, Camber Adjustment	1	1
31	Stud, Lower Kingpin Bracket Mtg. (2" long)	2	2
32	Stud, Lower Kingpin Bracket Mtg. (3-3/8" long)	2	2
33	Bracket, Left Lower Kingpin	1	-
34	Bracket, Right Lower Kingpin	-	1
35	Nut, Lower Kingpin Ball Stud Jam	1	1
36	Ball Stud, Lower Kingpin	1	1
37	Seal, Outer Drive Yoke	1	1
38	Washer, Spindle Mtg. Lock	10	10



Steerable Drive End Assembly
Disc Style Hub
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27, 38A
A
B
C
D
E

Steerable Drive End Assembly
(Disc Style Hub)

ITEM	DESCRIPTION	QUANITY PER AXLE END L.H.	R.H.
38A	Washer, Steering Stop Adjustment	A/R	A/R
39	Nut, Wheel Spindle Mounting Lock	10	10
40	Yoke, Outer Drive and Bearing Race	1	1
41	Seal, Assembly, Inner Drive Yoke	1	1
42	Cross and Bearing, Universal Joint w/Bolts	1	1
44	Washer, Drive Yoke Bolt Sealing	2	2
45	Washer, Drive Yoke retaining	2	2
46	Bolt, Inner Drive Yoke Retaining, 1-3/4" Long	1	1
46A	Bolt, Outer Drive Yoke Retaining, 2" Long	1	1
47	Yoke, Inner Drive	1	1
48	Shaft, Inner Axle (See Note 2, Table of Contents)	1	1
49	Ring, Inner Axle and Outer Axle	2	2
50	O-Ring, Lower Kingpin	1	1
51	Bearing, Lower Kingpin	1	1
52	Plate, Lower Kingpin Bearing	1	1
53	Fitting, 45^{o}	1	1
54	Yoke, Suspension	1	1
55	Stud, Suspension Yoke to Axle Housing	8	8

ITEM	DESCRIPTION		QUANITY PER AXLE END L.H.	R.H.
57	Nut, Upper Kingpin Ball Stud Lock		1	1
58	Washer, Upper Kingpin Ball Stud		1	1
59	O-ring, Upper Kingpin		1	1
60	Bolt, Upper Kingpin Bracket Mounting		1	1
61	Bolt, Steering Stop		1	1
62	Bracket, Upper Kingpin		1	1
63	Fitting, Grease		1	1
64	Bolt, Upper Kingpin Bracket Mounting		2	2
65	Bearing, Upper Kingpin		1	1
66	Ball Stud, Upper Kingpin		1	1
67	Stud, Steering Arm (2-9/16" Long)	*	2	-
68	Stud, Steering Arm (2-1/16" Long)	*	2	-
69	Arm, Steering (see note 2, Table of Contents)	*	1	-
70	Nut, Steering Arm Mounting Lock	*	4	-
71	Cap, Upper Kingpin	*	-	1
73	Bolt, Upper Kingpin Cap	*	-	4
74	Screw, Soc. Hd. Set 5/8-18		1	1
75	Nut, Jam, 5/8-18		1	1

* Steering arm, studs and nuts and/or cap and bolts may be mounted on either steerable end in any combination, two arms, two caps or one each.

SPRINGS

CONTENTS

SPRINGS

Replace old section with this revised Section in your CTS-4001 Manual.

SUSPENSION ALIGNMENT

CONTENTS

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GENERAL

Before performing axle alignment or upper torque rod adjustment, remove road debris from suspension and perform the preliminary procedures listed below.

1. Park vehicle on a level floor.
2. Release parking brake.
3. Check rear wheels for runout and correct if necessary.
4. Move vehicle forward and rearward several times to relieve internal stress.
5. Turn wheels in a straight ahead position.

AXLE ALIGNMENT

The following alignment check (measuring of the suspension) applies to all tandem suspensions covered in this manual, all 4 X 2 vehicles having spring suspension with torque rods, and IH air suspensions with tapered leaf springs. In the event axle adjustment is necessary, refer to the AXLE ADJUSTMENT portion of this section and the appropriate procedure for the suspension being serviced.

1. Clamp a straightedge to top frame rail ahead of forward rear axle on 6 x 4 vehicles and ahead of rear axles on 4 x 2 vehicles. Use a framing square against straightedge and outside surface of the frame side member to insure straightedge is perpendicular to frame, as in Figure 1.

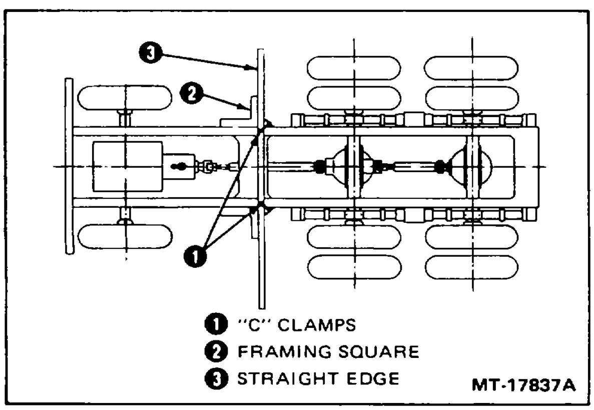


Figure 1 - Straightedge Location on Frame

2. Suspend a plumb bob from the straightedge in front of the tire and on outboard side of the forward rear axle on 6 x 4 vehicles or rear axle on 4 x 2 vehicles. (See Figure 2.)

3. Position a slotted bar such that pointers are engaged in center hole of (both) rear axles(s).

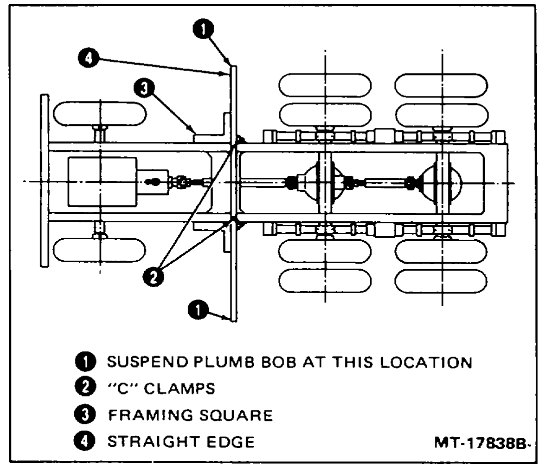


Figure 2 - Plumb Bob Locations

4. Measure distance between cord of plum bob and pointer on forward rear axle of 6 x 4 vehicles or rear axle on 4 x 2 vehicles. Record dimension "A" as in Figure 3.

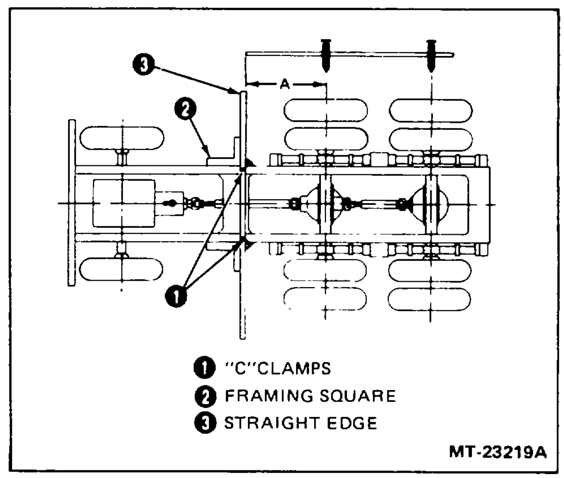


Figure 3 - Measure Dimension "A"

5. Position slotted bar with pointers on opposite side of vehicle in same manner and measure corresponding distance as in Step 4. Record this dimension.

6. Any difference in dimensions from side to side in excess of 3.175 mm (.125 inches) must be equalized.

7. Refer to the AXLE ADJUSTMENT portion of this section for procedures to equalize difference in dimensions which exceed 3.175 mm (.125 inches).

NOTE - Steps 8,9, 10, 11, and 12 apply to 6x4 vehicles.

8. Position slotted bar one side of vehicle so that pointers are engaged in center hole of both rear axles.

9. Measure distance between cord of plumb bob and pointer on rear rear axle and record (dimension "B" in Figure 4).

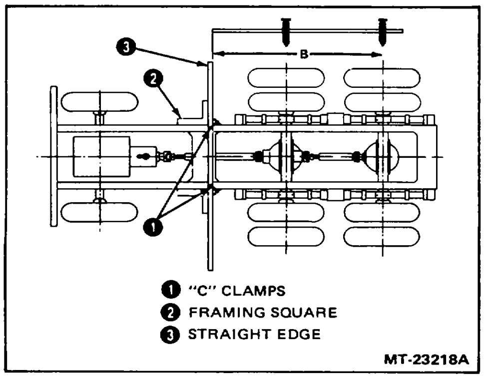


Figure 4 - Measure Dimension "B"

10. Position slotted bar on opposite side of vehicle with the same pointer being used on rear rear axle for both sides and measure distance between cord of plum bob and pointer on rear rear axle. Record dimension.

11. Any difference in dimensions from side to side must be equalized if in excess of 3.175 mm (.125 inches).

12. Refer to AXLE ADJUSTMENT portion of this section for procedures to equalize differences in dimensions which exceed 3.175 mm (.125 inches).

13. It is recommended that vehicle be driven a short distance and alignment rechecked.

AXLE ADJUSTMENT

HENDRICKSON

The design of Hendrickson suspensions does not provide for axle adjustment for alignment purposes. If the axles are measured to be significantly out of alignment, the following areas should be investigated as the possible cause.

1. Severely worn walking beam center or end bushings.
2. Worn spring pins.
3. Improper location of frame brackets on frame.
4. Any worn or damaged parts.

SPRING ASSEMBLIES
DESCRIPTION

Various types of spring assemblies used on IH vehicles are described below.

Constant Rate

Constant rate springs are leaf-type spring assemblies that have a constant rate of deflection. For example, if 227 Kg (500 pounds) deflect the spring assembly 2.54 cm (1 inch), then 454 Kg (1000 pounds) would deflect the same spring assembly 5.08 cm (2 inches). Thus, the rate of deflection is constant.

Constant rate springs are mounted to the axle with U-bolts, nuts and lock washers. The front end of the spring is mounted to stationary bracket. The rear end of the spring is mounted to a spring shackle. The shackle allows for variations in spring length during compression and rebound.

This type of spring assembly is used in both front and rear axle applications on IH vehicles.

Figure 1 and 2 show typical views of constant rate spring assembly applications.

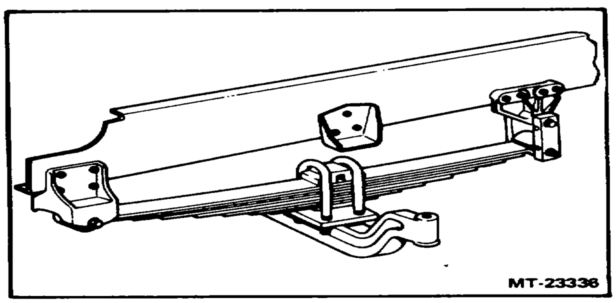


Figure 1 - Front Axle Application (Constant Rate)

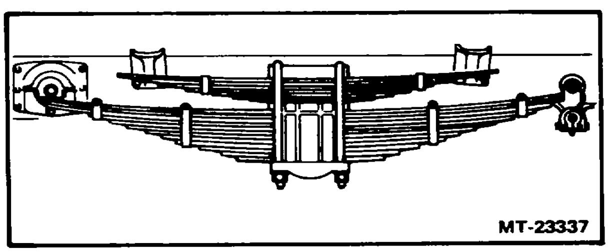


Figure 2 - Rear Axle Application (Constant Rate)

Tapered Leaf

Tapered leaf springs are leaf type spring assemblies which are thicker in the center than the ends. This design results in a fewer number of leafs, providing lighter weight.

Taper leaf springs are mounted to the axle with U-bolts, nuts and lock washers. The front end of the spring is mounted to a stationary bracket. The rear end of the spring is mounted to a spring shackle. The shackle allows for variations in spring length during compression and rebound.

Figure 3 illustrates a Taper leaf assembly.

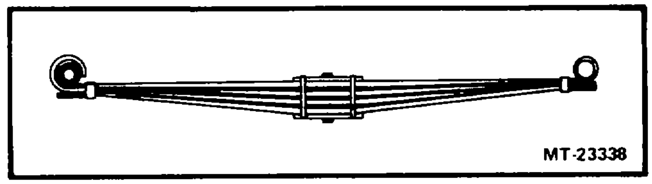


Figure 3 - Taper Leaf Spring Assembly

Auxiliary Springs

Auxiliary springs are leaf-type spring assemblies usually mounted on top of the vehicle rear spring assemblies. Auxiliary springs are used only when the vehicle is under heavy load. The auxiliary spring assumes part of the load by contacting special brackets attached to frame rail slides when the load is sufficient to compress the vehicle rear spring assemblies to the point of contact.

Figure 4 illustrates an auxiliary spring assembly.

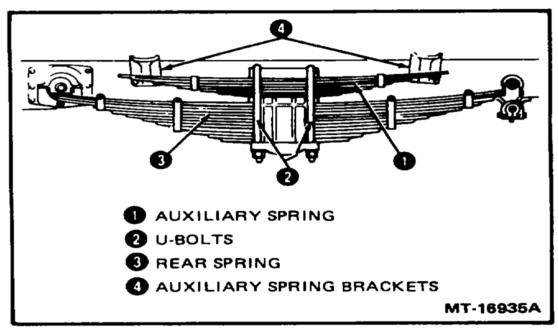


Figure 4 - Auxiliary Spring Assembly

Progressive (Vari-Rate)

Progressive (Vari-rate) springs are leaf-type spring assemblies with a variable deflection rate obtained by varying the effective length of the spring assembly. This is accomplished by using a cam-type bracket. As the spring assembly deflects, the point of contact on the bracket moves toward the center of the spring assembly shortening the effective length, Figure 5.

Vari-rate spring assemblies also incorporate a progressive feature in that the bottom spring leaves are separated at the ends. AS the spring assembly deflects, these leaves comes in contact providing increased capacity and stiffness.

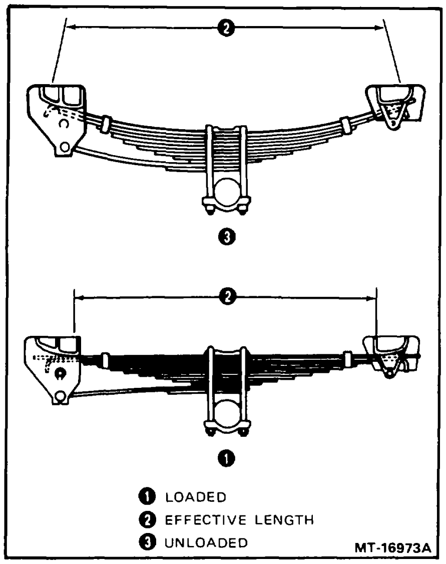


Figure 5 - Progressive Spring Assembly

MAINTENANCE

Lubrication

For lubrication intervals, refer to Operator's Manual. For types of lubricants recommended, refer to LUBRICATION section CTS-4033.

Retightening U-Bolt Nuts

U-bolt nuts must be retightened at the intervals listed below. This applies to both new vehicles and to vehicles on which spring service has been performed.

1. The U-bolt nuts must be retightened after the vehicle has operated **under** load for 1 600 kilometers (1,000 miles) or six months, whichever occurs first.

2. Thereafter, the spring U-bolt nuts should be retightened every 58,000 kilometers (36,000 miles).

CAUTION---WHEN CHECKING U-BOLTS TO DETERMINE IF LOOSENESS HAS OCCURRED, TORQUE VALUES OF 40% OF THE SPECIFICATIONS WOULD ASSURE JOINT INTEGRITY, PROVIDED THE U-BOLTS AND NUTS WERE IN LIKE-NEW CONDITION. HOWEVER, ALWAYS TIGHTEN TO *ORIGINAL SPECIFICATIONS*. RUSTY JOINTS MUST BE DISASSEMBLED, CLEANED AND LUBRICATED TO ASSURE A LIKE-NEW CONDITION PRIOR TO TIGHTENING.

SERVICING

Although the exact servicing procedures are different for each type of spring assembly and application, the basic procedures are similar. The following is a general outline for servicing all spring assemblies.

Removal

1. Place floor jack under truck frame and raise truck sufficiently to relieve weight from spring to be removed.
2. Remove shock absorbers where used.
3. Remove U-bolts, spring bumper and retainer or U-bolts seat.
4. Remove lubricators (not used on springs equipped with rubber bushings).
5. Remove nuts from spring shackle pins or bracket pins.
6. Slide spring off bracket pin and shackle pin.

Disassembly

1. Clamp spring end in vise and remove old bushing from spring eye.
2. Reposition spring in vise so that assembly will be clamped near center.
3. If bolted-type rebound clips are used, remove nuts, bolts and spacers. Where clinch type rebound clips are used, bend tabs of clips up, being careful not to break them. Heating clips with torch will help avoid breakage.
4. Remove nut from spring center bolt.
5. Release vise to permit spring leaves to separate. Remove spring from vise and separate leaves from center bolt.

Cleaning, Inspection and Repair

1. Wash all parts in cleaning solvent or use steam cleaning equipment to remove grease and scale. Use a wire brush to hasten dirt removal.

   Do not immerse rubber spring bushings in cleaning solvent. Use a non-petroleum base type rubber lubricant on a clean cloth to wipe these parts clean.

2. Inspect all spring leaves for breakage and cracks. Also compare arch of leaves with new leaves. If leaves are flattened out, replace.

3. Spring pins must be replaced if they are worn, corroded or cracked.

4. Spring eye bushing and spring shackle bushing must also be replaced if defective.
5. Check spring brackets for cracks or for wear around mounting bolt or rivet holes. Replace bracket if damaged.

6. Always use new center bolts at each overhaul.

Assembly

1. Lightly lubricate spring leaves with a thin coat of graphite grease. Place spring leaves in proper order and align center bolt hole with a long drift.

2. Compress spring leaves sufficiently for installing center bolt and nut.

3. Place spring assembly in vise and compress spring leaves fully.

   WARNING--WHEN ASSEMBLING SPRING LEAVES, BE CAREFUL TO PREVENT PHYSICAL INJURY TO PERSONNEL. THE USE OF SPECIAL HOLDING FIXTURES OR *"C"* CLAMPS FOR HOLDING SPRING LEAVES IN PLACE DURING ASSEMBLY IS STRONGLY RECOMMENDED.

4. Align spring leves by tapping with a hammer and position rebound clips on spring. If bolted type clips are used, install spacers, bolts and nuts. Tighten enough to hold leaves in alignment but not enough to restrict free movement. If clinch type clips are used, bend ends of clips down on top leaf. Heat clips with torch to help avoid breakage.

Installation

Before reassembly, all shackle bolts, U-bolts, etc. should be cleaned and lubricated.

While the actual installation procedures will vary with each spring type, the pivot end of spring is usually fastened to frame bracket first.Shackle end can then be fastened by aligning shackle to other frame bracket.

When installing U-bolts for securing axles, do not final tighten until springs have been placed under normal load. See SPECIFICATIONS for U-bolt torque.

Spring failures may occur at the center bolt hole if U-bolts become loosened. These bolts must be retightened at the intervals specified under **MAINTENANCE.**

SHOCK ABSORBERS
DESCRIPTION

Shock absorbers are provided to control body sway, to eliminate excessive tire wear, front wheel shimmy, and spring breakage. They also improve the riding qualities of the truck and are especially useful when the truck is empty or only partly loaded.

The direct-acting type shock absorber (Figure 6), sometimes called airplane type, has a sealed construction and requires no periodic maintenance. Shock absorbers of this type should be checked every 16,000 km (10,000 miles). Make sure they are functioning satisfactorily, that bushings are not worn, and that outer jacket has not been damaged by flying stones or debris from the road. If a shock absorber is leaking, fails to operate, or develops unusual noises, the complete unit should be replaced. Direct acting shock absorbers are nonrefillable and service is limited to unit replacement.

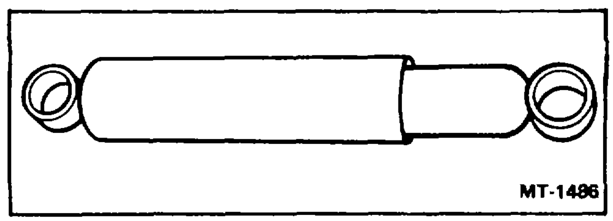


Figure 6 --- Direct Acting Shock Absorber

MOUNTING AND LINKAGE

Check for and correct loose, bent or broken shock absorber mountings and linkage when servicing the suspension system. Inspect all rubber bushings and grommets to see that they effectively keep metal from striking metal. Link or bushing wear can be checked by twisting link with pliers or by prying link connection with screwdriver or small pry bar. Outward appearance will usually reveal excessive wear.

TROUBLESHOOTING

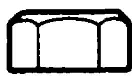
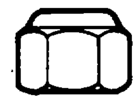
The following list covers the most frequent causes for troubles which may occur in the suspension system. However, several items may overlap similar complaints and causes that are common to axle and wheel alignment troubleshooting. For additional information on these or related items of troubleshooting, see AXLE-FRONT, CTS-4013.

Complaint	Possible Cause
1. Truck wanders.	a. Front axle shifted on springs. b. Broken spring. c. Out of alignment.
2. Truck bottoms.	a. Overloading. b. Broken spring leaves. c. Defective shock absorbers. d. Weak spring.
3. Truck lopsided.	a. Broken spring leaves. b. Wrong spring installed. c. Weak spring.
4. Frequent spring breakage.	a. Overloading or severe operation. b. Loose U-bolts. c. Defective shock absorbers. d. Tight spring shackle.
5. Noisy springs.	a. Loose U-bolts. b. Loose rebound clips. c. Loose shackles. d. Worn shackle bushings. e. Loose, bent or broken spring brackets. f. Worn spring pins.
6. Erratic steering when braking.	Loose U-bolts.

SPECIFICATIONS

TORQUE CHART

FOR ASSEMBLY OF SUSPENSION U-BOLTS

Recommended Wrench Torque						
U-Bolt Diameter and Thread	All Steel Locknut 		All Steel Flange Nut 		Nylon Insert Nut 	
Cut Thread U-Bolts (Prior to July 1974)						
	Newton Meters	Foot Pounds	Newton Meters	Foot Pounds	Newton Meters	Foot Pounds
7/16" - 20	68 - 81	50 - 60	—	—	79 - 92	58 - 68
1/2" - 20	88 - 102	65 - 75	—	—	104 - 118	77 - 87
9/16" - 18	109 - 129	80 - 95	—	—	130 - 151	96 - 111
5/8" - 18	163 - 190	120 - 140	—	—	197 - 224	145 - 165
3/4" - 16	197 - 224	145 - 165	—	—	339 - 407	250 - 300
7/8" - 14	258 - 312	190 - 230	—	—	448 - 502	330 - 370
1" - 14	298 - 353	220 - 260	—	—	651 - 786	480 - 560
—	—	—	—	—	—	—
Rolled Thread U-Bolts						
	Newton Meters	Foot Pounds	Newton Meters	Foot Pounds	Newton Meters	Foot Pounds
1/2"- 2 0	68 - 81	50 - 60	88 - 109	65 - 80	—	—
5/8" - 18	142 - 170	105 - 125	176 - 217	130 - 160	—	—
3/4" - 16	237 - 292	175 - 215	298 - 325	220 - 240	—	—
7/8" - 14	—	—	—	—	305 - 373	225 - 275
1" - 14	—	—	—	—	441 - 543	325 - 400

SPECIAL TOOLS

SE-2189 Torque Indicator Wrench (100-600 lb.-ft.)
SE-2221 Torque Indicator Wrench (0-150 lb.-ft.)

SPRINGS

Insert this new Section in your CTS-4001 Service Manual.

EQUALIZING BEAM SUSPENSION (HENDRICKSON)

CONTENTS

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CODE CONVERSION CHART-SUSPENSIONS (HENDRICKSON TO IH)

	Equalizer Beam Length						
	50"	52"	54"	56"	60"	65"	72"
RT340	14521	14516	14512	14655	14606		
RTE340	14518	14652					
RT380	14548	14589	14555	14656	14594		14645
		14644HD	14650HD	14681HD			
RTE380	14566	14590	14587		14596		
RT440		14591	14556		14607	14680	14643
			14557HD				
RT441		14599	14595	14661			
RT450			14666				
RT500				14524	14667		
RS340	14531	14515					
*RS380	14532	14517	14574		14593		14662
		14684TTR	14651HD				
RS440		14642	14569		14654	14675	14646
RS450		14668					
RS500				14539			
R380	14502	14507			14657		14662
R440			14678	14659	14658		
R500				14586			
U340	14688						
UE340	14665	14674					
RU340	14575						
RUE340	14578	14609					
Light Weight Equalizer Beam	14802	14805	14808				

*Code 03754 3rd Load Cushion for Rubber Spring Bogie Suspension
Code 14810 Heavy Duty Center and End Bushing.

DESCRIPTION

Tandem drive axles require a special suspension which permits flexibility between the axles but still withstands rugged usage with long service life. The equalizing beam type suspension system described herein embodies these required characteristics. The types of Hendrickson equalizing beam suspensions used on International trucks are the leaf spring type and rubber load cushion type.

LEAF SPRING TYPE

The leaf spring type suspension (Figure 1) uses semielliptic leaf springs to cushion load and road shocks. The springs are mounted on saddle assemblies above the equalizer beams and are pivoted at the front end on spring pins and brackets. Rear ends of springs have no rigid attachment to spring brackets, but are free to move forward and backward to compensate for spring deflection.

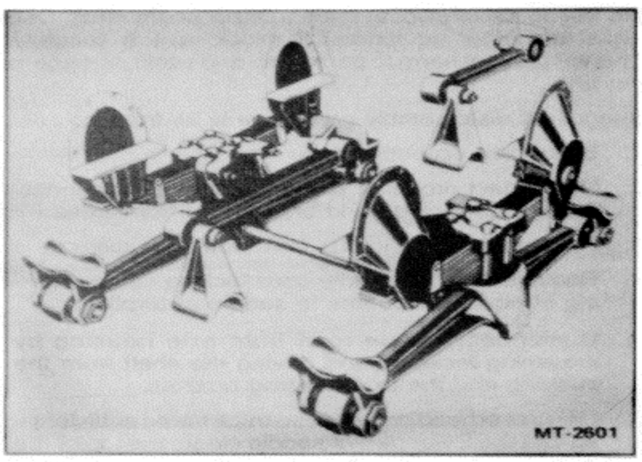


Figure 1 -- Equalizing Beam Suspension (Leaf Spring Type)

The equalizing beams utilize the "lever" principle to distribute the load equally between axles and to reduce the effect of bumps and road irregularities. The torque rods permit complete absorption of torque, which is the tendency of the axles to turn backwards or forward on their axis due to starting or stopping inertia. The cross tube connecting the equalizing beams assures correct alignment of the tandem and prevents damaging load transfer.

RUBBER CUSHION TYPE

This type of suspension system (Figure 2) uses rubber cushions in place of leaf springs to absorb load and road shock. On these units, rubber cushions are mounted on a saddle assembly at each side. Positive mounting between frame brackets and the suspension unit is secured by four rubber-bushed drive pins, one each of which passes through a rubber cushion.

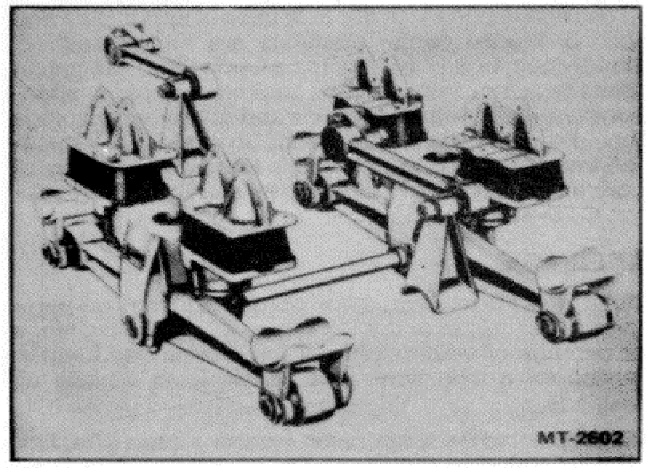
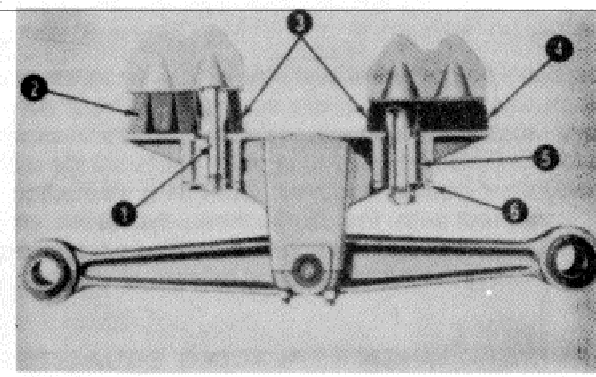


Figure 2 - Equalizing Beam Suspension (Rubber Cushion Type)

Without load, the unit rides on the outer edge of the load cushions. As the load increases, the crossbars of the cushions are progressively brought into contact to absorb the additional load. Cushioning and alignment are accomplished by the four drive pins encased in rubber bushings. The bushings permit the drive pins to move up and down in direct relation to movement of the load cushions. See Figure 3.



1 INTEGRAL DRIVE PIN WITH BRACKET
2 NO LOAD POSITION
3 RUBBER CUSHIONS
4 FULL LOAD POSITION
6 RUBBER DRIVE PIN BUSHING
7 BUSHING RETAINER CAP MT-2*03A

Figure 3 - Sectional View. Rubber Cushion Type Suspension

MAINTENANCE

LUBRICATION

All oscillating parts with the exception of spring pins and optional bronze center bushings are rubber bushed. Since rubber bushings require no lubrication, lubrication points have been reduced to a minimum. Those suspensions equipped with spring pins and/or bronze bushings should be lubricated at the fittings provided. For lubrication intervals, refer to Operator's Manual. For types of lubricants recommended, refer to LUBRICATION section CTS-4033.

SERVICE

Clean all dirt from suspension parts and inspect all parts carefully for cracks or damage. Inspect rubber bushings for damage or deterioration. If the vehicle has been in service for a long time, it is advisable to replace all bushings.

Most repairs to the suspension system consist of replacing worn or damaged parts. The major item which will concern the serviceman is removal and replacement of the rubber bushings.

While the bushings have long life and replacement will be limited, they can be replaced if damaged or deteriorated. Special service tools for performing this task are available, and though recommended are not absolutely necessary. If press equipment is available, standard steel tubing having diameters to match the bushing sleeves (metal bands surrounding rubber bushings) can be used as adapters for removing and installing the bushings (see SPECIFICATIONS). Press pressures required to remove the bushing and sleeve assemblies will generally be between 31 and 45 Mg (35 and 50 tons).

Special tool equipment is available which can be used to replace the equalizer beam bushings without completely removing the equalizer beam from the chassis.

The tool can also be used to replace the bushings with the equalizer beams removed. Operating instructions are furnished with the equipment. However,' the "CAUTION" notices pertaining to equalizer component replacement provided in this service manual should be followed.

WARNING - WHEN REPLACING EQUALIZER BEAM BUSHINGS ONLY THE PROCEDURES OUTLINE IN THIS MANUAL SECTION SHOULD BE EXERCISED.

WELDING, TORCHING, DRILLING, TAPPING OR ATTACHING MATERIAL TO THE EQUALIZER BEAM MUST NEVER BE PERFORMED AS SUCH PRACTICE CAN RESULT IN EQUALIZER BEAM FAILURE. EQUALIZER BEAMS ARE CONSTRUCTED OF ALUMINUM OR NODULAR IRON, METALS WHICH CAN EASILY BECOME BRITTLE WITH HEAT AT QUITE LOW TEMPERATURES.

WHEN REPLACING EQUALIZER BEAM BUSHINGS THE EQUALIZER BEAMS SHOULD BE THOROUGHLY INSPECTED TO ASCERTAIN IF THEY HAVE BEEN HEATED, IF CAVITIES HAVE BEEN PRODUCED OR OTHERWISE DAMAGED BY IMPROPER SERVICING AND IF SO, REPLACE ANY COMPONENTS WHICH ARE QUESTIONABLE.

DISASSEMBLY

Except for different suspensions (leaf springs or rubber cushions) and slight variations in size, all equalizing beam suspension systems are disassembled in the same manner. There are several approaches to servicing the suspension system, but when a major overhaul is required, the complete tandem unit can be removed from the truck chassis. Torque arms, equalizer beams, springs and other parts, however, may be removed separately as required. When complete removal is performed, be careful disconnecting torque rods, springs or rubber cushions from the frame since axle assemblies are free to roll or pivot at the equalizer beam ends. Use jacks and other equipment to block vehicle securely. This will prevent harm to personnel and avoid damage to the unit.

Suggested disassembly procedure is as follows:

1. Block tires on both axles.
2. Disconnect propeller shafts, inter-axle lock control linkage (or piping), and brake lines from axles.
3. Remove the axle shafts from both rear axles.
4. Remove the four saddle caps locking center bushing of equalizer beams to saddle assemblies.
5. Disconnect torque rods from axle housing by loosening locknuts and driving the shaft from the bushing and the axle housing bracket.
6. Using overhead crane, raise truck frame sufficiently so that the lower part of saddle clears the top of the axle housings. Block frame securely. Block axles to prevent them from pivoting on wheels.
7. Roll axles with beams attached out from under vehicle.
8. Disconnect equalizer beams from axle housings.

Bolt type beam end mounting, Figure 4.

a. Remove equalizer beam end bolt.
b. Drive bushing adapters and sleeve (if so equipped) out of bushing and axle housing brackets. Adapters are notched to help keep chisel in place between axle bracket and adapter. Driving chisel first one side then the other side of adapter will wedge out adapter.
c. After the first adapter is removed, the opposite adapter can be driven out with an impact hammer or heavy bar and hammer.

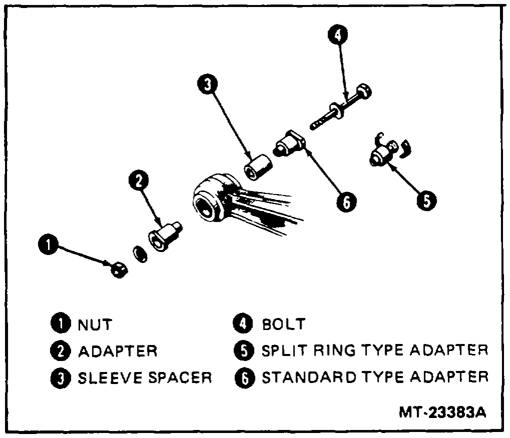


Figure 4 - Three Piece Adapter Bolt Type Beam End Mounting

Tube Type Beam End Mounting, Figure 5

a. Remove equalizer beam end tube nuts.

b. Pull or drive end tubes from axle housing brackets and beam end bushings. If end tube is frozen in bushing, install one nut on tube and tighten against bracket until tube breaks loose in bushing.

The tube can sometimes be removed by removing the nuts and using a spacer bushing between one nut and beam hanger. Tighten nut to pull tube loose.

If the afore mentioned methods do not pull tube loose, a portable hack saw can be used to saw through the tube along the inside surface of beam hanger bracket legs.

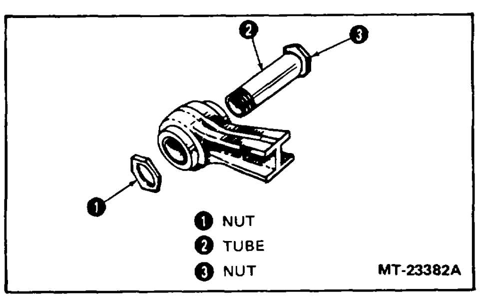


Figure 5 - Tube Type Beam End Mounting

Ball and Socket Beam End Mounting, Figure 10

a. Remove cotter key from each end of shaft.
b. Remove one or both castellated nuts.
c. Use a heavy bar and hammer to drive out shaft.

9. Separate equalizer beams from cross tube.

After both equalizer beams have been separated from axles, separate the beams from cross tube by pulling apart by hand.

The cross tube floats in the inner *sleeve* of the center bushings. Slide float is 76mm (3") plus, which will polish the cross tube where it enters the center bushing on each side. This visible polished area on the cross tube is normal.

10. Remove saddle assemblies, springs or cushions.

Leaf Spring Type, Figure 14

a. Support spring and saddle assembly on floor jack. Loosen spring aligning set screw (item 11). Remove spring top pad to saddle bolts and nuts. Remove top pad. Lower floor jack and remove saddle.

b. Remove spring assembly *by repositioning* floor jack under spring. Loosen locknut on spring pin draw key (item 3).

Back off nut sufficiently to protect draw key threads, then strike nut with soft hammer to loosen draw key. Remove draw key and drive spring pin out of spring and spring bracket. Lower spring assembly from frame and remove from jack.

Rubber Cushion Type, Figure 15

a. Remove the four vertical drive pin bushing retainer caps (item 6).

b. Remove drive pin nuts (item 8). Separate saddles (item 4) and load cushions from vertical drive pins.

In extreme cases, it may be necessary to cut drive pin nuts to remove them.

c. Replacement of drive pin bushings procedure will be found in REPAIR portion of this manual section.

11. Remove torque rods from crossmember frame bracket, should the bushings show evidence of wear.

CLEANING, INSPECTION AND REPAIR

LEAF SPRING ASSEMBLY

1. Wash all parts in cleaning solvent or use steam cleaning equipment to remove grease and scale. Use a wire brush to hasten dirt removal.
   CAUTION DO NOT IMMERSE RUBBER SPRING BUSHINGS IN CLEANING SOLVENT. USE A NON-PETROLEUM BASE TYPE RUBBER LUBRICANT ON A CLEAN CLOTH TO WIPE THESE PARTS CLEAN.
2. Remove spring center bolt. Inpect all spring leaves for breakage and cracks. Also compare arch of leaves with new leaves and if leaves are flattened out, replace.
3. Spring pins must be replaced if they are worn, corroded or cracked.
4. Spring eye bushing and spring shackle bushing must also be replaced if defective.
5. Inspect spring hangers for wear or elongated holes and cracks. Replace hangers if defective.
6. Always use new center bolts at each overhaul.
7. Lightly lubricate spring leaves with a thin coat of IH-251H-EP multi-purpose grease. Place spring leaves in proper order and align center bolt hole with a long drift.
8. Compress spring leaves sufficiently for installing center bolt and nut. Always use new center bolts at each overhaul. Tighten center bolt to specified torque.
   WARNING - WHEN ASSEMBLING SPRING LEAVES, BE CAREFUL TO PREVENT PHYSICAL INJURY TO PERSONNEL.THE USE OF SPECIAL HOLDING FIXTURES OR "C" CLAMPS FOR HOLDING SPRING LEAVES IN PLACE DURING ASSEMBLY IS STRONGLY RECOMMENDED.
9. Align spring leaves by tapping with hammer and position rebound clips on spring. If bolted type clips are used, install spacers, bolts and nuts. Tighten enough to hold leaves in alignment but not enough to restrict free movement. If clinch type clips are used, bend ends of clips down on top leaf. Heat clips with torch to help eliminate breakage.

LOAD CUSHIONS

Visual inspection will determine necessity for replacement.If the load cushion is cut or damaged, it will lose its capacity and replacement should be made. The height of the load cushion is 10 cm (3-15/16") and it is possible that a permanent set could come about in service. A permanent set of not more than 19mm (1/4") would still make the cushion acceptable for use. This means that a cushion with a free height of less than 9.37 cm (3-11/16") should be renewed.

The load cushions are made of butyl and natural rubber and are not resistant to petroleum products. If the cushions become saturated with these products they will split and disintegrate. In an operation where these products are used, an oil resistant compound load cushion is available.

Replace cushions, if they have taken a permanent set, and the height is 9.37 cm (3-11/16") or less.

DRIVE PIN BUSHING

1. vertical drive pin bushings should be pressed out of the saddles from the top side. If the outer sleeve is frozen to the saddle wall, press the inner sleeve and rubber out of the bushing and work the outer sleeve out of the saddle. **Do not cut with torch or use heat as aluminum saddle Is Heat Treated.**

2. Clean the bushing cavities in the saddles with solvent and remove any nicks with emery cloth.

3. This bushing is not pressed to fit as there is at least .18mm (.007") clearance and new bushings can be hand pressed.

4. Reinstall bushing caps and locknuts to specified torque rating. (See Torque Chart).

EQUALIZER BEAM END BUSHING REPLACEMENT

Refer to the SERVICE portion of this manual section pertaining to the WARNING regarding equalizer beams.

1. Cut off rubber bushing flush with equalizer beam, as shown' in Figure 6. Rubber must be removed to permit adapter to contact bushing sleeve squarely.

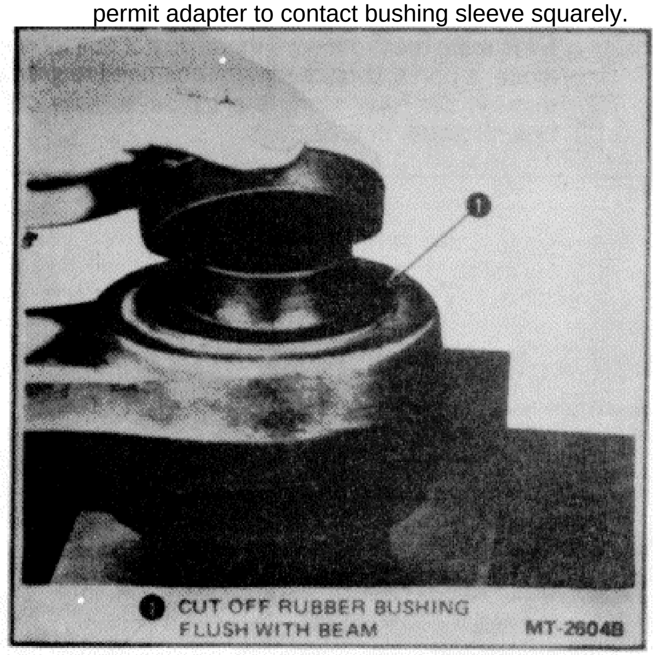


Figure 6 - PreparIng for Removal of Beam End Bushing Bushing

2. Support beam in press. Using a piece of standard tubing (which will contact the bushing sleeve) as an adapter, press the bushing from the beam. See Figure 7.

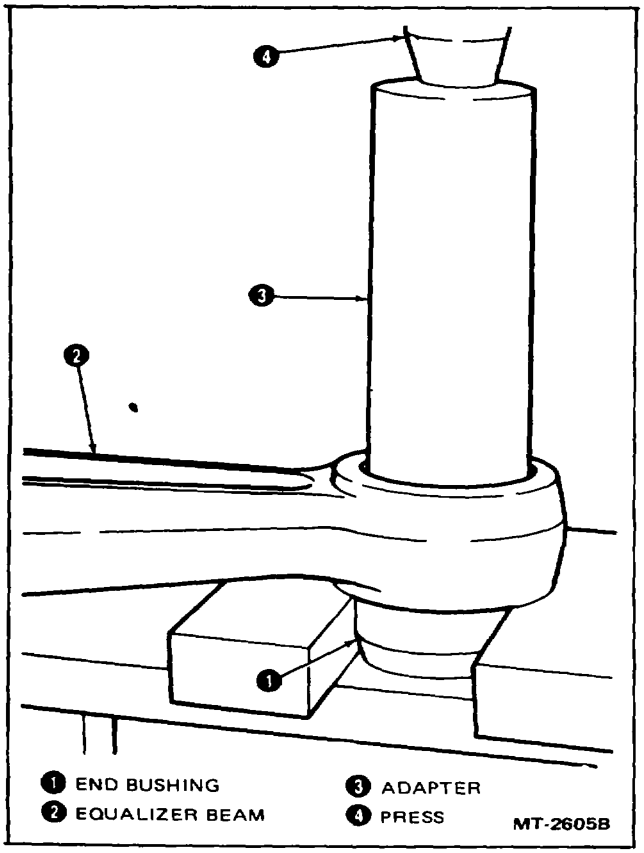


Figure 7 - Removing Equalizer Beam End Bushing

3. Apply a thin coat of IH-251H-EP multi-purpose high pressure lithium grease to outer diameter of bushing sleeve.

4. Install sheave puller over bushing and compress rubber until puller jaws will seat on the end of the bushing sleeve. Refer to Figure 8.

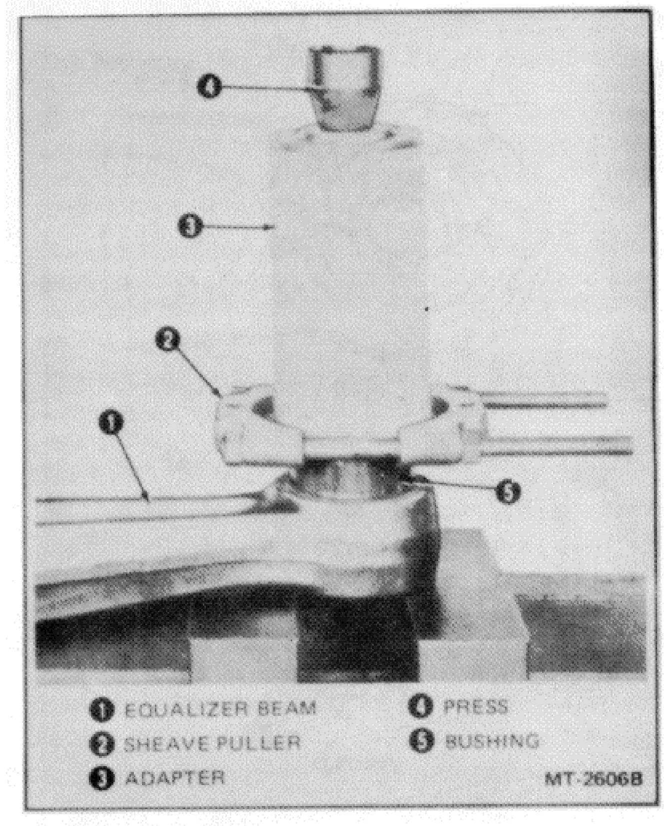


Figure 8 - Installing Equalizer Beam End Bushing

5. Continue pressing until bushing is centered in beam.

BALL AND SOCKET BEAM END BUSHING REPLACEMENT

1. Center sockets in beam end bore with socket split as shown in View A, Figure 9.

2. After new ball sockets are pressed into equalizing beams, sockets must be counterbored prior to installing the washers and bolts. Use a 28.57mm (1-1/8") cutter and counterbore to a depth of 2.38mm (3/32"). (Tool can be obtained from Owatonna Tool Co., Ref. No. P72-76A.)

3. Insert four 25.4mm (1") hardened flat washers top and bottom on both ends of the beam as shown in View B, Figure 9.

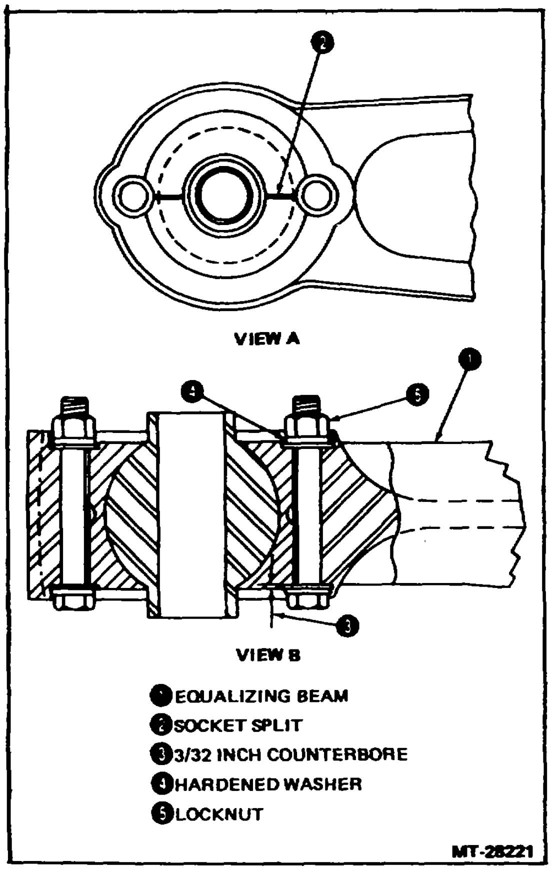


Figure 9 - Ball and Socket Beam Ford

4. Install bolts and locknuts and tighten to 6267 N-m (45-50 lb.-ft See Figure 10 for detailed view.

CAUTION - WHEN REINSTALLING THE "RUBBER BUSHED" EQUALIZING BPIST TO THE AXLES AND SADDLES, DO NOT TIGHTEN NUTS UNTIL TORQUE RODS ARE INSTALLED AND EQUALIZING BEAMS ARE LEVEL WITH THE FRAME. (THIS IS TO ASSURE THAT THE RUBBER IS IN A NEUTRAL POSITION, EUMINATING THE POSSIBILITY OF TORSIONAL WIND-UP, WHICH MAY AFFECT RIDE QUALITY.) THEN TIGHTEN ALL NUTS TO RECOMMENDED TORQUE (SEE SPECIFICATIONS).

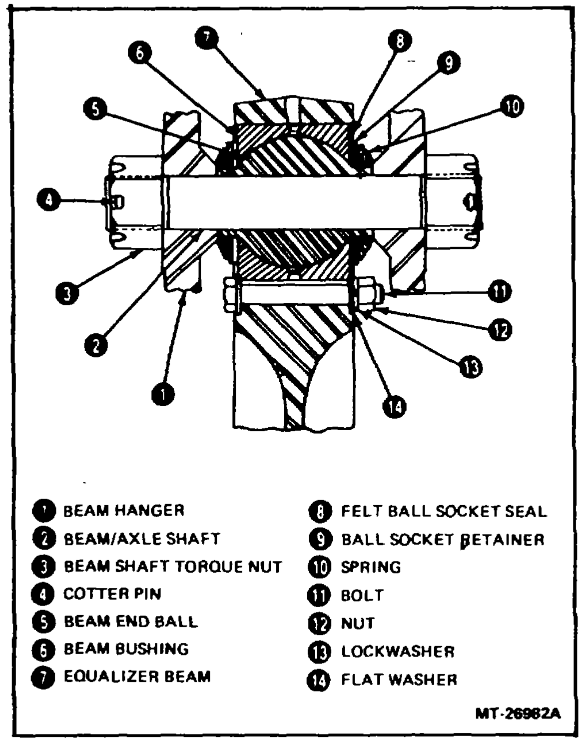


Figure 10 - Ball and Socket Beam End

BRONZE CENTER BUSHING REPLACEMENT

1. Remove the two saddle caps from each saddle.

2. Raise the vehicle frame and place safety stands under the frame.

3. Place a jack between the equalizer beam and the spring or saddle. Force the beam down from the saddle until the bushings clear the saddle.

4. Remove the center bushing from each beam.

WARNING - DO NOT USE UNSAFE MAKESHIFT METHODS TO REBUSH THE EQUALIZING BEAMS. DO NOT USE A CUTTING TORCH TO REMOVE THE BUSHINGS FROM THE BEAM CENTERS OR ENDS. ALL EQUALIZING BEAMS ARE HEAT TREATED FOR STRENGTH AND LONG SERVICE UFE. USE OF HEAT WOULD ADVERSELY AFFECT THE STRENGTH OF THE EQUALIZING BEAMS.

5. Lubricate the outside of each center bushing and the bushing bore in each beam with IH-251H-EP multi-purpose grease.

6. Install the center bushings in the beams. Then, remove the tools.

7. Install a new cross tube in the center bushings. Lubricate the tube end and bushing ID. Install the center bushing plugs and weld the plugs in the bushings.

8. Raise the axles until the saddles rest on the equalizer beam bushings, and remove the safety stands from under the vehicle.

9. Lower the axles and check the alignment of the saddles on the bushings. Install the saddle caps and tighten the attaching nuts to specifications as listed at the end of this Section. **The axles must be in the operation position when the saddle caps are tightened.**

EQUALIZER BEAM CENTER SLEEVE AND BUSHING

1. Support beam in press. Using adapter made from appropriate size standard tubing to fit against center sleeve and bushing assembly, press out bushing assembly. See Figure 11.

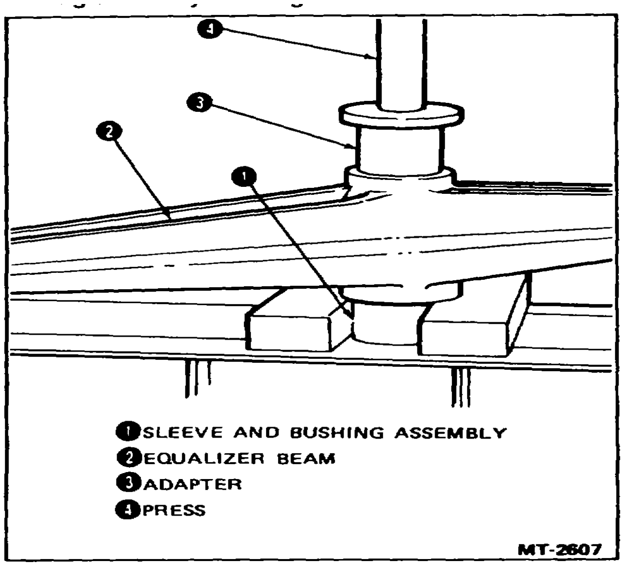


Figure 11 - Removing Equalizer Beam Center Sleeve and Bushing

2. Apply a thin coat of IH-251H-EP multi-purpose grease to outside diameter of sleeve and bushing assembly.

3. Support beam in press. Using adapter press bushing and sleeve assembly into beam. See Figure 12. Bushing and sleeve assembly should be centered in beam.

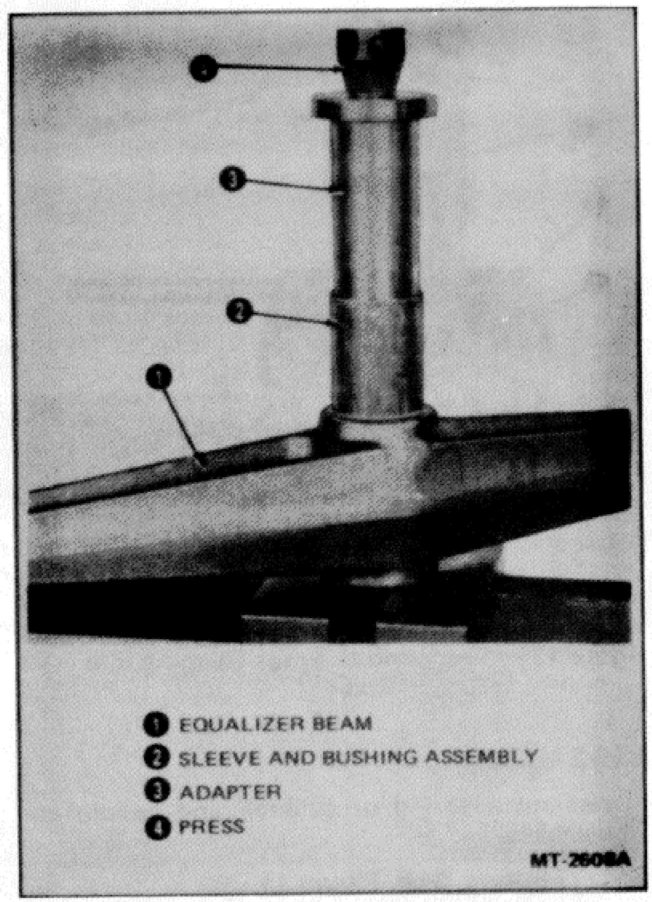


Figure 12 - Installing Center Sleeve and Bearing

TORQUE ROD BUSHING REPLACEMENT

1. Cut off rubber bushing flush with torque rod, as instructed for equalizer end bushing removal. Refer to Figure 6.

2. Support torque rod in press. Using a piece of tubing as an adapter, press bushing out of torque rod.

3. Apply a thin coat of IH-251H-EP, multi-purpose grease to outer diameter of bushing sleeve.

4. Install sheave puller over bushing and compress rubber until puller jaws will seat on end of bushing sleeve. Refer to Figure 8.

5. Place adapter over end of bushing, resting on sheave puller. (See Figure 13) Press bushing into torque rod until bushing is centered in bushing bore.

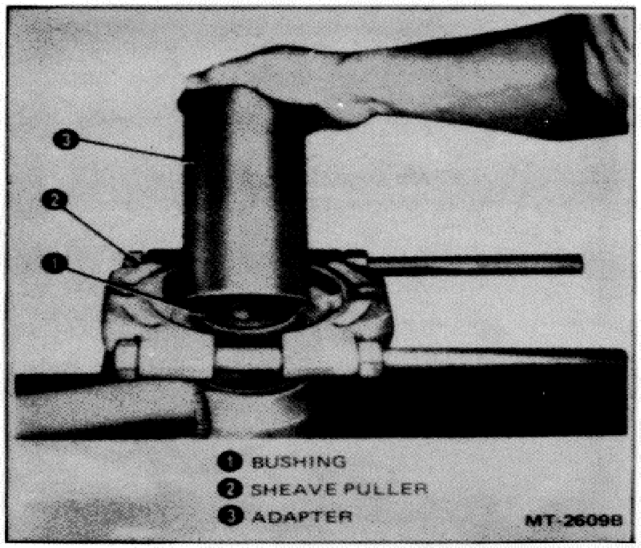


Figure 13 - Preparing to Press Bushing Into Torque Rod

ASSEMBLY

1. Assemble spring or cushion and saddle assemblies.

Leaf Spring Type, Figure 14

a. Seat spring in spring saddle with head of spring center bolt positioned in hole provided in saddle.

b. Position spring top pad over "cup" on main spring leaf.

c. Install saddle-to-top pad bolts and nuts. Run nuts up snug, but do not tighten completely at this time.

d. To properly position the spring in the saddle, tighten the spring aligning set screws to specified torque (see "SPECIFICATIONS"). Tighten aligning screw locknuts.

e. Tighten saddle-to-top pad bolt nuts to specified torque (see "SPECIFICATIONS").

f. Using roller jack, position spring (with saddle) in front and rear spring mounting brackets.

g. Align spring eye with spring pin bore in front bracket. Install spring pin, aligning draw key slot in pin with draw key bore in bracket.

h. Install draw key, lock washer and nut. Tighten nut to specified torque (see SPECIFICATIONS").

i. Install lubricator fitting in spring pin and lubricate

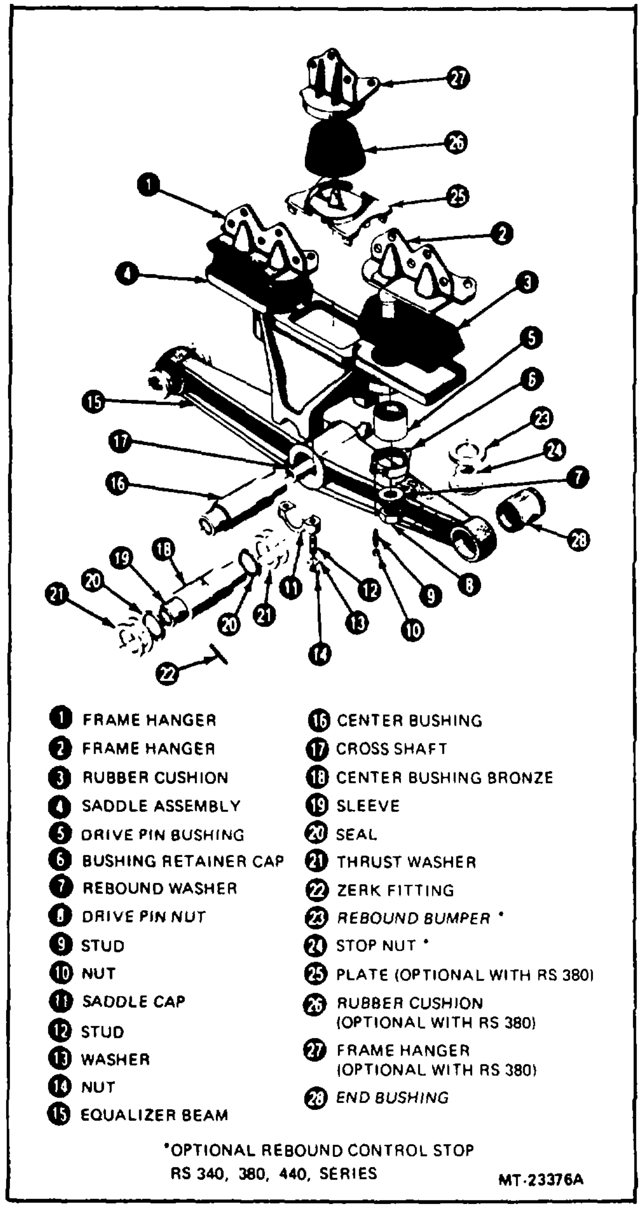


Figure 14 - Leaf Spring Type Suspension

Rubber Cushion Type

a. With the drive pin bushings assembled to the saddle and bearing caps installed, assemble the rubber load cushion on saddle.

b. Apply a light coat of IH-251H-EP multi-purpose grease to the drive pins on the frame brackets.

c. Assemble the frame brackets to the saddle by inserting the drive pins through the load cushions and the drive pin bushings.

d. Install drive pin nuts and washers. Washers are installed with flange down. Tighten nuts snug.

If frame hangers were removed, tighten nuts to specified torque after hangers have been assembled to chassis frame.

e. Assemble the preassembled saddles, load cushions and frame hangers to the chassis frame. Install mounting bolts, lock washers and nuts.

f. Tighten mounting bolt nuts to specified torque. (See SPECIFICATIONS.)

g. Tighten drive pin nuts to specified torque. (See SPECIFICATIONS.)

2. Assemble cross tube and equalizer beams to axle assemblies, Figures 14 and 15.

CAUTION -- WHEN ASSEMBLING SUSPENSION, EQUALIZER BEAM AND MOUNTING NUTS, AND EQUALIZER BEAM SADDLE CAP MOUNTING NUTS SHOULD HAVE FINAL TORQUE APPLIED WITH WHEELS OF VEHICLE ON GROUND.

WARNING -- THREE TYPES OF EQUALIZER BEAMS ARE UTILIZED IN THE MANUFACTURING OF INTERNATIONAL TRUCKS EQUIPPED WITH EQUALIZER BEAM SUSPENSIONS.ALTHOUGH THE APPEARANCE OF THE EQUALIZER BEAMS IS SIMILAR, THERE IS A SUBSTANTIAL DIFFERENCE IN THE MATERIAL OF WHICH THEY ARE MANUFACTURED.

THE MATERIALS OF THE EQUALIZER BEAMS INVOLVED ARE ALUMINUM, CAST STEEL AND NODULAR IRON.ALUMINUM AND CAST STEEL EQUALIZER BEAMS ARE MANUFACTURED SUCH THAT THEY CAN BE STRESSED IN EITHER DIRECTION. NODULAR IRON EQUALIZER BEAMS ARE MANUFACATURED SUCH THAT THEY CAN BE STRESSED IN ONE DIRECTION ONLY. THUS IT IS IMPERATIVE THAT NODULAR IRON EQUALIZER BEAMS BE INSTALLED WITH THE CORRECT SIDE UP.

TO AID IN IDENTIFICATION AND FACILITATE INSTALLATION OF NODULAR IRON BEAMS, AN ARROW AND THE WORD UP HAVE BEEN MOLDED ON THE SIDE OF NODULAR IRON

BEAMS. ALSO, REINFORCING GATE PADS HAVE BEEN DESIGNED INTO EACH END AND MIDDLE OF THE TOP SIDE OF NODULAR IRON BEAMS.

NODULAR IRON EQUALIZER BEAMS MUST BE INSTALLED WITH GATE PADS ON TOP SIDE OF BEAM AND THE ARROW MOLDED ON THE BEAM SIDE POINTING UPWARD.

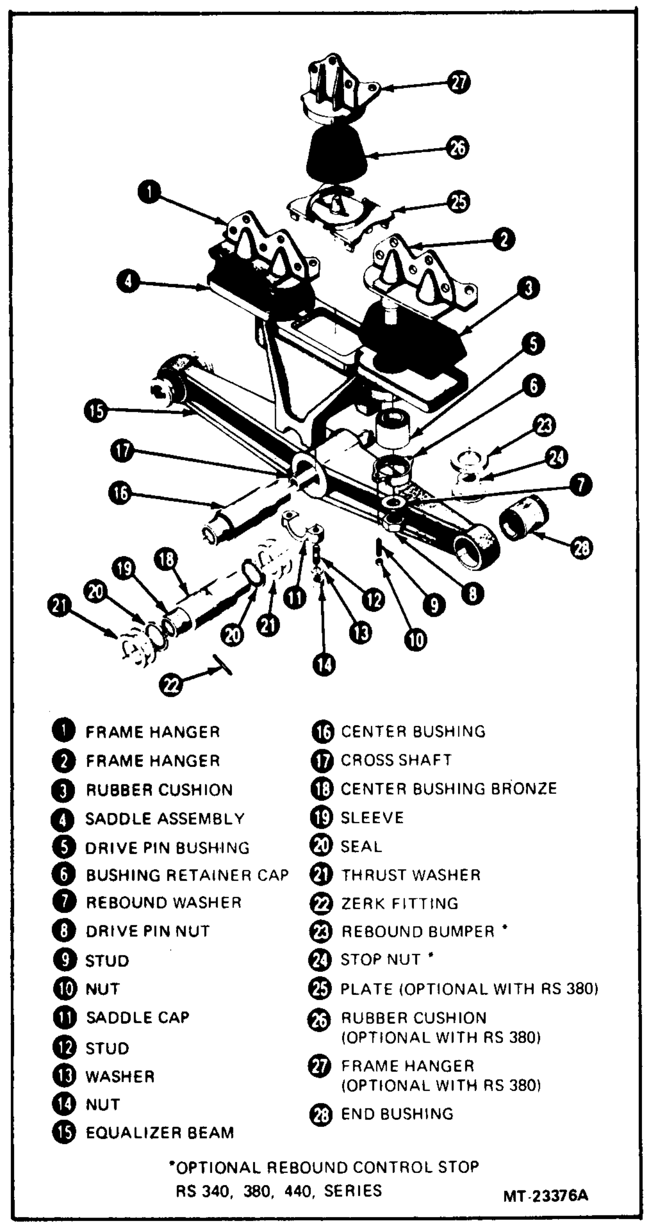


Figure 15 - Rubber Cushion Type Suspension

Tube Type Beam End Mounting, RS 500 and RT 500 only, Figure 5

a. Apply a light coat of IH-251H-EP multi-purpose grease to outer diameter of end tubes.

b. Align the beam end bushings with hanger brackets and insert end tubes. Center tubes in bushings so that ends of tubes are equidistant from outer faces of hanger brackets.

c. Install end tube nuts. Make sure nuts are properly threaded on tubes. Do not tighten nuts at this time.

Bolt Type Beam End Mounting, Figure 4

a. Align beam end bushings with hanger brackets and insert bushing adapters. Lubricate adapters with a light coat of IH-251H-EP mutli-purpose grease. Flat surface on adapters must be in vertical position.

b. Tap adapters into bushing until adapter flanges contact outer faces of hanger brackets.

c. Install bolt and locknut. Do not tighten nut at this time.

Bolt Type End Mounting with Split-Ring Type Adapters, Figure 4

a. Place inner adapter (with split-ring) inside beam end bushing with grooved end of adapter toward bowl of axle housing. Lubricate adapter with a light coat of IH-251H-EP multi-purpose grease. Make sure nut is in position in lugs of adapter.

b. Align beam end bushing with hanger brackets and install outer adapter.

c. Start bolt through outer adapter, push inner adapter with bolt until groove in adapter appears past face hanger.

d. Install split-ring. Thread bolt into nut. Do not tighten bolt to specified torque at this time. When bolts are torqued after torque tools are installed, place a bar between the lugs on the adapter to hold the nut while tightening the bolt with a wrench.

Ball and Socket Beam End Bushing Type Mounting, Figure 10

Assemble ball and socket beam end bushing type mounting as shown in Figure 10. Do not tighten nuts at this time. Repeat same procedure at opposite end of beam.

CAUTION -- WHEN REINSTALLING THE "RUBBER BUSHED" EQUALIZING BEAMS TO THE AXLES AND SADDLES, DO NOT TIGHTEN NUTS UNTIL TORQUE RODS ARE INSTALLED AND EQUALIZING BEAMS ARE LEVEL WITH THE FRAME. (THIS IS TO ASSURE THAT THE RUBBER IS IN A NEUTRAL POSITION, ELIMINATING THE POSSIBILITY OF TORSIONAL WIND-UP, WHICH MAY AFFECT RIDE QUALITY.) THEN TIGHTEN ALL NUTS TO RECOMMENDED TORQUE (SEE SPECIFICATIONS)

Place one end of cross tube into center sleeve of installed equalizer beam. Be sure tube seats into sleeve.

Assemble other equalizer beam to cross tube and position beam in spring saddle.

3. Roll axle assemblies with equalizer beams under center of saddle. Make sure the outer bushings are lined up with center of the saddle legs.

4. Lower vehicle frame centering saddles on beam end bushings.

5. Install saddle cap and nuts. Do not tighten until torque rods are installed and equalizer beams are level with frame. Torque nuts to recommended torque. Refer to SPECIFICATIONS.

   The cross center tube is free to rotate or float in the bushing assemblies at each side. However, in some cases where the vehicle has been operating in mud or perhaps water, the cross center tube may be seized. Whether it is loose or seized will have no effect upon its purpose. The function of the tube is to assure alignment between the left and right equalizer beams.

   The saddle caps serve to secure sleeve with bushing. The clamping effect of the caps against the sleeve and bushing has no effect upon the movement of the cross center tube.

6. Install torque rods to axle brackets and frame brackets. When tightening, rap bracket with ham mer to drive taper of torque rod stud into bracket. I ends of torque rods have straddle mount ends (: holes) as shown in Figure 16, use spacers between the bracket and crossmember for proper axle setting. Do not exceed 12.7mm (1/2") to obtain major adjustment. Tighten shaft nuts to specified torque

7. Tighten equalizer beam end fittings to specified torque. Refer to Torque Chart in SPECIFICATIONS

8. Install axle shafts. Connect propeller shafts, brake lines, interaxle lock control linkage or piping, etc

9. On vehicles equipped with hydraulic brakes, bleed brake system and check for leaks. On vehicles wit air brakes, check brake piping for air leaks.

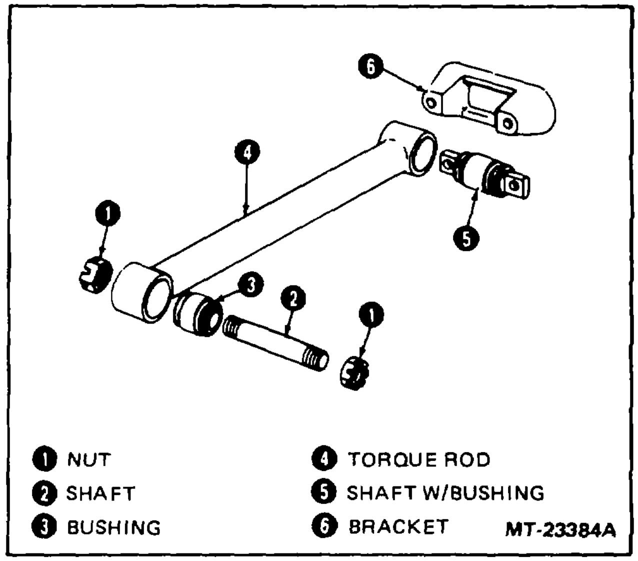


Figure 16 - Torque Rod

ALIGNMENT Refer to Section CTS-4016 of the Service Manual for suspension alignment information.

SPECIFICATIONS

ADAPTER CHART

Adapters which can be made locally from standard tubing for removing and installing rubber bushings. *Adapters to be used with sheave puller.

Application	Adapter Size
Torque Rod Bushing Remover (RT-340, RTE-340, RS-340 & RUE-340)	6.9 cm O.D. x 7.6 cm Long (2.75 in. O.D. x 3.0 in. Long)
Torque Rod Bushing Installer (RT-340, RTE-340, RS-340 & RUE-340)	7.6 cm O.D. x 7.6 cm Long* (3.0 in. O.D. x 3.0 in Long)*
Torque Rod Bushing Remover (RT-380, RTE-380, RS-380 & RT-440)	8.3 cm O.D. x 7.6 cm Long (3.25 in. O.D. x 3.0 in. Long)
Torque Rod Bushing Installer (RT-380, RTE-380, RS-380 & RT-440)	8.9 cm O.D. x 7.6 cm Long* (3.5 in. O.D. x 3.0 in. Long)*
Equalizer Beam End Bushing Remover	11.0 cm O.D. x 10.2 cm Long (4.25 in. O.D. x 4.0 in. Long)
Equalizer Beam End Bushing Installer	11.4 cm O.D. x 10.2 cm Long* (4.5 in. O.D. x 4.0 in. Long)*
Equalizer Beam Center Sleeve Bushing Remover and Installer (RT-340, RTE-340, RS-340 & RUE-340	8.9 cm O.D. x 17.8 cm Long (3.5 in. O.D. x 7.0 in. Long)
Equalizer Beam Center Sleeve Bushing Remover and Installer (RT-380, RTE-380, RS-380 & RT-440)	11.61 cm O.D. x 17.8 cm Long (4.63 in. O.D. x 7.0 in. Long)
Equalizer Beam Center Sleeve Bushing Remover and Intaller RT-500	13.7 cm O.D. x 25.4 cm Long (5.38 in. O.D. x 10.0 in. Long)

TORQUE CHART

Location	Recommended Torque	
	Newton Meters	Foot Pounds
Torque Rod Stud Nuts	675 - 810	500 - 600
Torque Rod Bracket Mounting Bolt Nuts	339 - 373	250 - 275
Spring Center Bolt 7/16-20	68 - 81	50 - 60
1/2-20	88 - 102	65 - 75
Spring Pin Draw Key Nut	102 - 136	75 - 100
Rear Spring Hanger Rebound Bolt Nut	95 - 108	70 - 80
Top Pad to Spring (Spring Aligning Set Screw)	136 - 203	100 - 150
Top Pad to Saddle Bolt Nut	373 - 407	275 - 300
Saddle Cap Stud Nut		
RU/RUE 340, U/UE 340	170 - 197	125 - 145
All Other 340, 380 and 450 Series	305 - 373	225 - 275
RT 441 and 450 Series	305 - 373	225 - 275
500 Series	373 - 407	275 - 300
Saddle Cap Stud	75 - 88	55 - 65
U-Bolt to Saddle (RU Series Only)	321 - 409	237 - 302
Vertical Drive Pin Nut (RS Series Only)	237 - 305	175 - 225
Vertical Bushing Retainer Stud Nut (RS Series Only)	136 - 169	100 - 125
Vertical Bushing Retainer Stud (RS Series Only)	75 - 88	55 - 65
Equalizer Beam End Bolt Nut		
All except 450 and 500 Series	285 - 325	210 - 240
450 Series	603 - 671	445 - 495
500 Series	814 - 1082	600 - 800
Equalizer Beam End Tube Nuts 500 Series	814 - 1082	600 - 800
Ball and Socket Beam Shaft Nuts	687 - 796	500 - 550
Saddle Nut (RT only)	373 - 406	275 - 300

BRAKES

CONTENTS

Replace old Section with this revised Section in your CTS-4001 Manual.

AIR BRAKES - GENERAL INFORMATION

FMVSS 121
SPLIT AIR SYSTEMS

CONTENTS

Printed in United States of America

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), issued a special Federal Motor Vehicle Safety Standard 121 (FMVSS 121) which specifies that all chassis equipped with air brakes must meet certain brake performance requirements.

Some factors that govern braking effort and effectiveness are brake design, brake lining area, brake dimensions such as diameter and width, contact pressure and type of lining material (functional characteristics). The law has special requirements for emergency performance which means if air loss occurs on any one of a vehicle's axles, the chassis must demonstrate stopping capability by activation of the service brake control. All chassis with air brakes will have dual or split air control circuits consisting of a primary and secondary system.

AIR SYSTEM

The air system is a split system consisting of a primary service system and secondary service system.

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 a 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 system. A tractor has the advantage of utilizing the trailer air brake system during emergency stopping.
There are three reservoirs in the split air system:

Supply Air Reservoir (Wet Tank)

Filled directly by the air compressor. Some air reservoirs will be a two or three compartment type.

Primary Air Reservoir

Air supply for the major portion of the split service brake system.

Secondary Air Reservoir

Air supply for the balance of the split system. This reservoir is also the air pressure supply for the brake inversion system on straight trucks.

INITIAL SPLIT AIR SYSTEM

Initial FMVSS 121 split air system has the primary service brake system on all chassis at the rear axle brakes and secondary service brake system at the front axle brakes. When the vehicle has tandem rear axles, the service brakes on both rear axles are in the primary service brake system. These are termed the "initial" split air systems. The initial split air system has relay valves (Figure 1) in the primary system and some park brake systems. Refer to Figures 3 through 7 for system identification. You will note that some initial systems utilize a quick release valve at the front axle in the secondary system.

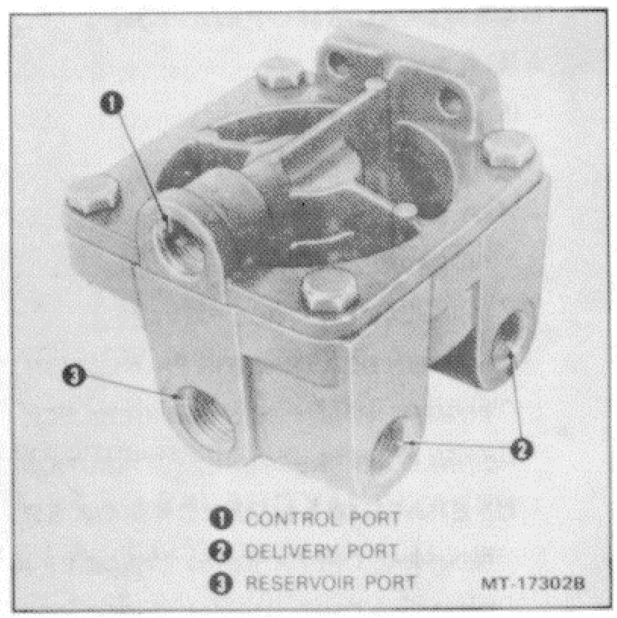


Figure 1 - Relay Valve

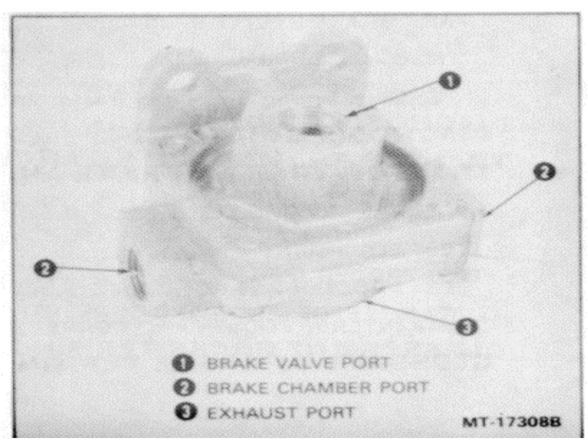


Figure 2 - Quick Release Valve

REFINED SPLIT AIR SYSTEM

Changes in the FMVSS 121 regulations made it possible to change the air system to what is called the "refined" split air system.

The refined split air system can be identified by the quick release valve (Figure 2) in both primary and secondary service brake systems as well as the parking brake system. The primary system will not always be at the rear axles.

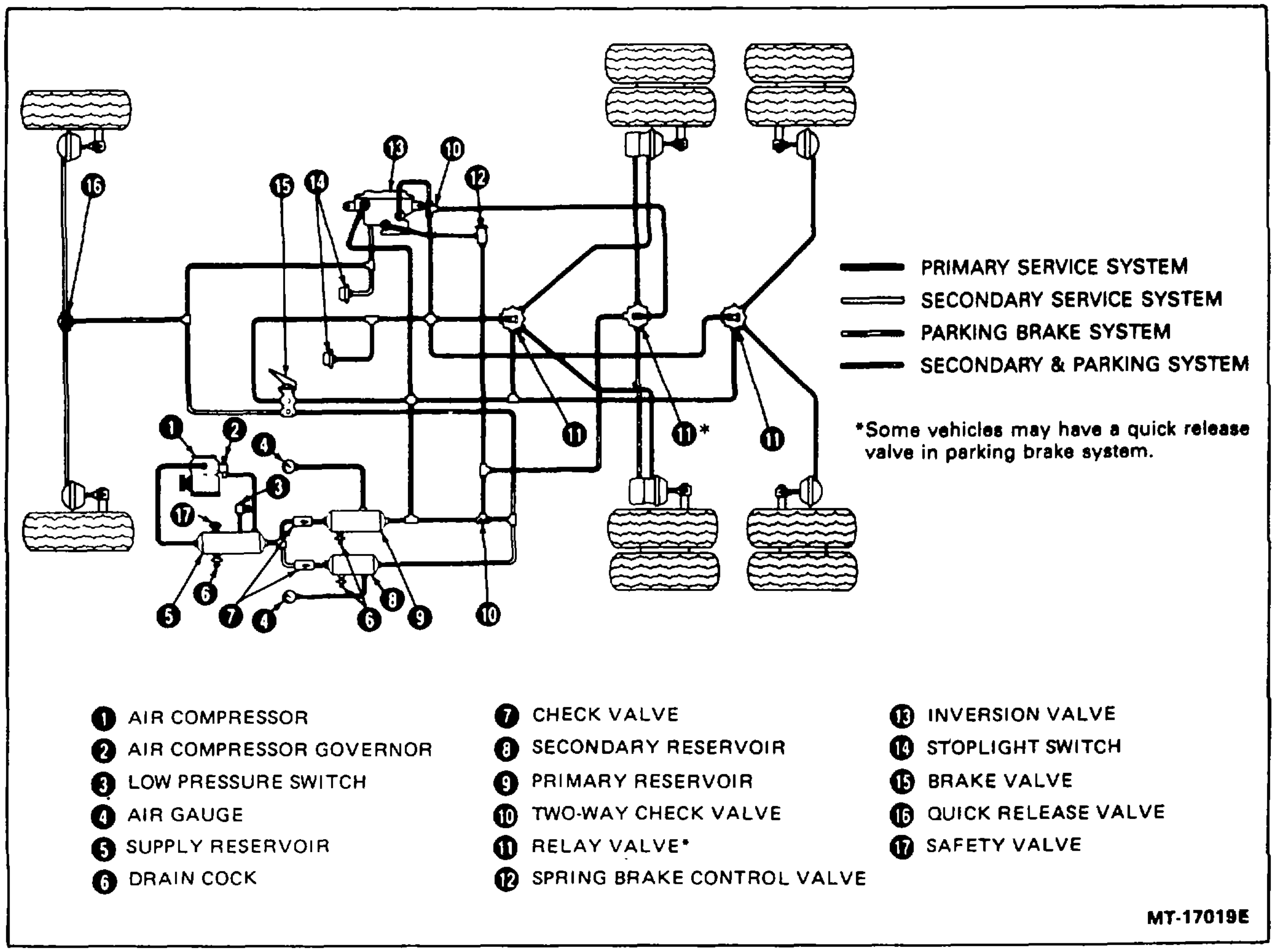


Figure 3 - 4x2 Truck With Initial Split Air System

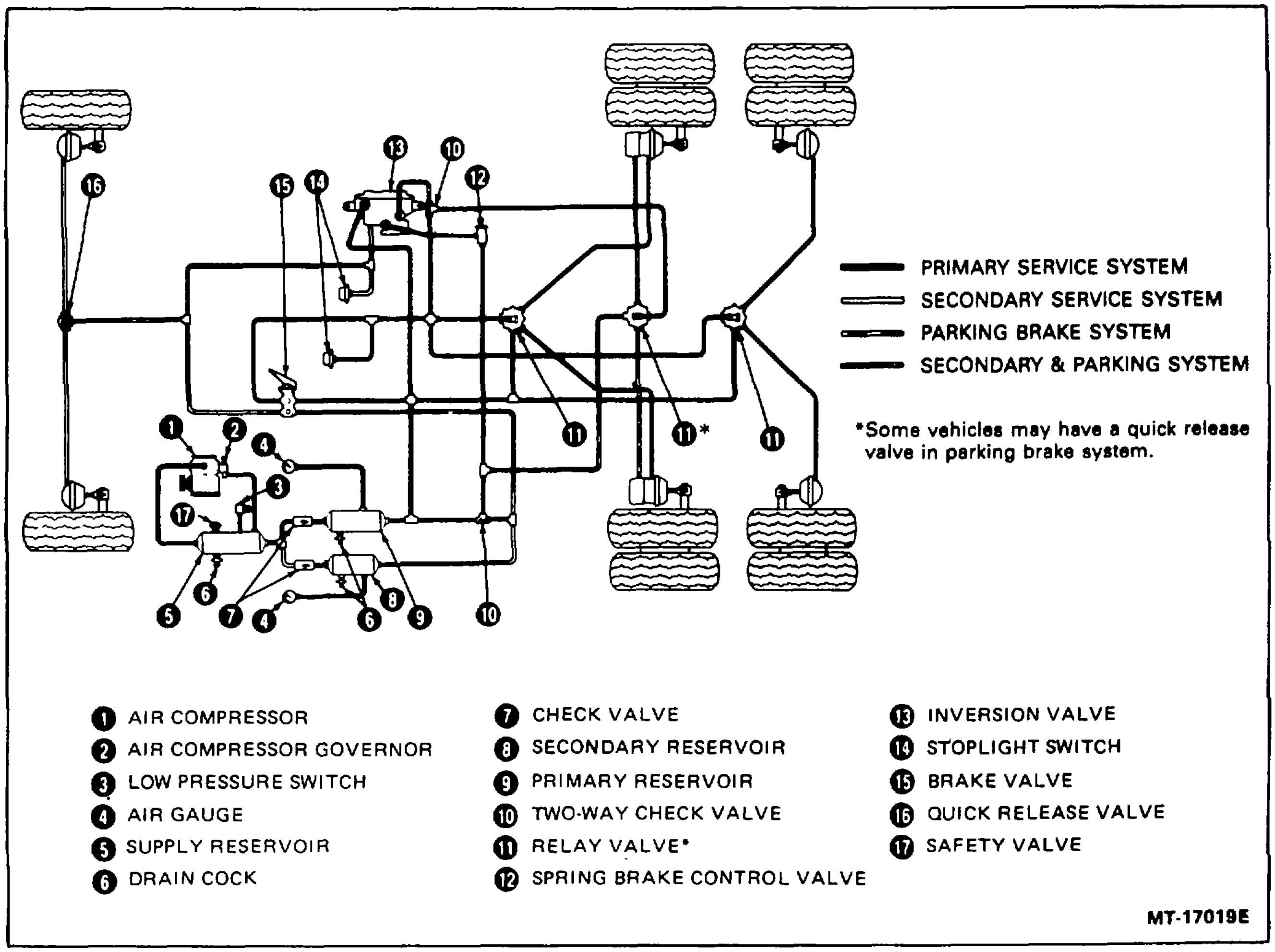


Figure 4 - 6x4 Truck With Initial Split Air System

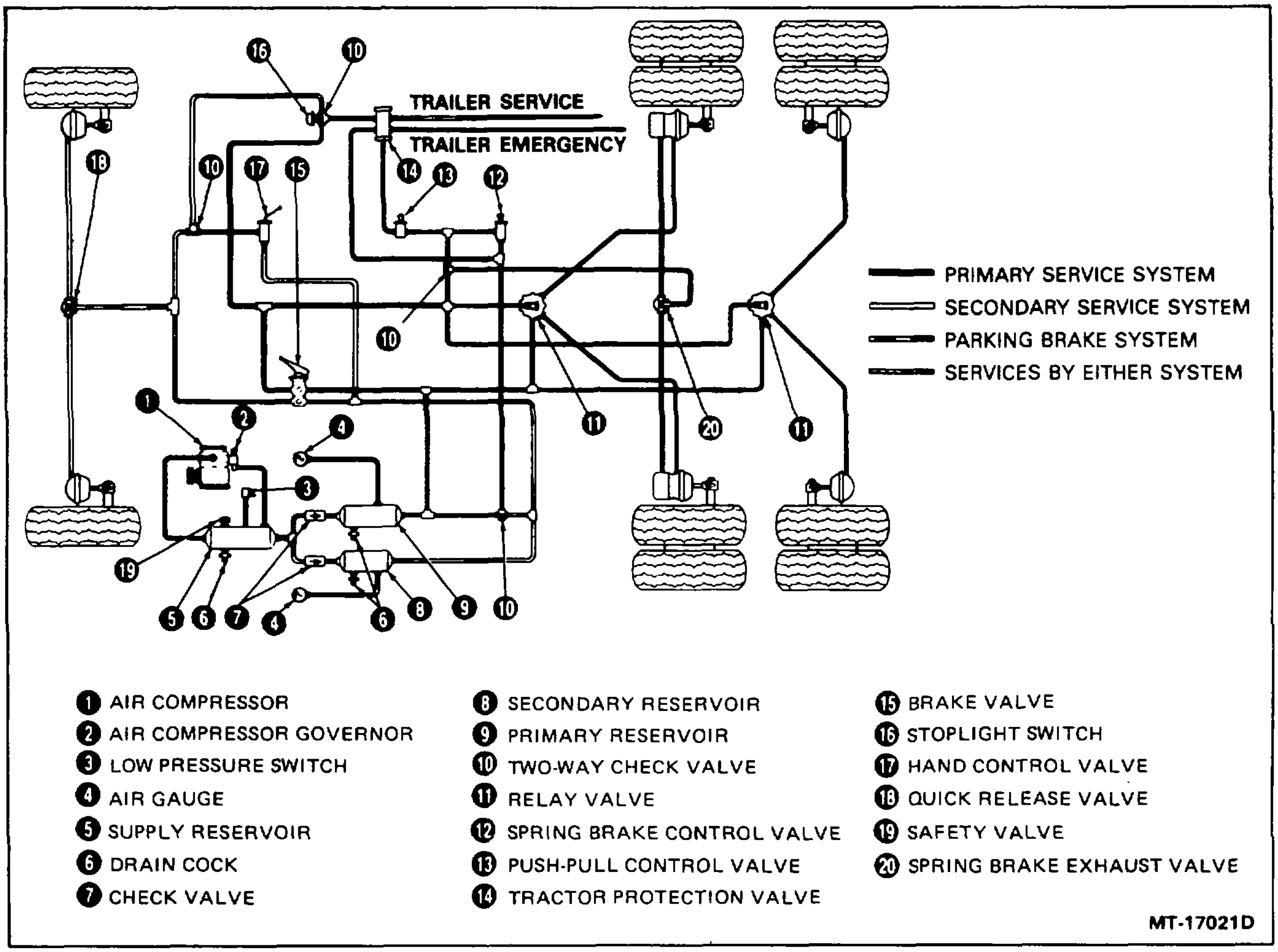


Figure 5 - 4x2 Tractor With Initial Split Air System With Separate Spring Brake and Tractor Protection Controls

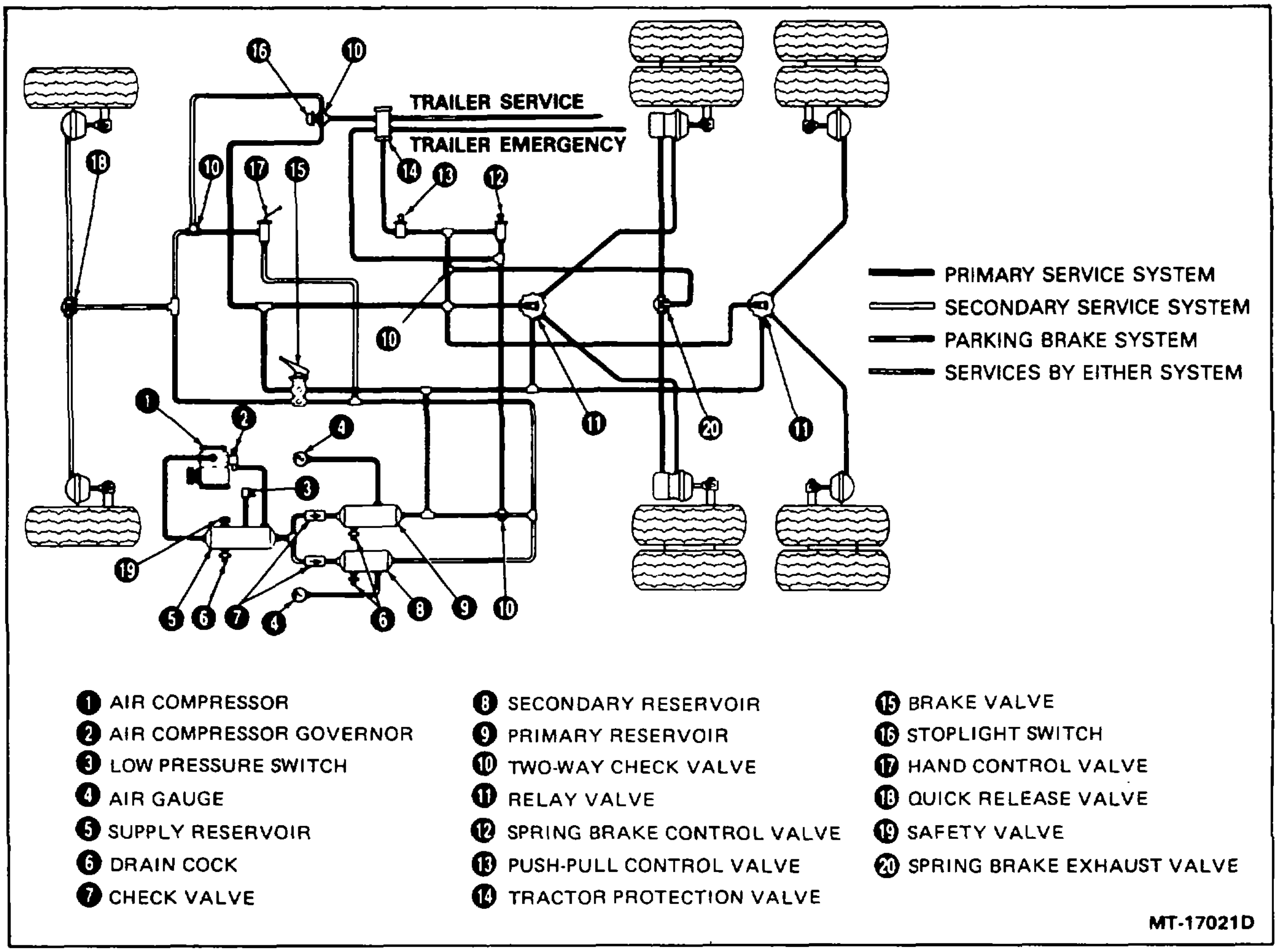


Figure 6 - 6x4 Tractor With Initial Split Air System With Separate Spring Brake and Tractor Protection Controls

6x4 Truck (Figure 9)

Primary service system is at the front axle and forward rear axle service brakes, secondary service system is at the rear rear axle service brakes. Like the 4x2 truck, an inversion valve is used to apply the park brake at the rear axle along with the secondary service brakes if air loss occurs in the primary system.

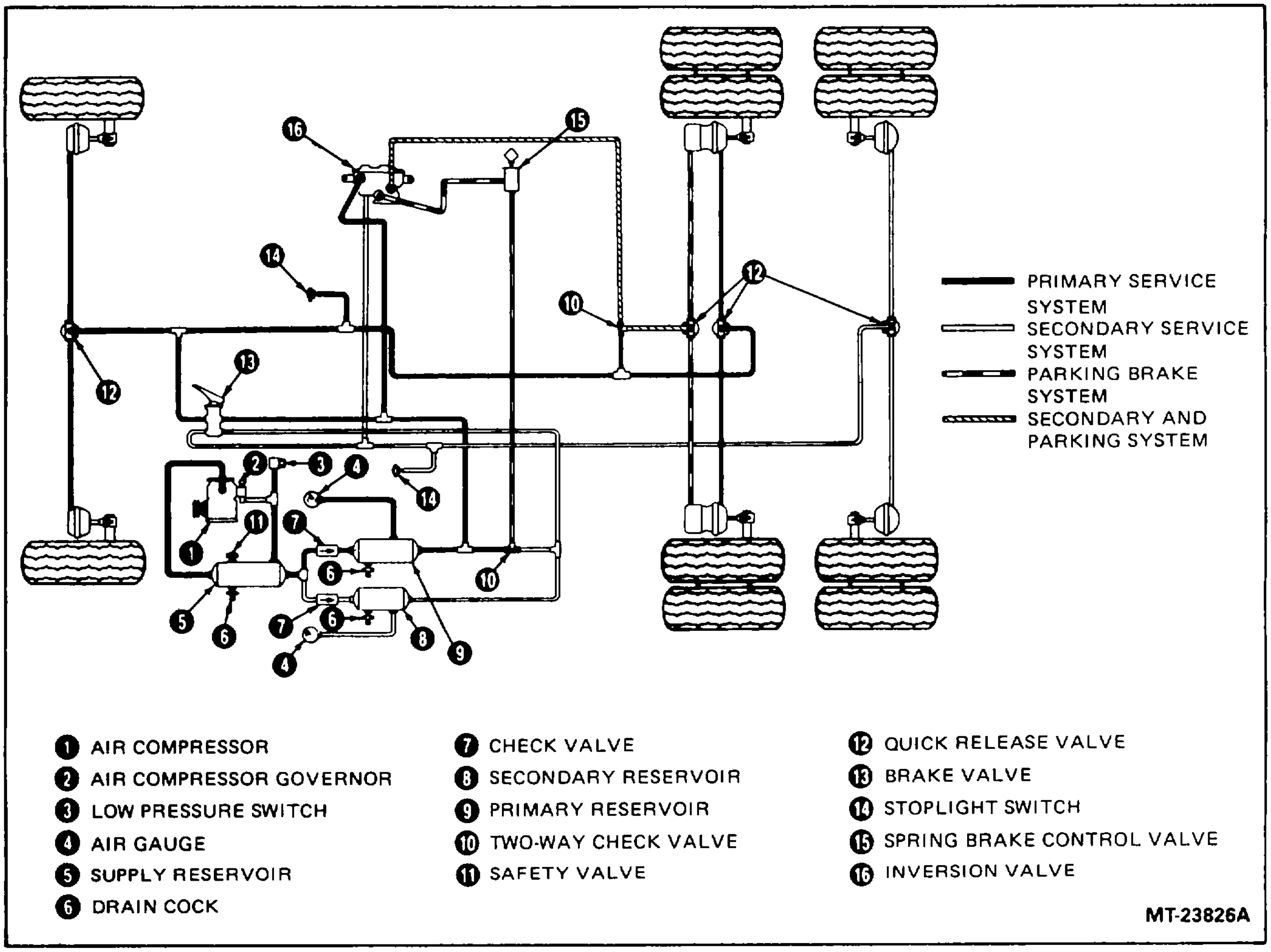


Figure 9 - 6x4 Truck With Refined Split Air System

4x2 Tractor (Figure 10)

Primary service system is at the rear axle brakes. Secondary service system is at the front axle brakes. The trailer service brakes will assist either the primary or the secondary systems during trailer applications.

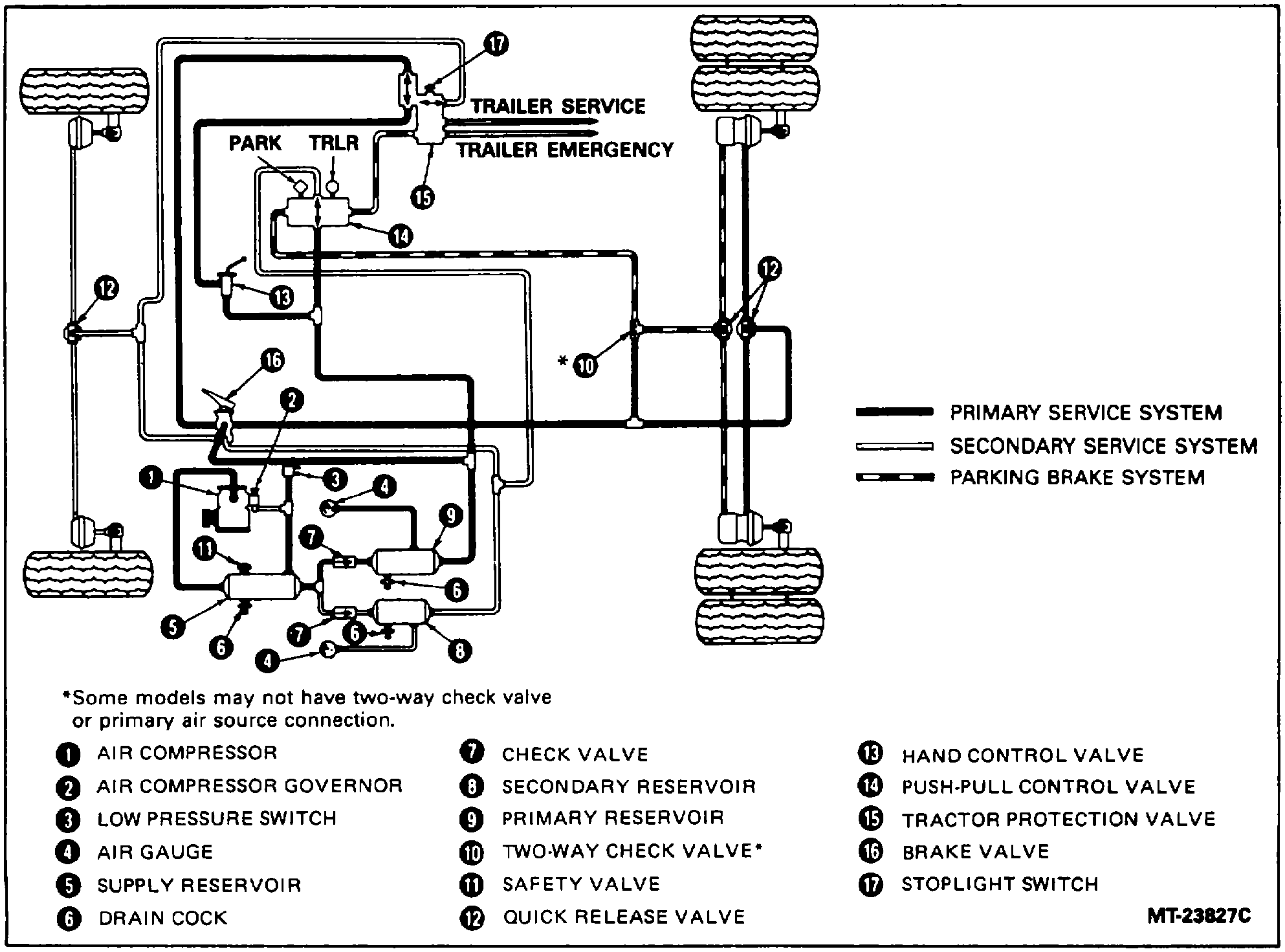


Figure 10 - 4x2 Tractor With Refined Split Air System and Modular Control Valve For Spring Brake and Tractor Protection Controls

6x4 Tractor With Steel Spring Suspension (Figures 11 and 12)

Figure 11 illustrates a tractor with a modular control valve for spring brake and tractor protection controls, while Figure 12 illustrates a tractor with separate spring brake and tractor protection controls. Primary service system is at the front axle and the rear rear axle brakes ,secondary service system is at the forward rear axle. The trailer service brakes will assist either the primary or secondary systems.

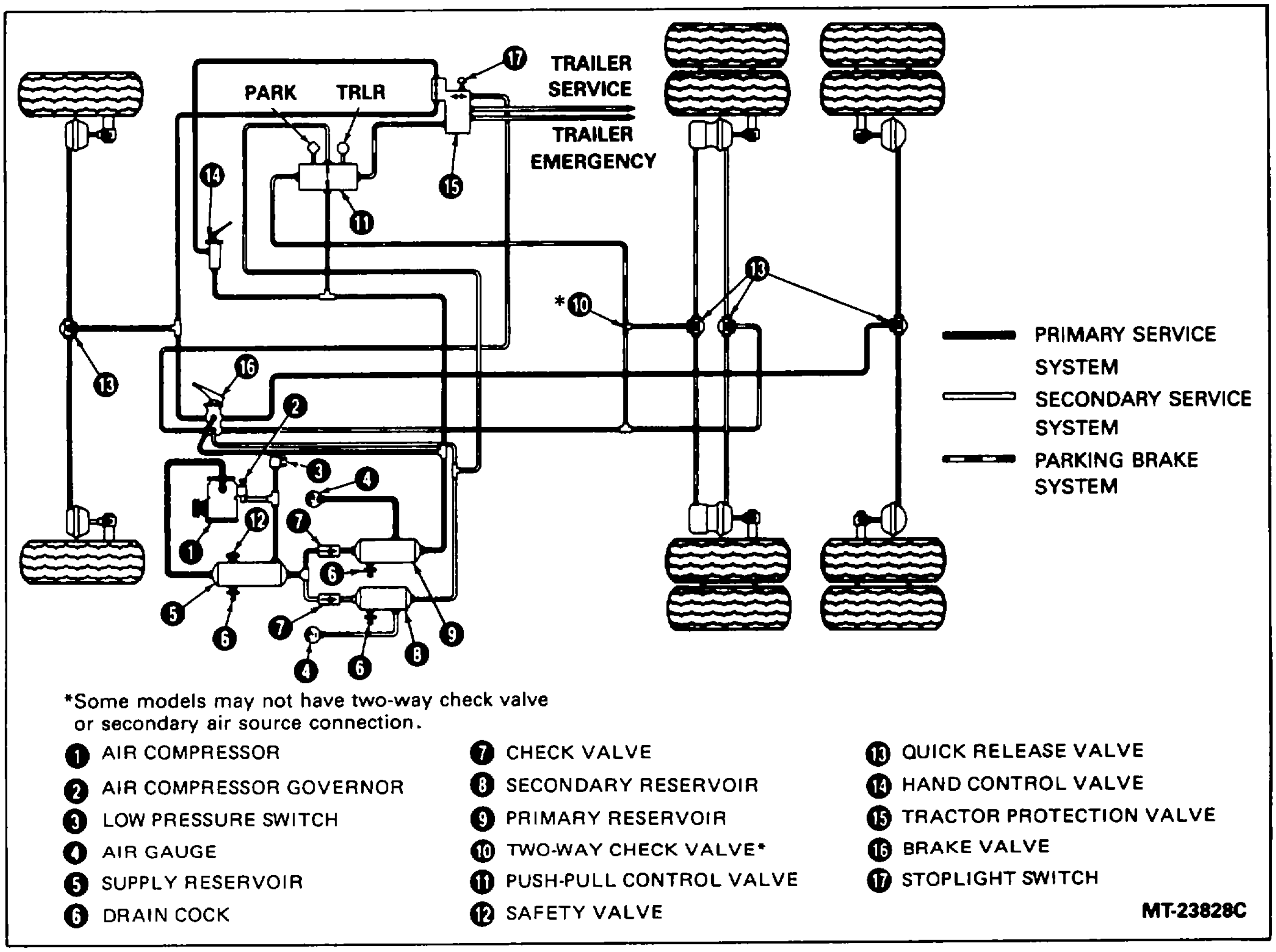


Figure 11 - 6x4 Tractor Refined Split Air System With Steel Spring Suspension and Modular Control Valve For Spring Brake and Tractor Protection Control

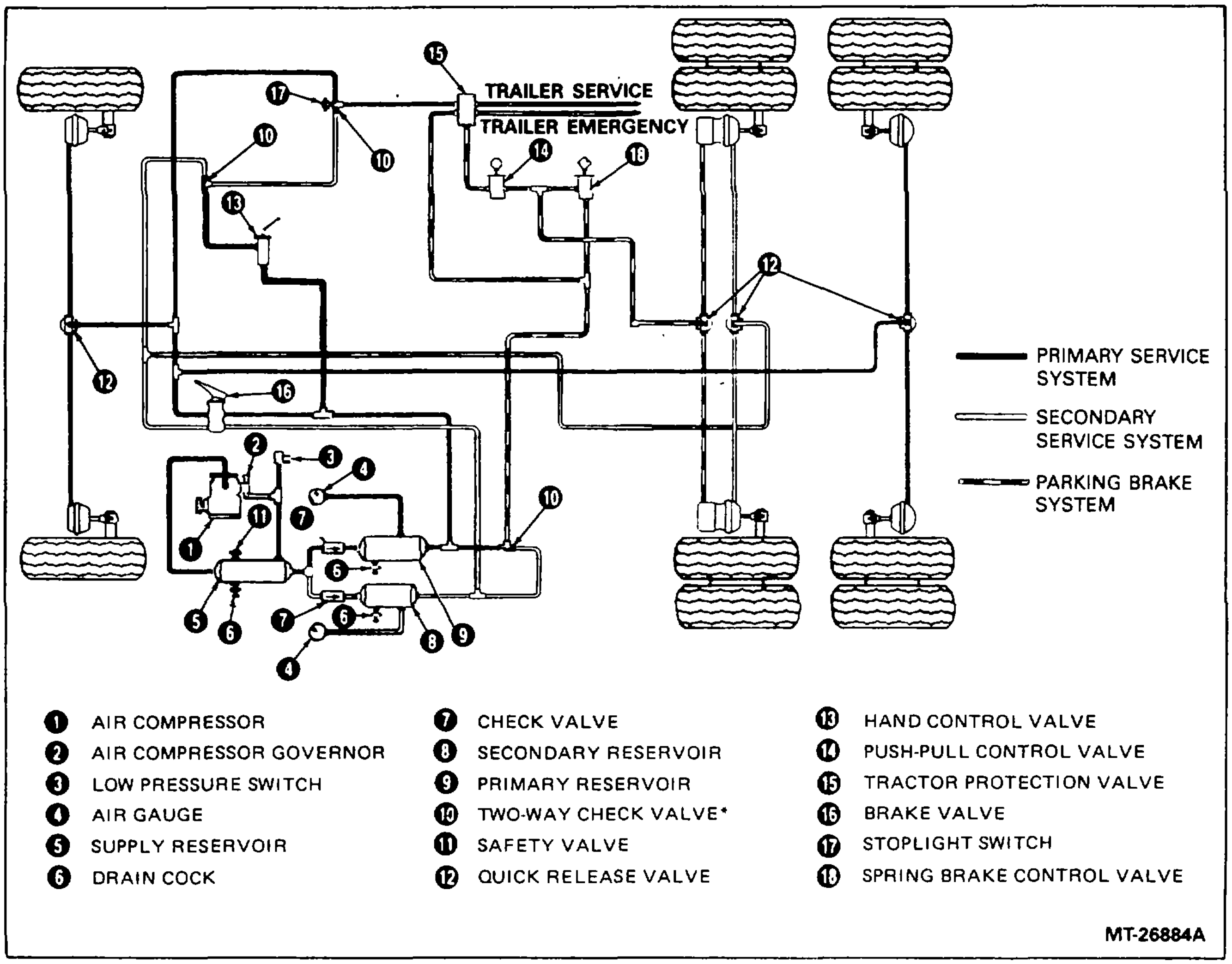


Figure 12 - 6x4 Tractor Refined Split Air System With Steel Spring Suspension and Separate Spring Brake and Tractor Protection Controls

AIR SYSTEM VALVES

NOTE: Complete detailed Information pertaining to each of the air brake components may be found in the Air Brake Components section.

INVERSION VALVE (FIGURE 15)

An inversion valve is used in both initial and refined split air systems. On straight trucks and buses, this valve Is installed in the air brake system to apply the parking brakes on the rear axle along with the secondary service brakes if air loss occurs in the primary system. The split air brake system on most tractors functions in a similar manner as a straight truck except there is no need for an Inversion valve to apply the parking 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 if there is an air loss on one of the systems.

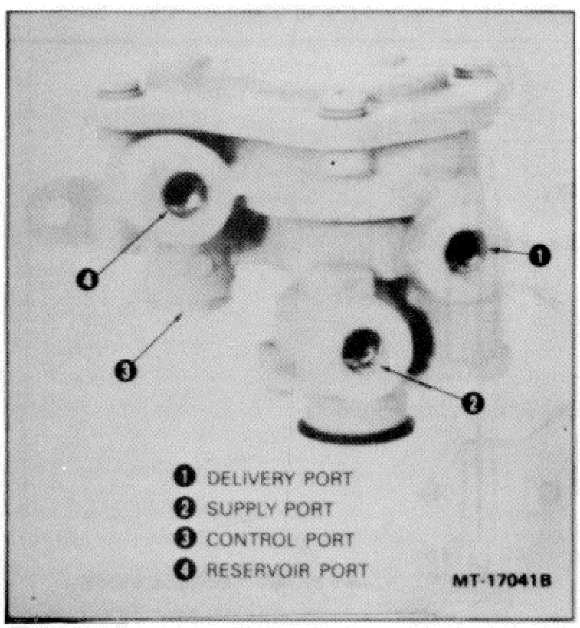


Figure 15 — Inversion Valve

Figure 15 - Inversion Valve

All 6x4 tractors with the refined air system and air suspension (as shown in Figures 13 and 14) will be equipped with an inversion valve. The inversion valve is required on these vehicles should a loss of air occur in the primary system when operating during bobtail operation.

On a straight truck which is equipped with trailer towing provisions, the vehicle will have a split air system which combines both straight truck and tractor air systems as previously described.

WARNING: A LOW AIR PRESSURE WARNING BUZZER WILL SOUND IN THE EVENT OF A FAILURE IN EITHER THE PRIMARY OR SECONDARY SYSTEM. UNDER NO CIRCUMSTANCES SHOULD THE VEHICLE CONTINUE TO BE OPERATED WHEN A FAILURE IS INDICATED SINCE AIR PRESSURE CANNOT BE BUILT UP IN THE SYSTEM UNTIL THE AIR LEAK IS CORRECTED, EVEN THOUGH AIR FOR EMERGENCY STOPPING IS RETAINED IN THAT PORTION OF THE SPLIT AIR SYSTEM NOT HAVING A FAILURE.

MODULAR CONTROL VALVE (FIGURE 16)

A one piece push-pull (modular control valve) includes both parking brake and trailer air supply controls. This valve also is equipped with a shuttle type double check valve which replaces a double check valve in the plumbing system. A modular control valve can be utilized in initial or refined systems.

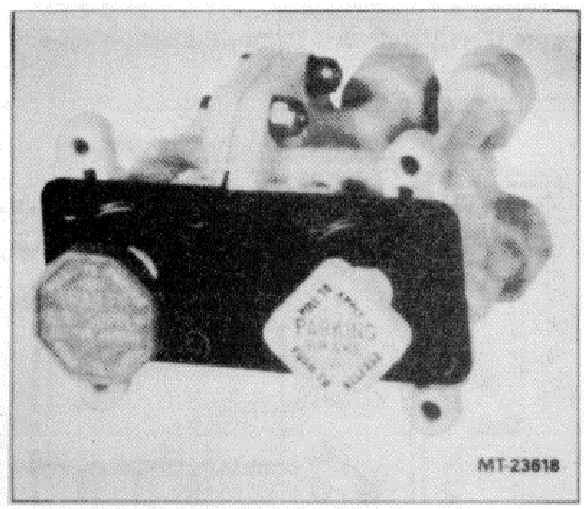


Figure 16 - Modular Control Valve

MANIFOLDED TRACTOR PROTECTION VALVE (FIGURE 17)

A manifolds tractor protection valve includes two double check valve assemblies along with the stoplight switch port. This valve may be utilized in initial or refined systems.

Vehicles with these valves also have the feature of Tractor Park Only and Trailer Charge with Tractor Spring Brakes Applied (tractor park only). Figures 10, 11 and 12 illustrated the use of a modular control valve and manifolds tractor protection valve in refined split air systems. Figures 18, 19 and 20 illustrate the use of a modular control valve and manifolds tractor protection valve in initial split air systems.

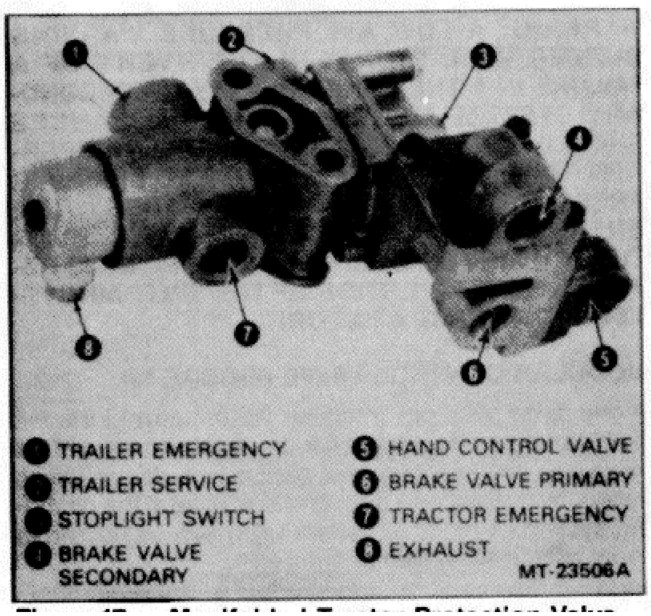


Figure 17 - Mainifoled Tractor Protection Valve

DIFFERENTIAL POWER DIVIDER LOCK VALVE

Air can be used to engage or disengage the power divider lock used on tandem drive rear axles. Three conditions are presented to clarify the identification of the power divider locks.

Condition 1

Prior to the FMVSS 121 regulation, the air operated power divider lock (PDL) had air pressure for engagement (lock) and-spring pressure for disengagement (released). The air source could be at any convenient location.

Condition 2

When FMVSS 121 split brake system was introduced, some tandem axles were equipped with power divider locks which were disengaged (released) with air pressure and spring controlled in lock or engaged mode. Plumbing of the spring brakes and power divider lock in this condition eliminated spring brake units at the rear axle. When the spring brakes are applied, air is expelled from the power divider lock allowing the spring pressure to lock up the differential and assist the spring brakes.

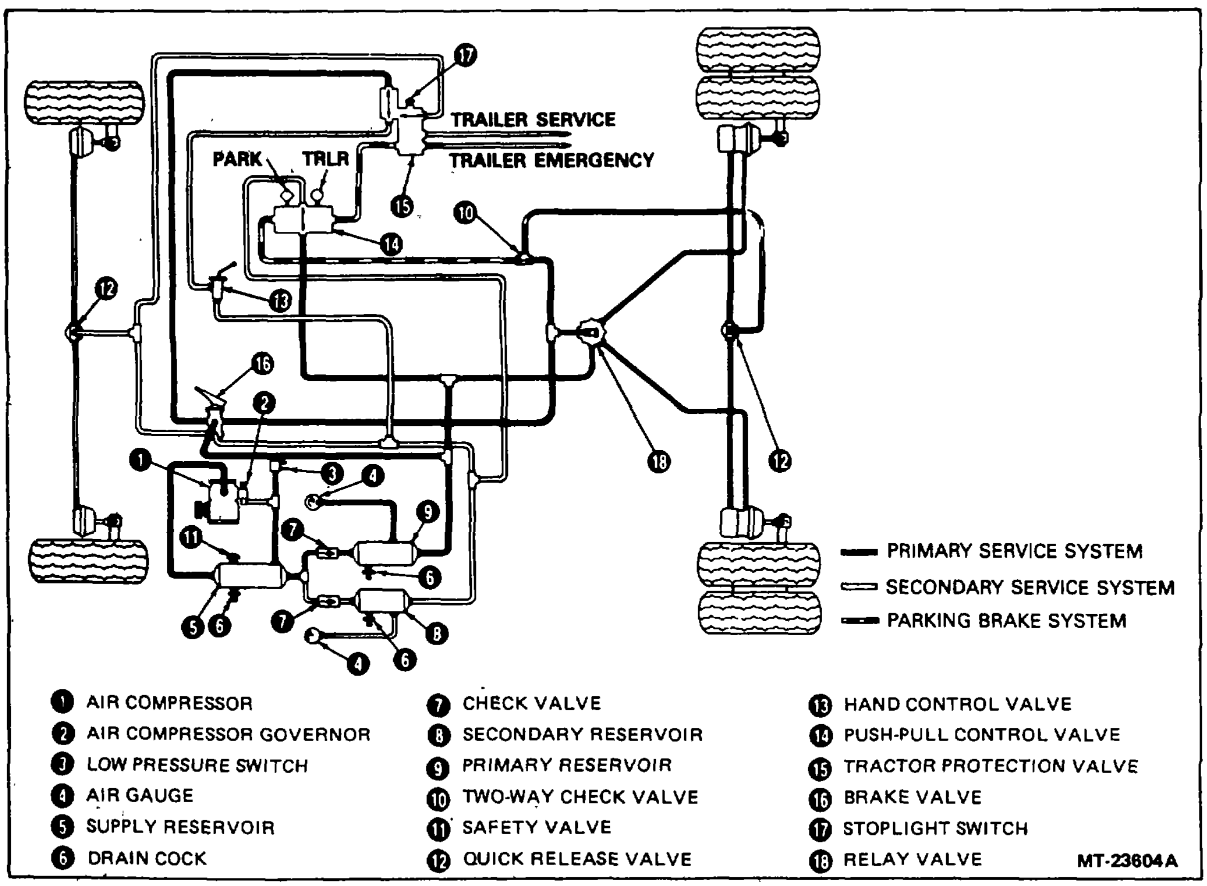


Figure 18 - 4x2 Tractor With Initial Spilt Air System With Modular Control Valve For Spring Brake and Tractor Protection Control

Condition 3

Due to their design, some tandem axles were not changed with the introduction of FMVSS 121. Application of the power divider lock remains the same as CONDITION 1. These tandem axles have spring brake chambers at each rear axle brake group. There are also some axle code applications which have been released since FMVSS 121 regulation went into effect that apply to this condition.

Identification by the number of spring brake chambers cannot be used since some vehicles under CONDITION 2 may have spring brake chambers at all rear axle brake groups. Rear axles with a GAWR of 44,000 lb. (20,000 kg) and above will have a spring brake chamber at each brake.

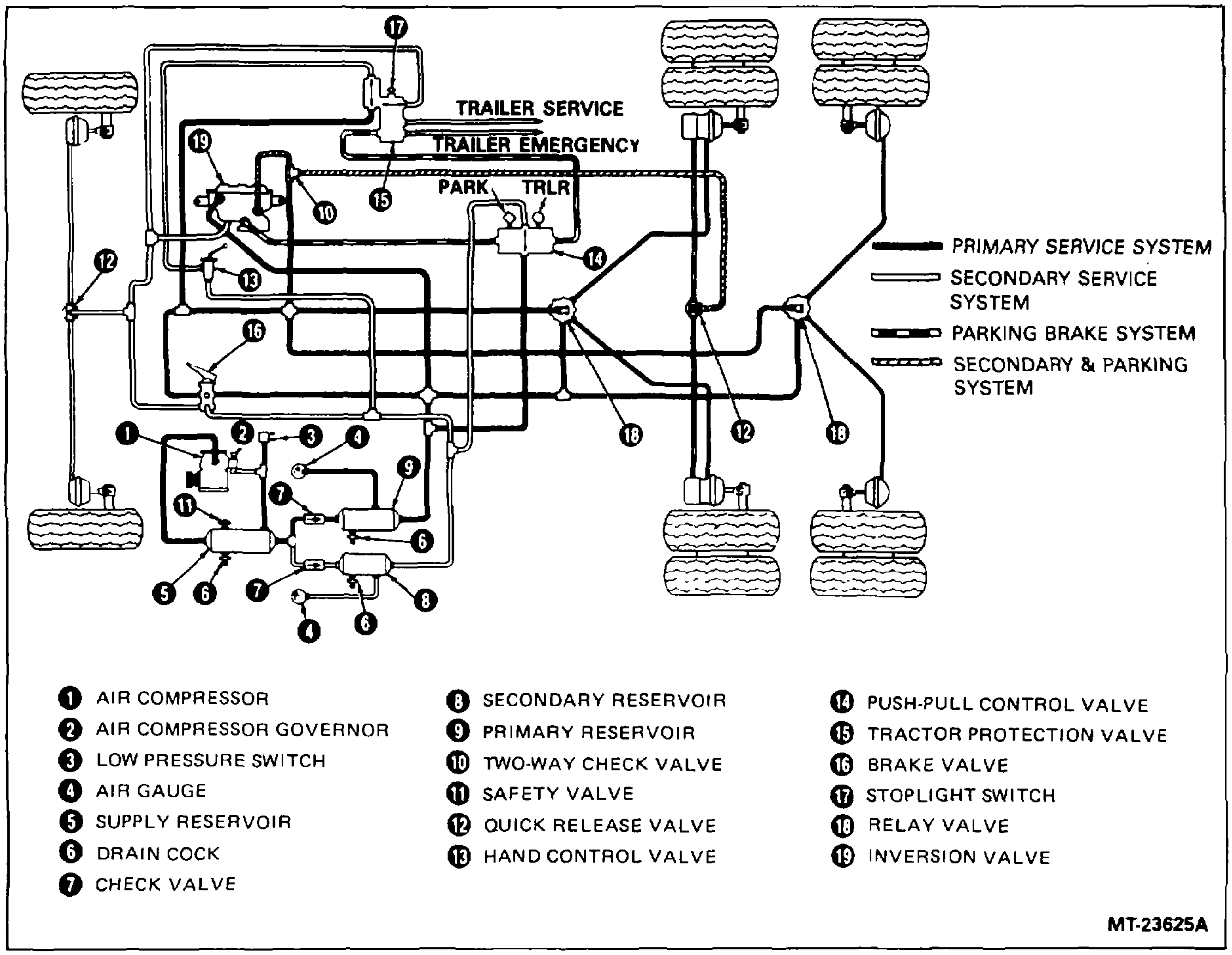


Figure 19 - 6x4 Tractor With Initial Split Air System With Modular Control Valve For Spring Brake and Tractor Protection Control

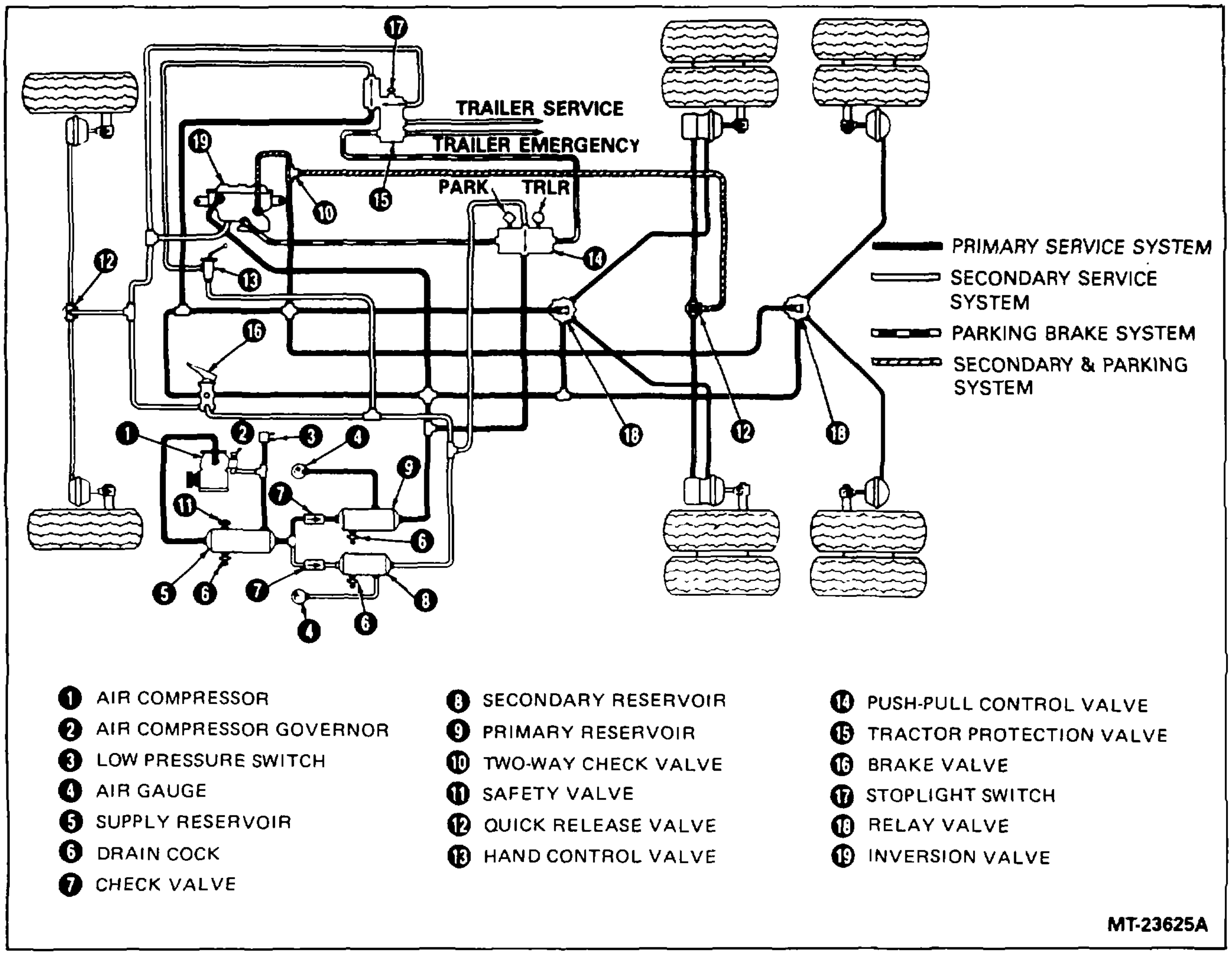


Figure 20 - 6x4 Tractor With Trailer Towing Provisions and Initial Split Air System With Modular Control Valve For Spring Brake and Tractor Protection Control

Operation

Figures 21 and 22 illustrate the power divider lock control connection at the instrument panel since the introduction of FMVSS 121.

Figure 21 illustrates three separate control valves (spring brake, tractor protection and power divider lock) used at the instrument panel. Figure 22 illustrates the power divider lock used with the modular control valve. Positive identification of the power divider lock system can be determined by installing an air test gauge in the air line to the power divider lock. Build pressure in the system, operate the valve and observe the air test gauge to determine which mode has air pressure. If air pressure is recorded on the air test gauge when the power divider lock is positioned in the lock mode, you have a CONDITION 1 or CONDITION 3 power divider lock. (Power divider lock is air actuated and spring released.) If no air pressure is recorded at the air test gauge when power divider lock is positioned in the lock mode, you have a CONDITION 2 power divider lock. (Power divider lock is spring actuated and air released.)

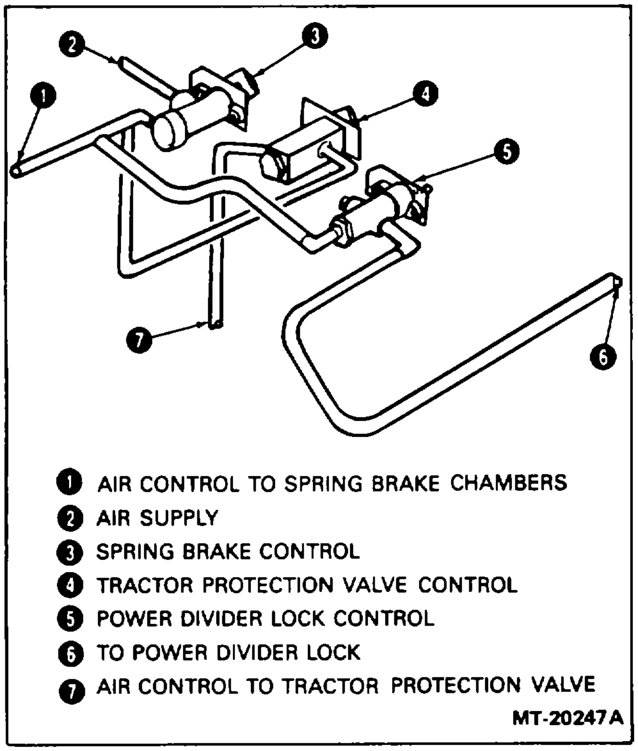


Figure 21 - Power Divider Lock Air Shift Control With Separate Spring Brake and Tractor Protection Control Valves

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. This 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 the introduction of FMVSS 121, 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. It should be noted that this is a constant function and is not controllable by the driver.

There is a valve made available (code 04567) for special requests. It, however, is not a true front wheel limiting valve but a brake air pressure distribution valve. This valve only limits full front wheel braking during light brake applications regardless of road conditions. However, in a hard or panic brake application, the driver obtains full front wheel braking (full braking potential).

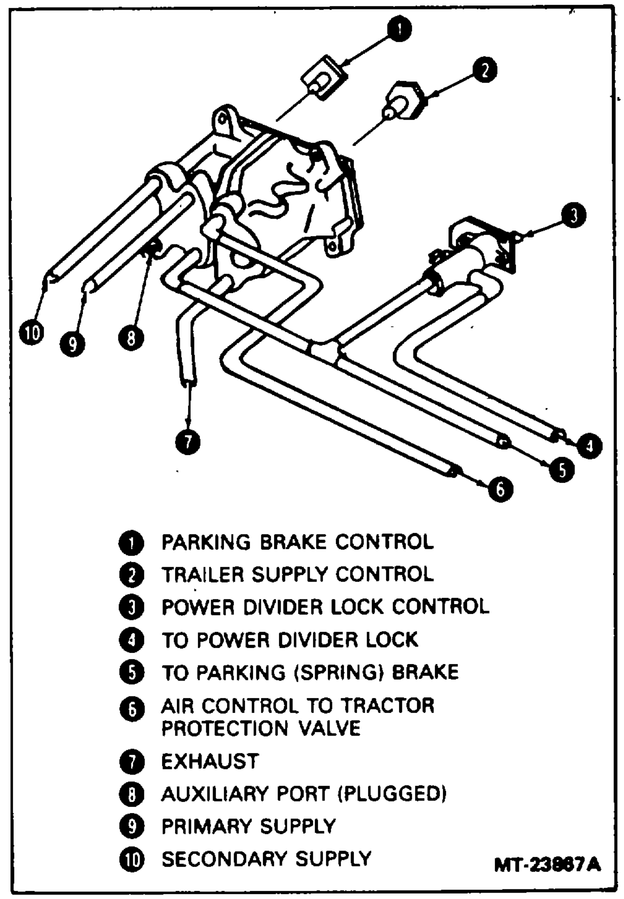


Figure 22 - Power Divider Lock Air Shift Control With Modular Control Valve For Spring Brakes and Tractor Protection Control Valve

There are other considerations which one should be aware of with the installation of the air pressure distribution valve. They are:

Increased Rear Axle Brake Wear

The vehicle’s brake wear balance, as designed, Is equal on front and rear brakes. During normal brake stops with the installation of an air pressure distribution valve, air pressure to front axle brakes is half of that applied to rear brakes, resulting in abnormal wear of rear service brake linings.

Glazing and Noise

During continued light brake applications glazing, poor burnish and noise problems could increase. The air pressure distribution valve reduces front axle braking work by about half.

OPERATIONAL CHECKS OF SPLIT AIR BRAKE SYSTEM

GENERAL OPERATIONAL CHECK OF AIR SYSTEM

1. Block wheels to prevent vehicle from moving.
2. Inspect primary and secondary reservoir check valve operation.
   a. Build 758 kPa (110 psi) of air in system.
   b. With ignition switch "ON," open drain cock at supply air reservoir and completely drain reservoir. Low air pressure buzzer should come on at approximately 483 kPa (70 psi).
   c. Both primary and secondary reservoirs should retain air pressure.
   d. If loss of air is noted in either system by observing the air gauges, the check valve could be faulty.
3. With the park brake control (yellow) and trailer supply control (red) positioned in, open drain cocks in primary and secondary reservoirs.

Trucks

The park brake control (yellow) knob should automatically apply between 48-103 kPa (7-15.psi).

Tractors

a. The red knob should pop out when reservoir with highest pressure reaches 276 ± 27.6 kPa (40 ± 5 psi). The red knob could pop immediately if air is depleted quickly at the trailer supply (emergency) line.
b. When air pressure in reservoir with higher pressure reaches 207 ± 27.6 kPa (30 ± 5 psi) the yellow knob may pop out. When air is depleted to 172 ± 27.6 kPa (25 ± 5 psi), the yellow knob must pop out.

4. Close all reservoir drain cocks.
5. Build up air supply in chassis system to approximately 758 kPa (110 psi).
6. With red knob pushed in, disconnect trailer emergency coupling from bracket. The red knob -should pop out instantaneously.
7. If red knob pops out, reconnect trailer emergency coupling. Position yellow knob in released position (in) and red knob in applied position (out).
8. 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.
9. 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. One system will show a loss of air. With ignition switch on, low pressure indicator buzzer should sound at approximately 483 kPa (70 psi).
10. Apply service brakes and observe the slack adjusters and service brake chamber push rods. Movement of the brake chamber push rods should occur at axles as follows:
    a. Rear axles on all 4x2 vehicles and rear axles on 6x4 vehicles with initial split air system.
    b. Front and rear rear axles on 6x4 vehicles with spring suspension system and refined split air system.
    c. Steering and forward rear axles on 6x4 vehicles with air suspension and refined split air system. If movement is noted at other axles, the primary reservoir was bled. Refer to Step 13. If brake chamber push rod travel movement is as described, the primary system is good.
11. Close drain cock in secondary air reservoir.
12. Build air supply in air system to 758 kPa (110 psi).
13. Open drain cock in primary reservoir. Observe opposite air pressure indicator for loss of air. Be sure to open drain cock all the way.
14. Apply service brakes and observe the slack adjusters and service brake chamber push rods. There should be movement of brake chamber push rod travel as follows:
    a. Steering axle on all 4x2 vehicles and on straight trucks with initial split air system the spring brakes will apply and release until air pressure drops to 48-241 kPa (7-35 psi), then full spring brake application will occur.
    b. Forward rear axle on 6x4 vehicles with refined split air system.
    c. Rear rear axle along with parking brake application and release at forward rear axle on 6x4 vehicles with air suspension and refined split air system. When checking system the parking brakes will automatically apply on tractors when air pressure is depleted to 172 ± 27.kPa (25 ± 5 psi).
15. If movement of brake chamber push rods are as described, the secondary system is functioning as it should.
16. Close all drain cocks and return vehicle to service.

DETAILED OPERATIONAL CHECK OF TRAILER SUPPLY AND PARK BRAKE SYSTEMS

Modular Control Valve

1. Use two air test gauges 0-1103 kPa (0-160 psi) or Duplex gauge (SE-2325') with hoses and two additional trailer couplings (service and emergency); attach the gauges to service and emergency couplings on vehicle.
2. With the trailer supply knob (red) and parking brake knob (yellow) out, charge primary and secondary air systems to 448 kPa (65 psi). Push red knob in. The red knob should remain in and air pressure at instrument panel and test gauge at trailer emergency port should read approximately the same. Test gauge at service connection should show no pressure.
3. Push yellow knob in and apply foot valve to deplete air supply. The red knob should pop out when the reservoir with the highest pressure reaches 276 + 27.6 kPa (40 + 5 psi). The red knob could pop immediately if air is depleted quickly.
4. Apply foot valve to further deplete air pressure. Air should escape the exhaust port of the trailer supply portion of valve. When air pressure in reservoir with the higher pressure reaches 207 + 27.6 kPa (30 + 5 psi), the yellow knob may pop out (park brake application).
5. Deplete the air system even further using foot valve. At 172 + 27.6 kPa (25 + 5 psi), the yellow knob must pop out (park brake application).
6. Rebuild air supply to at least 276 kPa (40 psi), push yellow knob in. It should remain in.
7. Push red knob in and pull yellow knob out. The red knob must pop out almost instantaneously.
8. Rebuild air supply to 689-861 kPa (100-125 psi) in both primary and secondary reservoirs. Push red and yellow knobs in. Pressure at trailer emergency connection should equal pressure in primary reservoir.
9. Reduce air pressure in primary reservoir. Pressure at trailer emergency connection should descend to 724-621 kPa (105-90 psi) at which point the double check valve in the modular control valve should switch to the secondary reservoir and pressure at emergency connection should adjust (equalize) to secondary reservoir pressure. Close off leak at primary reservoir.
10. With the red knob in and the hand control valve released, apply brake valve. Pressure at trailer service should be within 27.6 kPa (5 psi) of gauge at instrument panel.
11. Replenish air system to 689-861 kPa (100-125 psi). Slowly vent the secondary reservoir pressure with yellow knob in. As the secondary pressure and trailer emergency pressure descend, between 793-724 kPa (115-105 psi) the double check shuttle in the valve should switch to the primary reservoir and the pressure should adjust to the primary reservoir pressure.
12. With the red knob pushed in, disconnect the trailer emergency coupling from the test gauge. The red knob should pop out instantaneously. If red knob pops out, reconnect the trailer emergency coupling to gauge.
13. Replenish air in system. With the red knob in, apply the hand control valve. There should be a minimum of 586 kPa (85 psi) at trailer service gauge.
14. Release hand control valve and apply foot valve. Pressure at service port should be within 35 kPa (5 psi) of the pressure indicated at the instrument panel.
15. Close all vents or leakage points and charge system to 689-861 kPa (100-125 psi). Apply brake valve, pull red knob out (yellow knob in). The air gauge connected to the service connection should record the same value (689-861 kPa or 100-125 psi) as gauge at instrument panel. Gauge at emergency connection should indicate "0."
16. With red knob out and yellow knob in, develop a leak in the spring brake delivery (line) and hold yellow knob in. The primary reservoir pressure must reduce to zero and secondary reservoir pressure to 138-207 kPa (20-30 psi). The double check valve in the modular control should cycle several times during the leak down period. If the foregoing checks perform as described, the chassis is ready for service. Remove air test gauges from trailer couplings.

If the operational checks revealed malfunctions within the system, a more detailed investigation of components will be required. Refer to COMPONENTS Section for detailed information regarding service check on various components.

Separate Spring Brake and Tractor Protection Controls

1. 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.
2. Build up air pressure in chassis air system.

* At one time the Sealco duplex air gauge (model 110122) was available under Tool Equipment No. SE-2325.

3. 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.
4. Apply service brakes using the foot valve; the air gauge at service coupling should indicate approximately the same pressure as the gauges in cab, +41 kPa (+6 psi). Release service brakes. Air pressure at the service coupling should drop to zero, while the air pressure at emergency coupling should correspond approximately to that of air gauges in cab.
5. Pull tractor protection control valve (TRAILER EMERGENCY) out. Air pressure should drop to zero at air test 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.
6. 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.
7. 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 for detailed information regarding service check on various components.

DIAGNOSIS GUIDES

CONDITION	POSSIBLE CAUSE	RESOLUTION
Insufficient Brakes	Brakes need adjusting or relining Drum or rotor wear Low air pressure in brake system Brake valve delivery pressure low Excessive condensation in reservoir Failure of part of a split air system	Adjust, replace or reline as necessary Check governor function Check brake valveRepair or replace as necessary Drain reservoirs Repair or replace as necessary
Brakes Apply Too Slowly	Brakes need adjusting or lubricating Low air pressure in brake system or repair as necessary Insufficient brake valve delivery pressure Excessive leakage with brakes applied replace as necessary Restricted tubing or hose Treadle travel restricted	Adjust or lubricate as necessary Check governor functionAdjust Check brake valveRepair or replace as necessary Check all connections, chamber diaphragms and hosesRepair or Repair or replace as necessary Repair or lubricate as necessary
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* Brake Valve, Quick Release Valve, Relay Valve	Adjust or lubricate as necessary Clean, inspect and lubricate as necessary Repair or replace as necessary Repair or replace as necessary Repair or replace as necessary
Brakes Do Not Apply	No air pressure in brake system supply and delivery systems Restricted or broken compressor discharge line tubing or hose Faulty brake valve	Check air compressor, governor, Repair or replace as necessary Repair or replace as necessary
Brakes Do Not Release	Sticking shoe guide pins Sticking anchor pins Broken or weak return springs Brake valve not fully released replace as necessary Parking brake chamber leaking Faulty brake valve or relay valve Restricted or collapsed tubing or hose	Repair or replace as necessary Repair or replace as necessary Repair or replace as necessary Check brake valveRepair or Replace diaphragm Repair or replace as necessary Repair or replace as necessary

DIAGNOSIS GUIDES (Cont 'd.)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Brakes Grab or Erratic Braking	Grease on brake lining Faulty brake valve or relay valve Sticking shoe guide pins Sticking anchor pins Broken or weak return springs High brake pressure systems No vehicle load when not under load Loose drum or brake mounting	Reline brakes Repair or replace as necessary Repair or replace as necessary Repair or replace as necessary Repair or replace as necessary Check air supply and delivery Operate vehicle with caution Re-torque fasteners
Uneven Brakes	Brakes need adjusting or relining Improper axle mounting Grease on brake lining Brake shoe return spring broken Brake drum out of round exceeding maximum diameter, or replace as necessary Brake chamber diaphragm failure Wrong or mixed brake lining Broken foundation brake parts	Adjust or reline as necessary Check and repair as necessary Reline brakes Replace as necessary Refinish drum if possible without Repair or replace as necessary Replace as necessary Repair or replace as necessary
Air Pressure Will Not Rise to	Faulty air gauge (registering Normal Excessive valve or fitting leakage Repair or replace as necessary Governor out of adjustment Slipping compressor drive belt necessary Broken supply line Faulty compressor	Repair or replace as necessary incorrectly) Check all valves and connections Adjust or replace as necessary Tighten or replace belt as Replace as necessary Repair or replace as necessary
Air Pressure Rises to Normal	Excessive valve or fitting leakage Too Slowly 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	Check all valves and connections Repair or replace as necessary Repair or replace as necessary Adjust or regulate as necessary Repair or replace as necessary Repair or replace as necessary Repair or replace as necessary Repair or replace as necessary

DIAGNOSIS GUIDES (Cont'd.)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Air Pressure Rises Above Normal	Faulty air gauge (registering incorrectly)	Repair or replace as necessary
	Governor out of adjustment	Adjust as necessary
	Faulty governor and safety valve	Repair or replace as necessary
	Frozen line to governor	Thaw and drain condensation
	Restriction in line between governor and compressor restricted unloading valve	Repair or replace as necessary
	Too much clearance at compressor unloader valves or compressor unloading mechanism stuck in closed position	Adjustor repair as necessary
Air Pressure Drops Quickly With Engine Stopped and Brakes Released	Leaking brake valve	Repair or replace as necessary
	Leaking tubing or hoses	Repair or replace as necessary
	Excessive leakage elsewhere in air brake supply system	Check air supply system Repair or replace components as necessary
	Parking brake chamber leaking	Replace diaphragm
Air Pressure Drops Quickly ' With Engine Stopped and Brakes Fully Applied	Leaking brake chamber, actuator or brake cylinder	Repair or replace as necessary
	Leaking brake valve	Repair or replace as necessary
	Leaking tubing or hose line	Replace as necessary
Compressor Knocks Continuously or Intermittently	Loose drive pulley	Repair or replace as necessary
	Backlash in drive gears or drive coupling	Repair or replace as necessary
	Worn or burnt out bearings	Repair or replace as necessary
	Excessive carbon deposits in compressor cylinder head	Clean or repair as necessary
Safety Valve "Blows Off"	Air pressure in air brake system above normal	Check unloader mechanism Repair or replace as necessary
	Faulty governor	Check governor function
	Frozen line to governor	Thaw and drain condensation
Excessive Oil in Brake System	Compressor passing excessive oil	Repair or replace compressor as necessary
	Compressor air strainer restricted	Repair or replace as necessary
	Excessive engine oil pressure	Check and adjust engine oil pressure as necessary
	Back pressure from engine crankcase	Check and repair/adjust as necessary
	Excessive oil in compressor crankcase	Drain excess from compressor

TRACTOR-TRAILER BRAKE ANALYSIS PROCEDURE

The air brake system on a tractor-trailer combination must provide balanced braking at all wheels and axles of the combination for optimum brake performance and life. This means that the braking effort produced at each wheel of the combination must be capable of doing its share of the work in controlling the speed of the two units.

There are several factors which can affect brake balance. These are:

1. Loads must be properly distributed between tractor and trailer. A balanced condition should not be expected with the combination vehicle if the load is not properly distributed. The brakes on each axle are designed to meet specific performance criteria based on the axle's Gross Axle Weight Rating (GAWR). For example, 15400 kg (34,000 lb.) GAWR tandem axles used on both the tractor and trailer in combination are deigned to meet similar performance standards. Overloading or under loading either the tractor or the trailer tandem axle can cause unbalanced braking in the combination vehicle. A typical symptom would be early lockup of the brakes on an axle loaded to less than the rated capacity.
2. Tractor and trailer brakes must be compatible. The foundation brakes used on the tractor and trailer should be of the same type. Operating characteristics, such as fade and speed sensitivity, are different for wedge, cam and disc-type brakes. Consequently, under some operating conditions, the intermixing of brake types can cause or exaggerate an imbalance condition between tractor and trailer(s). Extreme care must be used when operating a combination equipped with brakes of different types.
3. Tractor and trailer brakes must be maintained in proper adjustment. The force output of an air brake chamber push rod Increases linearly for approximately 75% of its maximum travel. Beyond 75%, the force is reduced. Therefore, if the brake adjustment is not maintained within specification and the push rod travel is allowed to increase beyond 75% of maximum travel, the brake torque output at the wheel will be reduced. For example, when air pressure of 689 kPa (100 psi) is applied to a Type 30 service air brake chamber, approximately 3,000 lbs. of force is produced with a push rod travel of 38mm (1-1/2 in.) or less. When the push rod travel is increased to 57mm (2-1/4 in.) at the same air pressure, the force produced decreases to approximately 11,121N (2,500 lbs.), a reduction of about 17%. A reduction in force at the push rod causes a similar reduction in the brake torque output at the wheel. A reduction in the brake torque output capability at any one or several wheels of a combination vehicle places added work on the brakes at other wheels. The result can be uneven lining and drum or rotor wear (between brake assemblies), trailer surging and increased brake fade.

   If automatic adjusters are used, they should be used on both tractor and trailer to insure compatibility between the two units. While automatic adjusters do maintain the brakes in reasonable adjustment, it is important that the adjusters be inspected periodically to be sure that they are functioning properly.
4. Tractor and trailer brake assemblies and air sys-tems must be Inspected and properly maintained. Corroded anchor pins, frozen camshafts, weak or broken return springs, or deformed shoes, etc., can reduce the efficiency of the brake assembly at any wheel(s). It is important to inspect the air system - reservoirs, valves, fittings and lines -periodically for damage. This includes draining the reservoirs as required.

Whenever complaints of touchy brakes, inadequate braking, short service life of brake linings, drums or rotors on either the tractor or the trailer (but not both) are encountered, there may be an imbalance between the tractor and trailer air brake systems.

It is suggested that a brake analysis be performed. This analysis includes testing for 1) pressure balance, 2) pressure build-up rate (timing), and 3) torque balance. However, before conducting the tests, the following questions should be considered:

1. Are all or a majority of the drivers operating the combination units obtaining the same results or registering the same complaints?
2. Are the same results or complaints being registered on similar combination units?
3. Are the same results or complaints being registered under similar operating conditions?
4. Were complaints always received on the combination unit or did complaints originate after some brake service was performed, or vehicle operating conditions changed?

The answers to these questions may help in identifying the cause(s). Such problems could be the result of incorrect or malfunctioning brake components, or simply the conditions under which the combination vehicle is operated.

If the response to these questions seems to indicate that a brake Imbalance condition may be present in the air brake system, the preliminary checks and test pro-cedures in the following text can be used to isolate the cause.

PRELIMINARY CHECKS

NOTE - Before conducting the Pressure Balance, Pressure Build-up Rate, and the Torque Balance Tests, make the following checks of the air brake system on the tractor-trailer combination. These checks are intended to detect and correct conditions which otherwise could produce misleading or Inconclusive test results.

1. Check the adjustment of all brakes on both the tractor and trailer(s). Adjust the brakes as required.
2. Visually check the slack adjuster movement (if applicable) to determine that all brakes are actuating and releasing freely. If not, inspect and lubricate the suspect brakes thoroughly. DO NOT allow any lubricant on the linings, drums, or rotors.
3. Check the air brake system to be sure that it is free of significant air leaks. Air leakage should not exceed the following values with an air system pressure of 655 kPa (95 psi) or more and the brake pedal released:
   - 13.8 kPa (2 psi) per minute, on tractor only.
   - 20.7 kPa (3 psi) per minute, on tractor with trailer combination.
   - 34.5 kPa (5 psi) per minute, on tractor with two trailer combination.

   Repair any leakage points if these values are exceeded.
4. Drain the reservoirs of any moisture and contamination.
5. Visually inspect for damage or kinked lines and replace any lines found to be defective.
6. Inspect combination units for loose fifth wheel and kingpin condition. A loose fifth wheel to kingpin fit can exaggerate an unbalanced brake condition and therefore must be adequately tightened.

Any deficiencies found in the above areas may be contributing factors in the brake complaints. These should be considered in the overall analysis of the brake system.

TEST EQUIPMENT

The test equipment described below and illustrated in Figure 23, with the exception of the Brake Timing Unit, is required in conducting the pressure balance, pressure build-up rate, and torque balance tests. DOUBLE GLADHAND ASSEMBLY

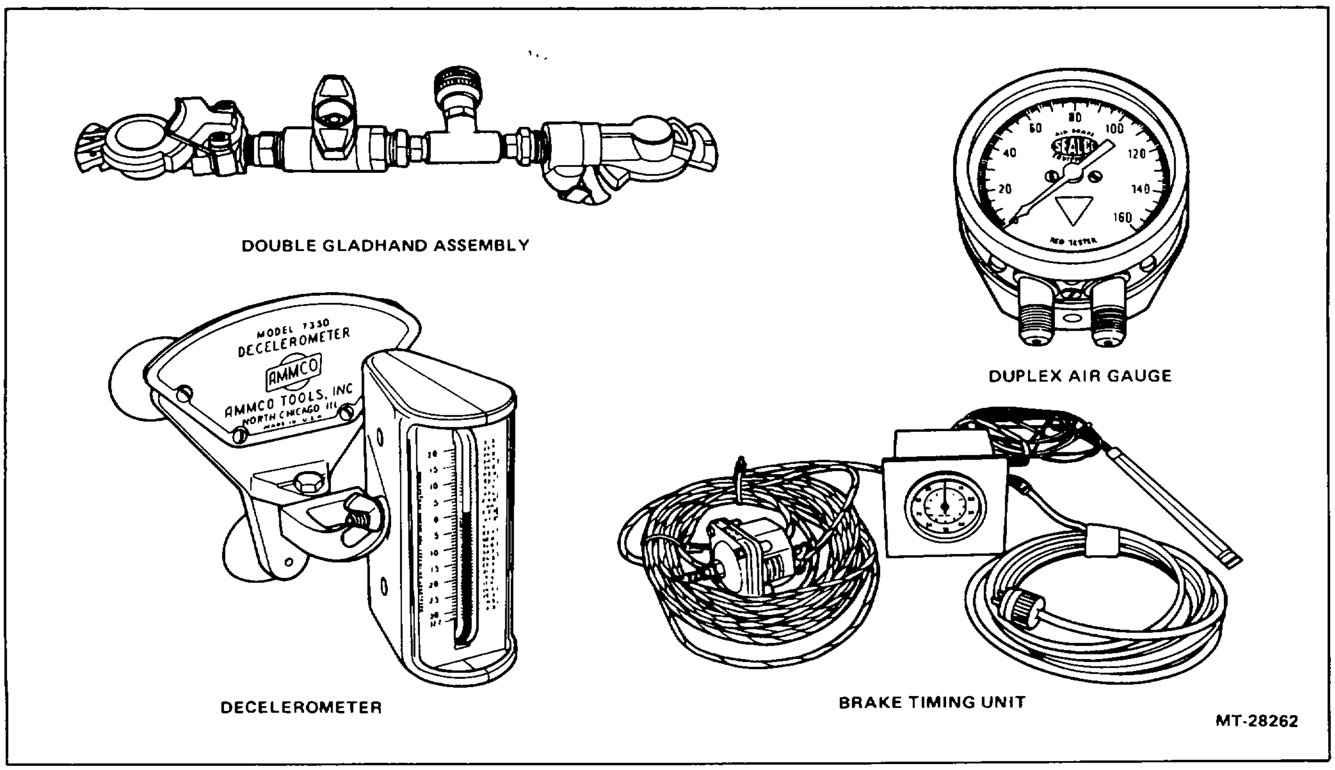


Figure 23—Air Brake Test Equipment

Double Gladhand Assembly (with quick-connect coupling and shut-off cock). This assembly is used in the service line connection to the trailer for the torque balance test. Refer to Figure 24 for the parts and the manner of assembling this test equipment.

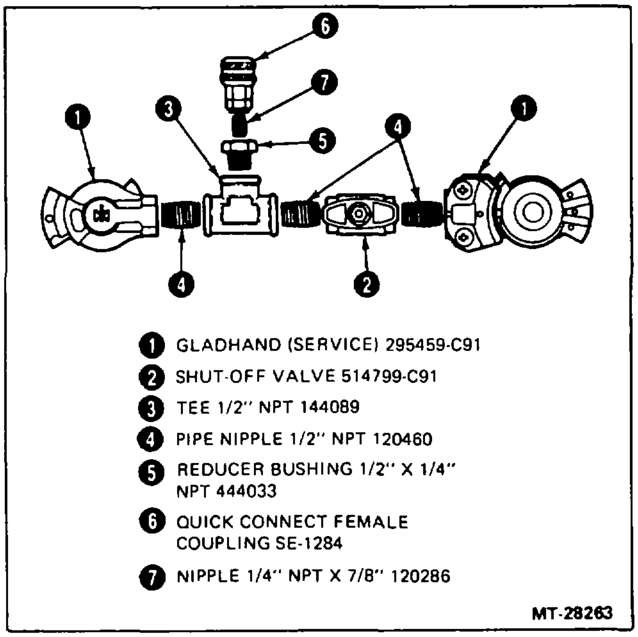


Figure 24 - Double Gladhand Assembly - Exploded View

Duplex Air Gauges Two sets are required. Seal Incorporated Model 110122 or equivalent quality gauge is to be used. Each set includes one duplex gauge and two 7.62m (25 ft.) long air hoses. The duplex air gauges are required for all tests. (At one time, the Seal gauge was available under Tool Equipment No. SE-2325.

Additional Air Hoses for Long Single-Trailer and Multiple-Trailer Tests Two are required which are of sufficient length and with quick-connection couplings. These hoses are used for making the test connections between the service brake chambers on the various axles of the tractor and trailer(s) and the air gauge(s).

Decelerometer AMMCO Tools Incorporated Model 7350 or equivalent quality decelerometer is to be used. The decelerometer is required for conducting the Torque Balance Test. (At one time, the AMMCO decelerometer was available under Tool Equipment No. SE-2210.)

Brake Timing Unit (Use optional). This is a sophisticated test instrument which can be used to record more accurate brake application times for the Pressure Build Rate Test. These units are available from some electronic laboratories and air valve manufacturers.

TEST PROCEDURES

Before performing any of the test procedures which follow, record the preliminary data required on the Brake Test Data Sheet (Form CTS-1033Y, Figure 25.) This

BRAKE TEST DATA SHEET

PRELIMINARY DATA

Record the combination vehicle information. This information (except for the owner's name) can be obtained from the certification labels.

VEHICLE	OWNER	MODEL	SERIAL NO	GVWR
Tractor				
First Trailer				
Second Trailer*				

*If used

TEST APPLICATION PRESSURES @ Tractor's Rearmost Axle	PRESSURE READINGS														
	FIRST TRAILER					SECOND TRAILER (IF APPLICABLE)									
	@ Rearmost Axle					@ Dolly Axle					@ Rearmost Axle				
	Application				Press. Diff.†	Application				Press. Diff.†	Application				Press. Diff.†
kPa (PSI)	1st	2nd	3rd	Average		1st	2nd	3rd	Average		1st	2nd	3rd	Average	
PRESSURE BALANCE															
34 (5)															
69 (10)															
103 (15)															
138 (20)															
172 (25)															
207 (30)															
345 (50)															
483 (70)															
621 (90)															
Average															

PRESSURE BUILD-UP RATE (TIMING)

	PRESSURE DIFFERENCE, Lag (−) or Lead (+)
0.207 min (0.30 min)	

TORQUE BALANCE

VEHICLE DATA	Tractor + Trailer
Typical Weight (Estimated)‡	Lbs
Test Weight (Actual Axle Weights)	Lbs

	TEST SPEED			TEST APPLICATION PRESSURES		DECELEROMETER READINGS (FT SEC²)			
	Recommended		Other (If used)			Application			
	km/hr.	(mph)		kPa	(PSI)	1st	2nd	3rd	Average
Using Tractor-Trailer Combination Brakes	64	(40)		276	(40)				
Using Tractor Brakes Only									
Using Trailer Brakes Only									

† Compared to TEST APPLICATION PRESSURE @ Tractor's Rearmost Axle
‡ For Normal Highway Operation — Maximum

TOTAL (Tractor Only + Trailer Only)

BALANCE RATIO CALCULATION: [Typical Tractor Weight] ÷ [Typical Trailer Weight] × [Average Trailer Deceleration Rate] ÷ [Average Tractor Deceleration Rate] = [Balance Ratio].

INTERNATIONAL TRUCKS

CTS 1033Y

MT-28233

Figure 25 - Brake Test Data Sheet

data includes the owner's name, model, serial number, and GVWR for both the tractor and trailer. All of this information (except the owner's name) can be obtained from the certification labels.

PRESSURE BALANCE AND PRESSURE BUILD-UP RATE (TIMING) TEST

Conditions: This test is performed on the combination vehicle (tractor-trailer) with wheels blocked, parking brake released and air system fully charged.

1. Connect two test hoses to a duplex gauge.
2. Connect the hoses from the duplex gauge to the combination vehicle (Figure 26) as follows:
   a. One hose to the left service brake chamber on the tractor's rearmost axle. The gauge reading from this connection will be used as a reference for comparing pressure and timing differences with other axles.
   b. The remaining hose to the left service chamber on the traller's rearmost axle.

NOTE-- If unused chamber ports do not exist, It will be necessary to disconnect the service brake hose, Install a tee fitting between the service brake hose and chamber (Figure 27), and then connect the test hose to the remaining opening In the tee fitting. 3. Check pressure balance as follows: While observing the duplex gauge, slowly apply the service brakes in increments of 34 kPa from 34 to 207 kPa (5 psi from 5 to 30 psi) and increments of 138 kPa from 207 to 621 kPa (20 psi from 30 to 90 psi)

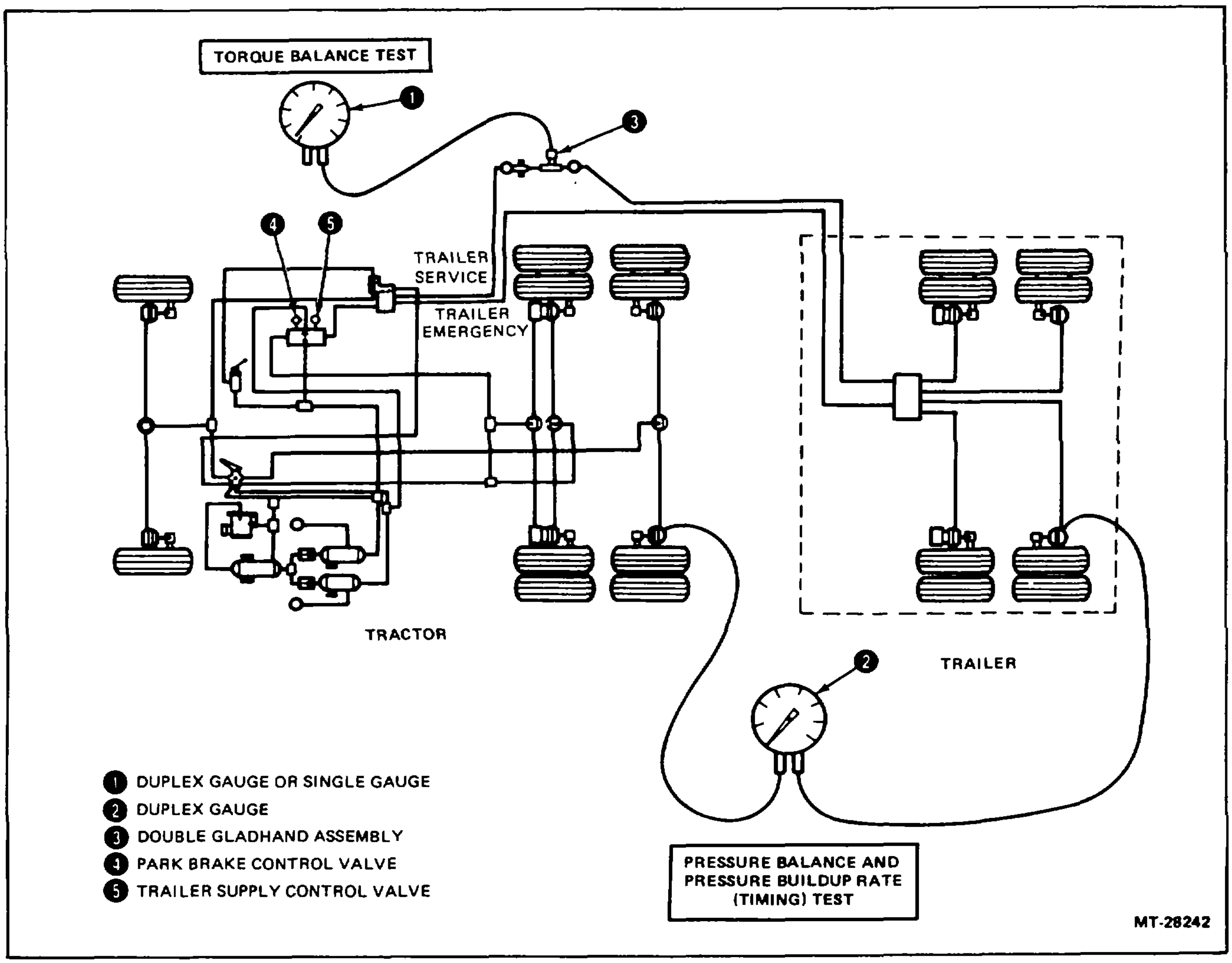


Figure 26 - Test Connectlon8 - Single Trailer

respectively, as shown in Figure 28. As each pressure increment is reached at the tractor's rearmost axle, note and record the pressure reading for the trailer's rearmost axle. Repeat this step three times.

IMPORTANT - When applying the brakes, air pressure must be Increased steadily and maintained at each step. Any slight decrease In pressure will affect the accuracy of the gauge readings and must be avoided. Note and record the pressure only after all gauge recordings are stabilized.

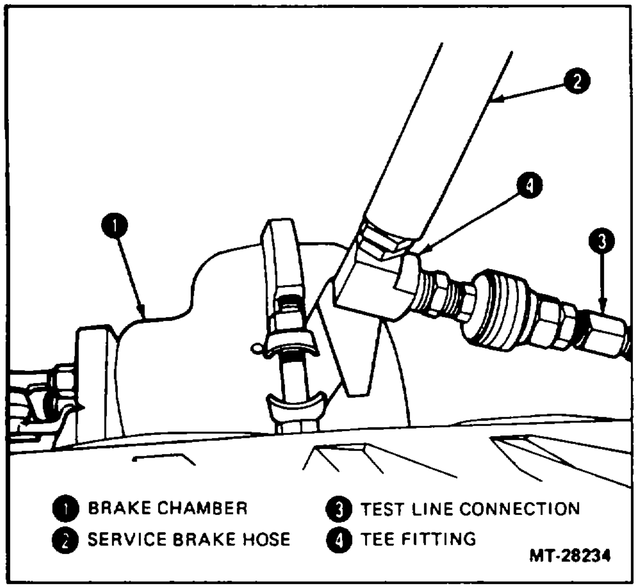


Figure 27 - Test Gauge Hose Connection (At Service Brake Chamber)

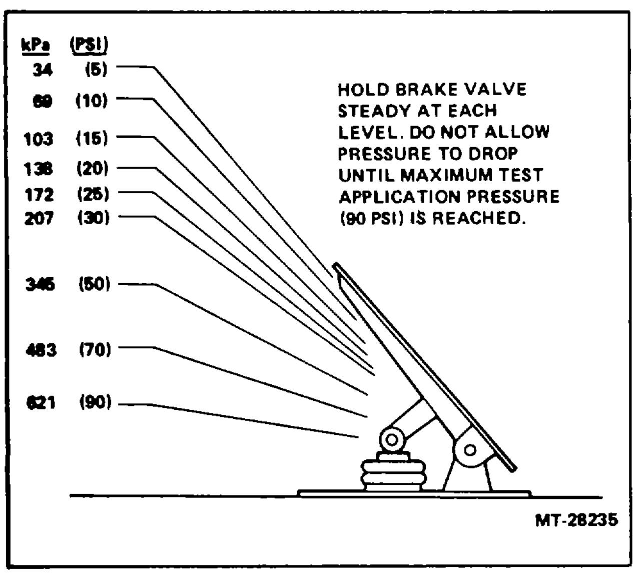


Figure 28 - Brake Test Application Pressures

Under normal conditions, the average pressure vari-ance between axles through the pressure range as test-ed should not exceed 28 kPa (4 psi) for optimum performance. (See Data Interpretation and Corrective Measures.)

4. Check pressure build-up rate as follows: While observing the duplex gauge, apply the service brake control moderately to at least 207 kPa (30 psi). The moderate rate of application should simulate that used in day-to-day braking under normal operating conditions. Observe and record the pressure difference between the hands on the test gauge dial (Figure 29). The dual pressure readings give an indication of the timing difference between the axles. If the pressure build-up in the trailer brakes leads the tractor brakes, the gauge reading should be recorded as a positive (+) number. If the pressure build-up lags, the reading should be re-corded as a negative (-) number. Release the service brakes. Repeat this step at least three times and record the average of the total readings.

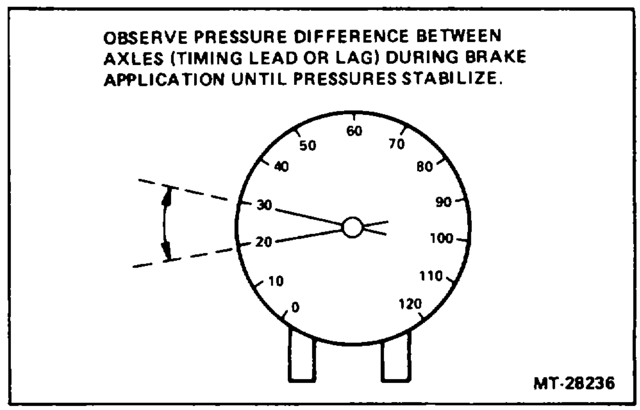


Figure 29 - Gauge Reading - Pressure Balance Check

Initial pressure difference (lead or lag) between axles should normally be no greater than 69 kPa (10 psi) for single-trailer combinations before the pressures begin to equalize.

NOTE - Since pressure lead and lag derived from using a duplex test gauge are estimates only, pressure build-up rate tests involving large fleets of vehicles can be performed more easily and accurately using pneumatic timing devices. These Instruments are available from electronic laboratories and air valve manufacturers. The above check, however, will provide an indication if slow pressure build-up rate Is a cause for compatibility complaints.

5. If pressure balance and/or pressure build-up rate differences between axles exceed the acceptable limitis1. refer to the Data Interpretation and Corrective Measures section.

Multiple Trailers

The Pressure Balance and Pressure Build-up Rate Test also can be used for checking combination vehicles with multiple trailers. One duplex test gauge is installed as described in the test procedure to read brake pressures at the rearmost axles of the tractor and the first trailer. A second duplex test gauge is installed to read pressure at the dolly axle and the rearmost axle of the second trailer (Figure 30). Two additional air hoses may be required to make the gauge connections at the second trailer in order to keep both duplex gauges at one observation point. The test is then conducted as described, noting and recording the pressure differentials and build-up times obtained from the four sources - the rearmost axles of the tractor and first trailer, and the dolly axle and rearmost axle of the second trailer.

Multiple-trailer combinations and their related complexity make it difficult to establish positive criteria. However, meeting the following guidelines should help optimize performance. For the pressure balance check, the average pressure difference between axles through the pressure range tested should fall within 28 kPa (4 psi) for optimum performance.

For the pressure build-up rate check, the maximum pressure difference (lead or lag) between axles should normally be no greater than 103 kPa (15 psi) before the pressures equalize.

Again, if the pressure balance and/or pressure build-up rate differences exceed the acceptable limit(s), refer to the Data Interpretation and Corrective Measures section.

Torque Balance Test

NOTE - If the pressure difference recorded for the pressure balance check exceeds the acceptable limit, the Imbalance must be corrected before a Torque Balance Test Is performed. However, if the pressure build-up rate indicates a problem condition, the Torque Balance Test can and should be conducted, especially if the operator's basic concern Is that of uneven lining wear between tractor and trailer.

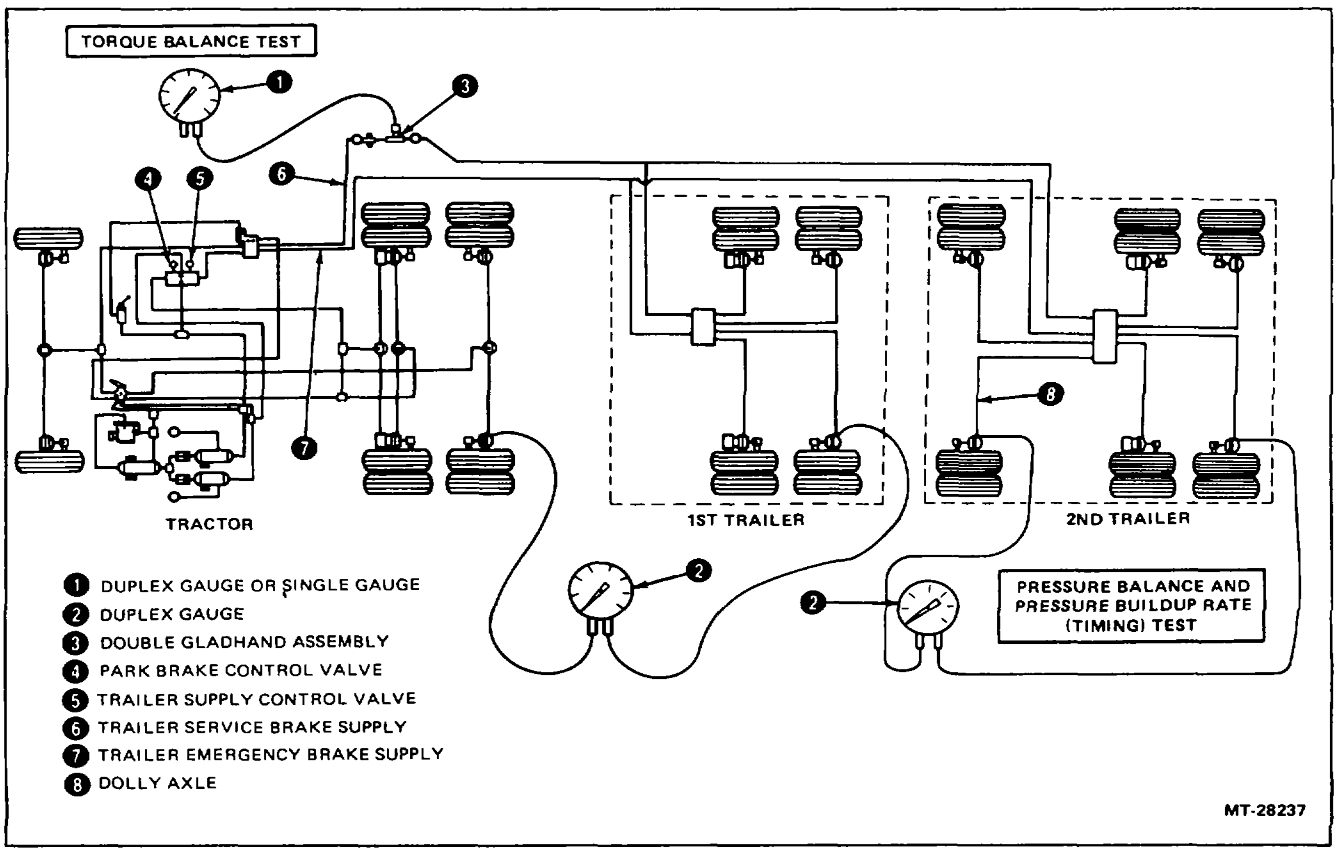


Figure 30—Test Connections—Multiple Trailers

1. Mount a decelerometer (Figure 31) to the inside windshield - as follows:
   a. Moisten the vacuum cups and press the decelerometer assembly to the windshield so it can be read by the observer.
   b. Loosen the bracket lower clamp nut and adjust the decelerometer so that its sides are-parallel to the direction of travel, then tighten the clamp nut.
   c. Loosen the side adjusting clamp nut and adjust the vertical position so that the fluid registers zero when the truck is on level ground, then tighten the clamp nut.

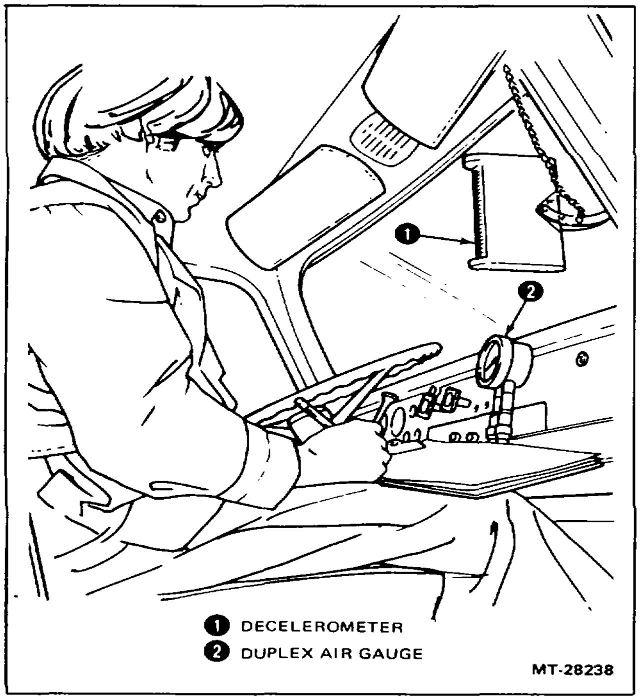


Figure 31 - Test Instrumentation (In-Cab)

2. Install the single or duplex air test gauge (Figure 31) and connections as follows:
   a. Install the double gladhand assembly in the tractor to trailer service line (Figure 32).
   b. Mount the single or duplex test gauge in the cab so it can be seen by both the driver and the observer.
   c. Connect an air hose between the double gladhand assembly and the gauge.

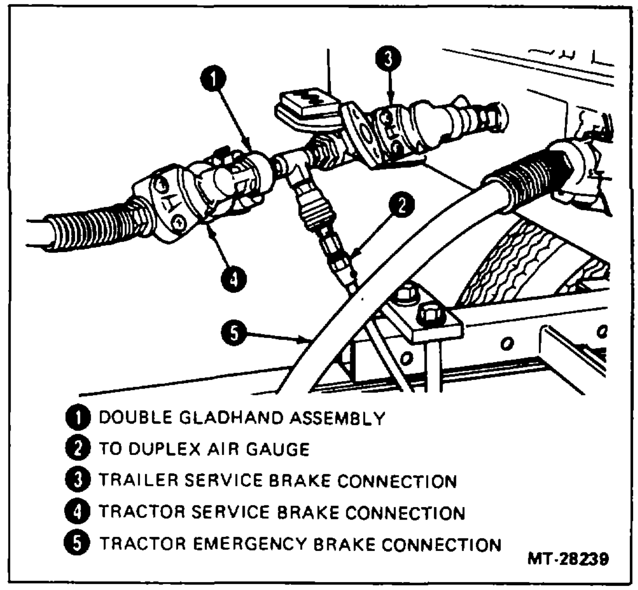


Figure 32—Double Gladhand Assembly Installation

   d. Secure the air hose to the vehicle so that it will not snag when the vehicle is turned (Figure 33).

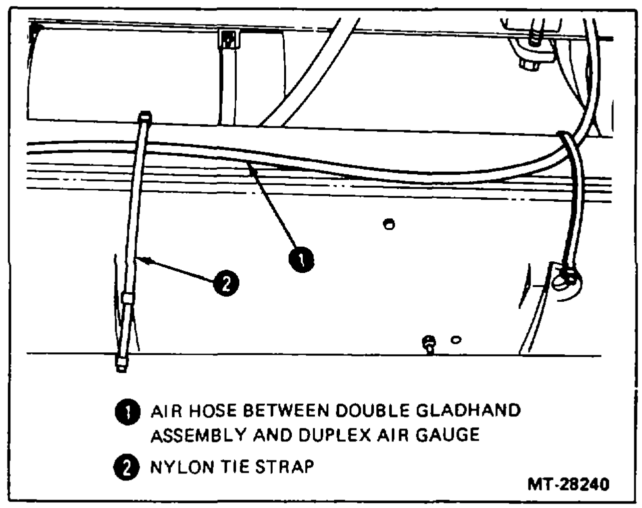


Figure 33 - Gauge Test Hose Routing

3. Record the following Preliminary Data (vehicle information) on the Data Sheet (CTS-1033Y) before initiating the test:
   a. Typical Weight (estimated) for normal maximum highway operation.
   b. Test Weight (actual axle weight or best estimate). The vehicle should be loaded to the extent that wheel lockup will not occur with a 276 kPa (40 psi) brake application at a test speed of 64 kmh (40 mph).

c. Initial Test Speed - If other than the recommended 64 kmh (40 mph). If speeds of 64 kmh are not permitted in the area chosen for the test, the test speed for the snubs can be reduced to 30 mph. Whatever speed is used, it should be the same for each of the checks noted below.

4. Check the brake torque output of the tractor and trailer in combination and individually as follows:

NOTE - An observer should be used to record all data for these tatas. Only the SUSTAINED decelerometer reading a should be recorded and not the peak readings at the beginning and end of each step.

a. Tractor-Traller Combination Torque Output
The initial step in evaluating the performance of a tractor-trailer Is to determine whether the combination is capable of operating at its designed performance level.
While operating the tractor-trailer combination in a suitable test area, make three (3) stops from 64 kmh (40 mph) at 276 kPa (40 psi) brake application pressure. Record the sustained deceleration reading (to the nearest .5 ft./sec.2) for each stop in the appropriate space on the Data Sheet. Determine the average for the three readings.

b. Tractor Torque Output
With the service brakes released, close the shut-off cock in the double gladhand connection between the tractor and trailer.
WARNING - SINCE CLOSING THE SHUT-OFF COCK MAKES THE TRAILER SERVICE BRAKES INOPERATIVE, ALLOW MORE DISTANCE FOR STOPPING THE COMBINATION VEHICLE. IF POSSIBLE, USE A NON-PUBLIC AREA FOR CONDUCTING THE TEST.
Again, operate the tractor-trailer combination, this time using the tractor brakes only to make three (3) stops from 64 kmh (40 mph) at 276 kPa (40 psi) brake application pressure. Record the decelerometer readings on the Data Sheet; determine and record the average reading.

c. Trailer Torque Output
With the service brakes released, open the shut-off cock In the double gladhand assembly.
Again, operate the tractor-trailer combination and, using only the trailer hand control valve (Figure 34) make three stops from 64 kmh (40 mph) at 276 kPa (40 psi) and record the readings and average on the Data Sheet.

NOTE - It may be helpful to preload the traller air lines for smooth brake application and more accurate test results. This Is accomplished by maintaining vehicle speed while lightly applying the hand control valve just prior to the test stop.

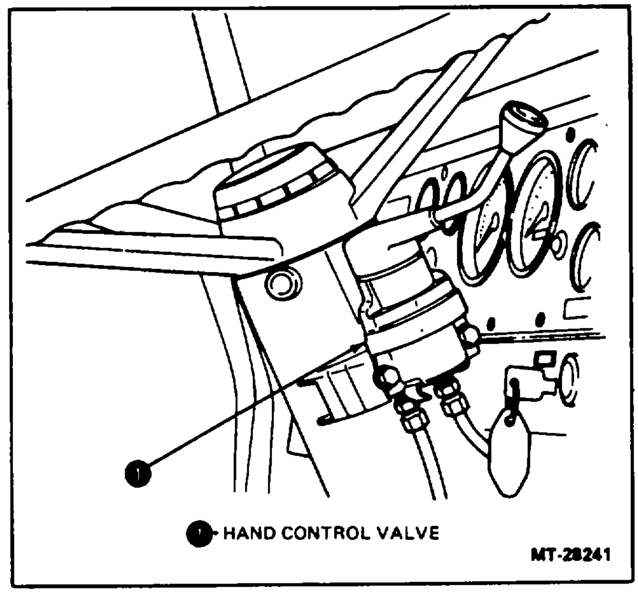


Figure 34 - Trailer Hand Control Valve

5. Add the average deceleration reading for the tractor to the average deceleration reading for the trailer.

The sum should be within +.5 ft./sec.2 of the average deceleration reading obtained from the combination test. If not, the individual tractor and trailer torque output tests must be rerun.

Evaluating the Performance of Tractor and Trailer

6. From the test results, compute the Balance Ratio using the following formula:

NOTE - Typical Weights In the formula are those weights normally being carried by the vehicle. If a realistic estimate cannot be made, it Is recommended that the tractor and trailer (with typical load) be weighed.

7. Record the Balance Ratio on the Data Sheet. a If the balance ratio is 1.00, the tractor-trailer combination is in ideal torque balance.

- If the balance ratio is below 0.75, the combination unit is out of balance and the tractor is providing more than its share of braking efforts.
- If the balance ratio is above 1.25, the trailer is providing more than its share of braking efforts.

DATA INTERPRETATION AND CORRECTIVE MEASURES

After the test, the data needs to be interpreted. Guidelines and concepts are provided below but it must be recognized that values which are acceptable depend on many factors.

These factors include terrain, weather, operator and fleet preference, maintenance and the tractor and trailer foundation brake and vehicle characteristics as well as the interrelationship of pressure balance, pressure buildup rate and torque balance.

Also it must be remembered that data taken on one vehicle combination may or may not be representative of other units in a fleet.

Pressure Balance

Combination Units - A 28 kPa (4 psi) or less pressure differential is generally acceptable between the tractor rearmost axle and the trailer rearmost axle. Some users prefer to have a slightly higher pressure at the trailer than at the tractor. This may require special valves on the tractor.

For combinations involving multiple trailers, it is the preference of some operators to have lower pressure in the dolly axle brake chambers than at other axle brake chambers.

Individual Valves-- If the pressure differential between the tractor and trailer brake chambers exceeds the above guidelines, the system should be checked for pressure drops across individual valves. This is accomplished by connecting air lines from the duplex test gauge to the inlet and outlet ports of the individual valves and checking the variation of input to output pressures at 34 kPa (5 psi) increments up to 207 kPa (30 psi).

Combination Unit Overview

The vast majority of brake applications are made at less than 207 kPa (30 psi). Due to this fact, minimizing pressure differentials between the tractor and trailer(s) brake chambers becomes very Important if each axle is to do its share of braking the combination. For example, If on a specific brake application the drive axle receives 103 kPa (15 psi) and the trailer axle(s) only 55 kPa (8 psi), then the tractor brakes could be doing almost 50% more work in slowing the combination than the trailer brakes. Therefore, minimizing the pressure differentials on the trailer axle(s) is very important to optimize performance, wear and stability.

It is extremely difficult to obtain exactly the same pressure on all axles due to the additional valves used on each of the trailer axles. However, controlling differentials and maintaining them within the 28 kPa (4 psi) noted earlier is important.

Pressure Build-up Rate (Timing)

Tractors and trailers built since 1975 are required to meet FMVSS-121 application and release timing reuirements. However, meeting these requirements does not insure timing compatibility. Evaluating the time it takes to build up pressure in the various axle brake chambers and the time to exhaust this pressure from these chambers takes sophisticated equipment nor-mally not available to the user. If such a check is desired, the vehicle manufacturer should be contacted.

However, a general comparison of the pressure build-up rates in the tractor and trailer chambers can be checked by the procedure noted earlier. This check will give you an indication if the pressure build-up differential between the tractor and trailer is reasonable. Usually, there will be a difference (the trailer will usually be slower) due to the added piping and valves required to actuate the trailer brakes. Minimizing this difference is important in achieving combination compatibility. As noted earlier, maintaining this lag to 69 kPa (10 psi) or less should be the objective.

If the Pressure Build-up Rate Test indicates the lag is not within the 69 kPa (10 psi) guideline, the system should be checked for restrictions in the lines and hoses, damaged fittings, or incorrect lines or fitting sizes. If no problem is noted, the individual valves should be checked for contamination and/or failed components.

Torque Balance

Normally, acceptable combination unit performance can be achieved with a tractor-trailer balance ratio of between .75 and 1.25.

If these guidelines are exceeded, the modifications to consider include:

1. If ratio is less than .75
   - Increase the power of the trailer brakes or
   - Decrease the power of the tractor brakes
2. If ratio is greater than 1.25
   - Decrease the power of the trailer brakes or
   - Increase the power of the tractor brakes

NOTE - A tractor-trailer combination (with each axle loaded to its GAWR) that meets the performance criteria for pressure balance and timing, and torque balance should also reach a 9-1/2 I1 ft./sec.2 deceleration (minimum) without any wheel lock from 64 kmh (40 mph) at 276 kPa (40 psi).

Common causes of torque imbalance or lack of combination unit performance include:

1. Use of replacement parts, particularly linings, other. than those originally specified.
2. Tractor and/or trailer brake torque output(s) not compatible with the loads being carried..
3. Lining contamination, poorly maintained brakes, and broken or malfunctioning brake components.
4. Brakes out of adjustment

The trailer and/or tractor manufacturer should be consulted for any modifications to the respective trailer and/or tractor system that would cause deviation from the original specification

GLOSSARY OF BRAKE TERMINOLOGY

BRAKE ACTIVATION TIME: The length of time required for a given amount of air to start a mechanical movement in the brake system foundation brake

COEFFICIENT OF FRICTION: The amount of friction produced by any two bodies in contact with each other; the amount of force required to move one body while it remains in contact with another

DECELERATION: The actual rate at which a moving body is losing speed; expressed by number of miles per hour or feet per second

DUAL BRAKE VALVE: An application valve (floor-mounted or suspended pedal type) having separate supply and delivery circuits, providing the operator with a graduated control for applying and releasing a vehicle’s brakes

INVERSION VALVE: Supplies a limited "hold-off" pressure to the spring brakes through use of the service brake valve

KINETIC (MOTION) ENERGY TO HEAT ENERGY: Heat that is produced by friction during brake lining-rotor/drum contact while the vehicle is in motion (decelerating)

MODULATED SPRING BRAKE CONTROL: Referring to the fact that spring brakes are applied with some degree of control

REACTION TIME: The time required from the operator’s initial thought of stopping to the activation of the brake system

Replace old Section with this revised Section in your CTS-4001 Manual

BRAKES, AIR
AIR COMPRESSOR
MIDLAND BRAKE MODELS EL-1300 AND EL-1600

CONTENTS

CONTENTS (Continued)

DESCRIPTION

The EL-1300 compressor (Figure 1) has a rated displacement of .36 cubic meters per minute (12.9 cubic feet per minute) at 1250 rpm. The EL-1600 compressor has a rated displacement of .46 cubic meters per minute (16.1 cubic feet per m inute) at 1250 rpm. The EL-1600 is basically the same as the EL-1300 except the EL-1600 has a longer stroke. Both units are two cylinder reciprocating type compressors.

The crankshaft main bearings of the base mount compressors are ball bearing type, front and rear (Figure 2). 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, with two oil rails and one expander ring below the piston pin. Snap rings are used to retain the pin in the piston.

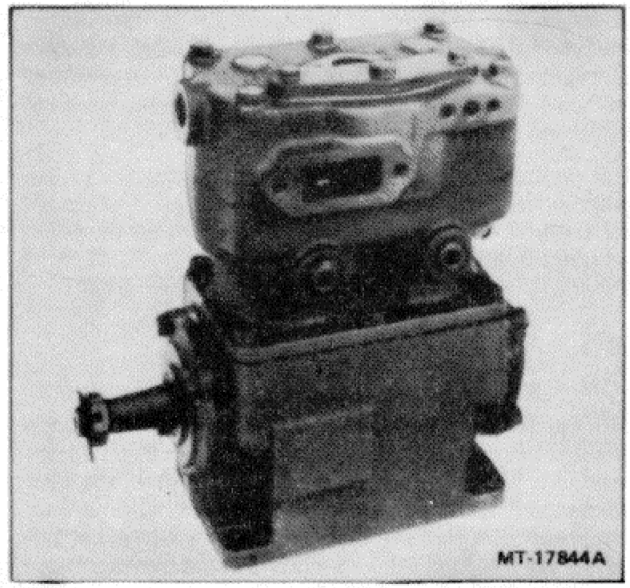


Figure 1 - EL-1300 Model Air Compressor

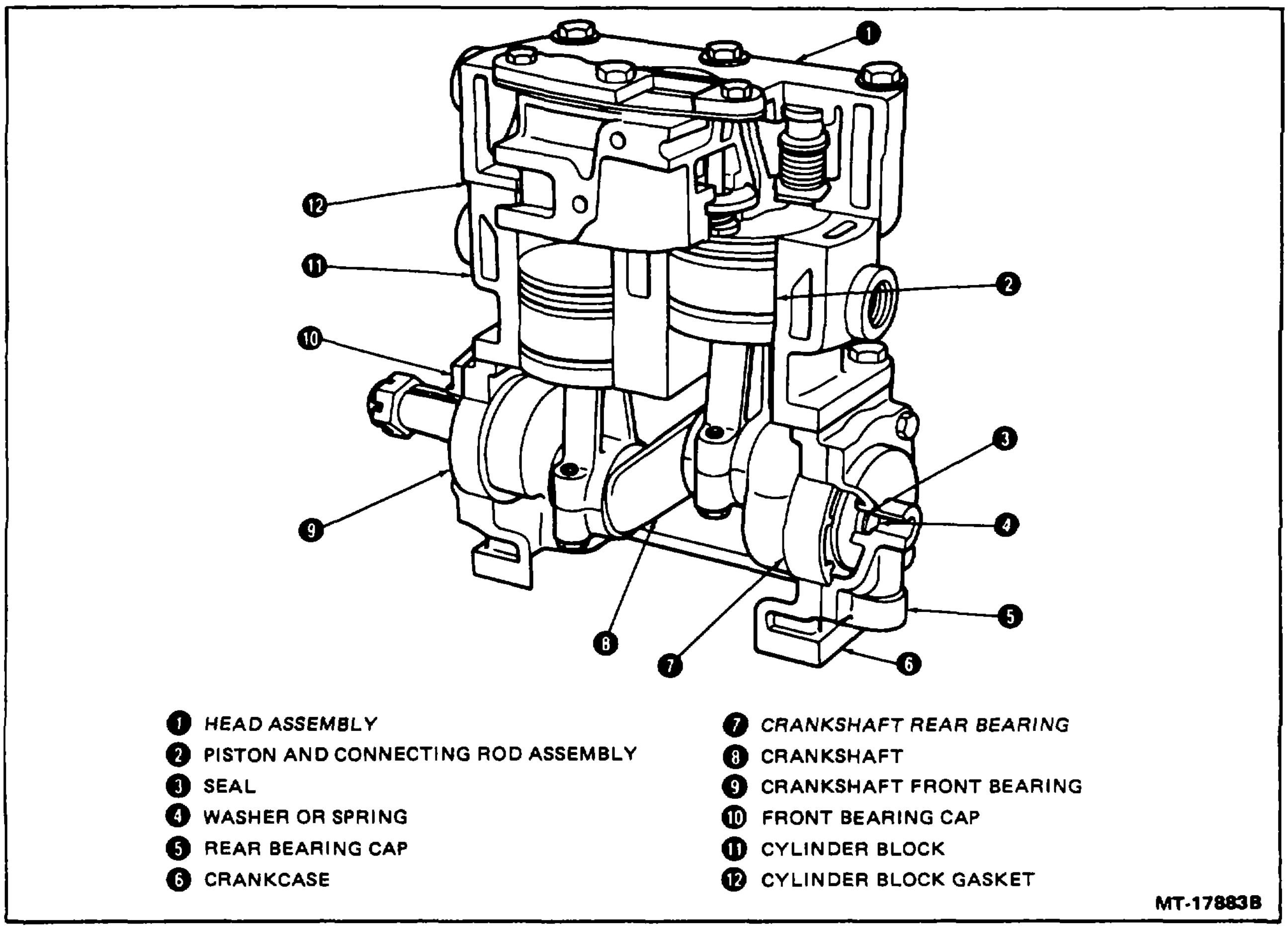


Figure 2 - Cutaway View of Air Compressor

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, and from there 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 the maximum governor pressure setting, the governor is actuated causing the unloader pins to hold the inlet valves off their seats (open). With the inlet valves open, air passes freely back and forth between the cylinder bores and the intake cavity in the cylinder head. This suspends the compression of air until the pressure in the system Is reduced to the governor cut-in setting. The governor then exhausts the air pressure to the unloader mechanism, releasing the unloader pins. This allows the inlet valves to function normally and the resumption of air compression.

MAINTENANCE

Air filters should be cleaned or replaced when the vacuum level exceeds 508.0mm (20 Inches) of water at compression. The governor settings and unloader operation should be checked regularly. Maximum desirable reservoir pressure is 826 + 27.6 kPa (125 + 5 psi). Type of air cleaner, operating conditions and experience may dictate additional service activity.

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.

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's engine.

Refer to disassembly procedures for unloader on page 6 and assembly procedures for unloader on page 11.

TROUBLESHOOTING GUIDE

CONDITION	POSSIBLE CAUSE	RESOLUTION
Compressor fails to maintain sufficient pressure or adequate air supply.	Dirty intake cleaner	Clean or replace element as necessary.
	Restriction in compressor cylinder head intake, discharge cavities or line.	Repair or replace as necessary.
	Leaking or broken inlet or exhaust valves	Repair or replace valves as necessary.
	Excessive wear	Repair or replace compressor as necessary.
	Drive belt slipping	Adjust or replace belt.
	Excessive system leakage	Check all fittings and connections.
	Defective governor	Repair or replace governor as necessary.
	Governor with improper setting	Adjust governor as necessary.
	Gauge defective	Replace gauge as necessary.

TROUBLESHOOTING GUIDE (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Noisy operation	Loose drive pulley	Tighten repair, or replace pulley as necessary.
	Restrictions in cylinder head or discharge line.	Repair or replace as necessary.
	Worn or burned out bearings	Replace bearings as necessary.
	Compressor not getting proper lubrication	Service lubrication system as necessary.
	Excessive wear	Overhaul or replace compressor as necessary.
Compressor not unloading (excessive pressure.)	Defective unloader pins or seals	Replace pins/seals as necessary.
	Defective governor	Repair or replace governor as necessary.
	Reservoir line to governor restricted	Repair or replace line as necessary.
	Unloader mechanism binding or stuck.	Repair unloader as necessary.
	Gauge defective	Replace gauge as necessary.
Compressor passes excessive oil	Excessive wear	Overhaul or replace compressor as necessary.
	Dirty air cleaner	Clean or replace element as necessary.
	High inlet vacuum (obstructed intake).	Service intake as necessary.
	Small or restricted oil return line flooding compressor	Repair or replace return line as necessary.
	Excessive oil pressure	Service lubrication system as necessary.
	Defective or worn oil seal in rear bearing cap.	Replace seal as necessary.
	Piston rings improperly installed	Remove and reinstall as necessary.
	Back pressure from engine crankcase	Check engine ventilation system, excessive engine blow by (piston rings).
	Intake pipe restricted, too long or too small	Repair or replace pipe as necessary.

REMOVAL AND INSTALLATION

WARNING - WHEN ANY COMPONENT IS SER- VICED OR REMOVED FROM THE AIR SYSTEM, BE SURE TO SET THE PARKING BRAKE AND/OR BLOCK THE VEHICLE TO PREVENT IT FROM MOV- ING WHILE ANY SERVICE IS BEING PERFORMED. REMOVAL

1. Drain air pressure from main reservoir.
2. Drain engine cooling system and cylinder head of compressor if compressor is water-cooled.
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.

INSTALLATION

Installation of compressor is performed by reversing the removal procedures. Items to be observed when reinstalling compressor are:

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 holes in gasket and compressor are properly aligned with oil supply line.

Inspect drive pulley (gear) for water or damage. It should fit securely on the crankshaft, contacting the shaft only, not riding the key. Tighten drive pulley nut to recommended torque, refer to SPECIFICATIONS in this Section.

Insure that the air cleaner is clean and properly installed. If air intake is connected to the engine air cleaner, connections should be tight with no leakage.

Clean or replace any dirty, corroded, or damaged air or water lines before connecting them to the compressor.

Use a new discharge fitting gasket.

Align compressor drive and adjust to proper belt tension. Tighten mounting bolts to recommended torque, refer to SPECIFICATIONS in this Section.

After compressor is installed, operate it and check for air, oil or water leaks at connections. Be sure to check for noisy operation.

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

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.

UNLOADER

1. Bleed off main air reservoir. (For on vehicle maintenance only.)
2. Remove two hex head unloader cover bolts and cylinder head bolt located in center of unloader cover (Figure 3).

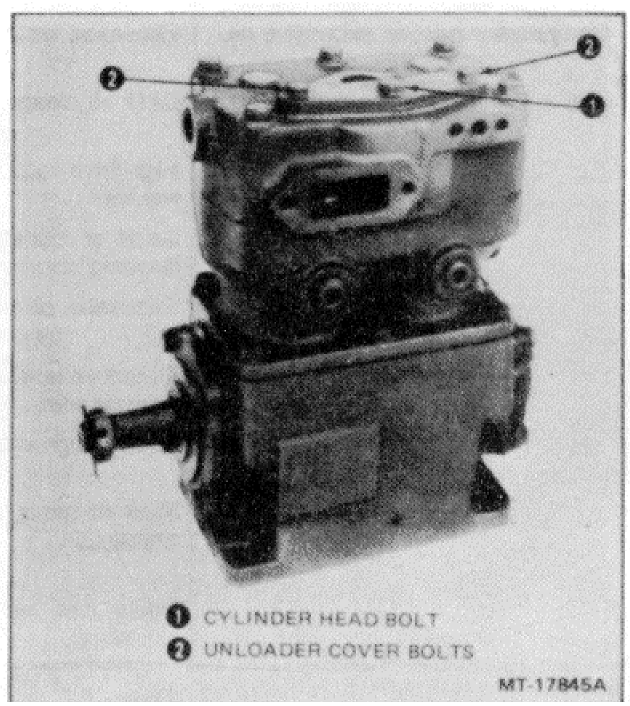


Figure 3 - Unloader Cover Removal

3. Remove unloader cover. Unloader seal and end of pin will protrude from head.
4. Remove unloader pins with seals and unloader springs (Figure 4). Discard seals and cover gasket.

NOTE -- Refer to ASSEMBLY, UNLOADER In this section for reassembly procedures.

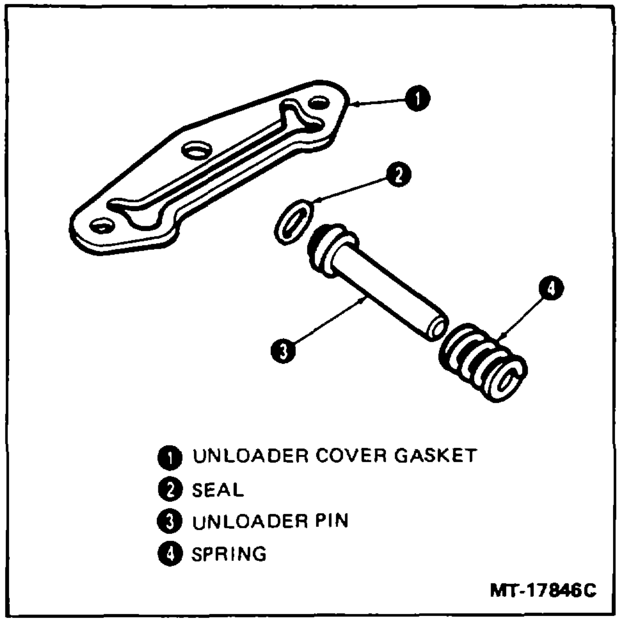


Figure 4 - Unloader Components

CYLINDER HEAD

1. 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.

NOTE - Refer to Figure 5 during the following procedures:

2. If the unloader has not already been removed, position cylinder head on table and remove the two unloader cover bolts (Item 3) and washers. Remove unloader gasket (Item 1) and discard. Remove unloader pins and springs (Items 4 and 6). Remove seals (Item 5) from unloader pins and discard seals.
3. Turn head over and remove exhaust valve seats (Item 11) using a 14mm (9/16 in.) Allen wrench. Remove exhaust valve (Item 10), washer (Item 12), and spring (Item 9). Discard washer.

CAUTION - THE EXHAUST VALVE STOPS ARE PRESSED INTO THE CYLINDER HEAD. DO NOT ATTEMPT TO REMOVE THEM. IF THEY ARE DAMAGED, LOOSE, WORN, OR IF THE DISTANCE FROM THE EXHAUST VALVE STOP SURFACE TO THE SPRING SEAT SURFACE EXCEEDS LIMITS INDICATED IN THE SPECIFICATIONS PORTION OF THIS SECTION, THE COMPLETE HEAD ASSEMBLY MUST BE REPLACED.

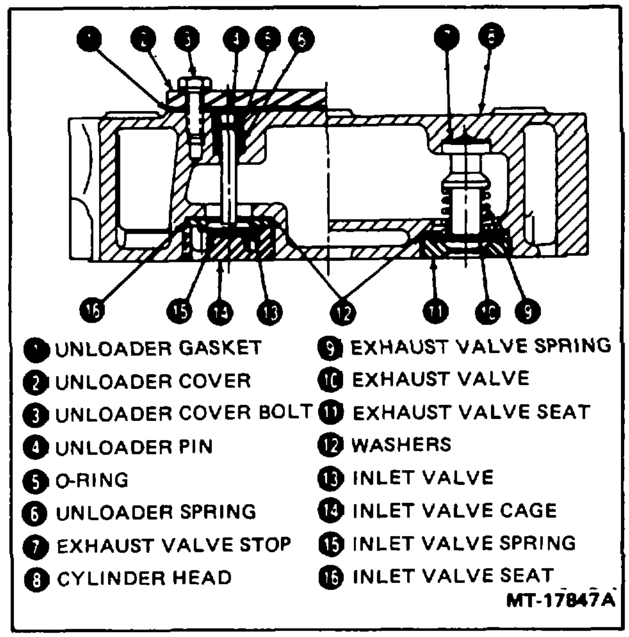


Figure 5 - Cross Section of Cylinder Head

4. Remove inlet valve cages (Item 14) with valve cage tool SE-2613 as shown in Figure 6. Then remove inlet valve springs (Item 15), inlet valves (Item 13), inlet valve seats (Item 16), and washers (Item 12). Discard washers.

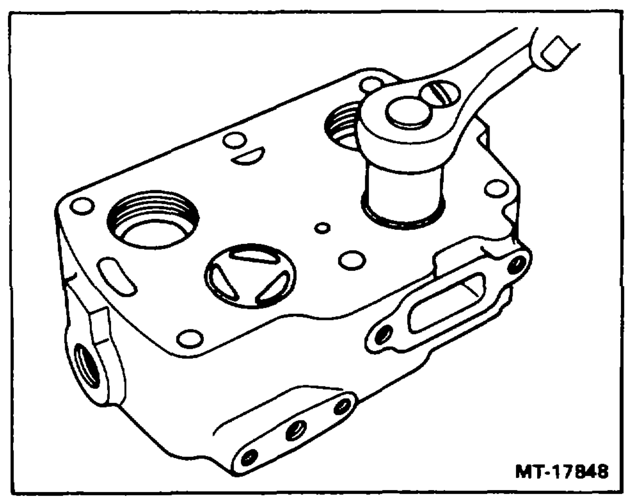


Figure 6 - Removing Valve Cage Using Tool SE-2613

PISTONS AND CONNECTING RODS

1. Turn crankshaft so that one connecting rod is at bottom of stroke. Remove connecting rod, bolts and bearing cap (12-point 5/16 in. socket). Remove piston and rod assembly from top of cylinder block.

2. 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.
3. Position other rod at bottom of stroke by turning crankshaft and remove rod and piston as previously described.
4. 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. Refer to Figure 7.

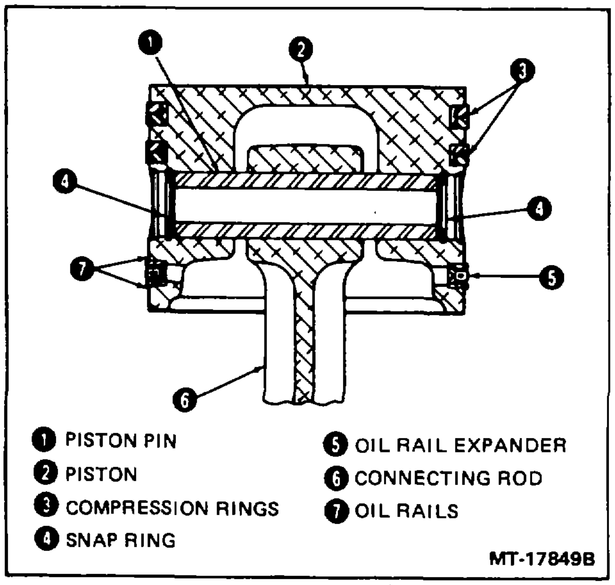


Figure 7 - Cross Section of Piston Assembly

CYLINDER BLOCK

Remove six bolts and lockwashers which secure cylinder block to crankcase; then separate cylinder block from crankcase. Discard gasket.

CRANKSHAFT AND BEARINGS

1. Remove the four crankshaft bearing cap bolts on each bearing cap and remove caps. Discard gaskets.
2. Press the shaft seal from front bearing cap and discard seal.
3. Remove seal and bowed washer or spring from rear bearing cap.

IMPORTANT - Do not remove crankshaft and bearings from crankcase unless an inspection reveals the necessity for removal.

4. Place crankcase-crankshaft-bearing assembly in an arbor press, supporting crankcase adjacent to rear bearing. Use an adapter (shown in Figure 8) and press crankshaft rear bearing assembly from crankcase and out through rear bore.

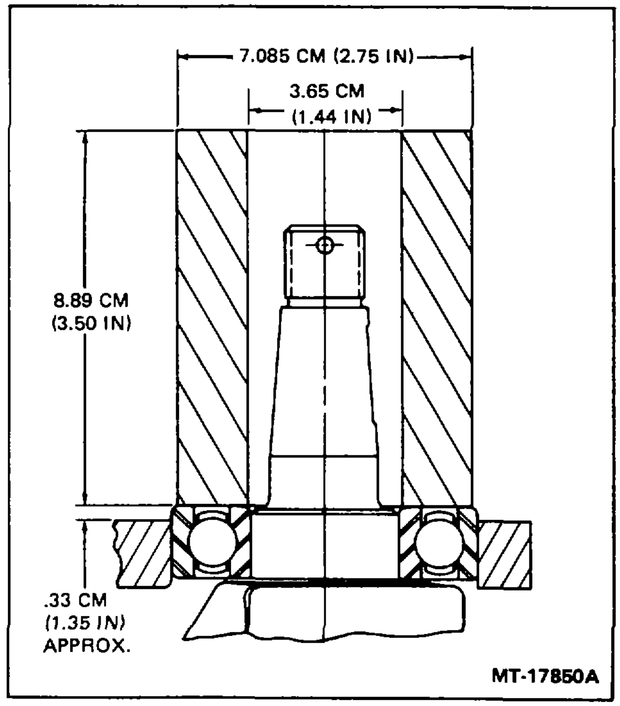


Figure 8 - Crankshaft Bearing Adapter

5. When rear bearing is free from case, use a bearing puller and pull rear bearing from crankshaft.
6. 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 as noted in SPECIFICATIONS in this Section, that particular part must be replaced.

UNLOADER

Examine unloader components for excessive wear or deformation. Parts which do not conform to standards as noted in SPECIFICATIONS in this Section should be replaced.

Inspect unloader spring for loads at specified heights. Visually check unloader pins for damage and measure length.

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 insure correct measurement.

If piston diameter is more than .020 cm (.008 in.) smaller than cylinder bore, the piston must be replaced. Service pistons are available in .051 cm (.020 in.) 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 Figure 9. Refer to SPECIFICATIONS in this Section for ring gap limits and ring groove clearance. Rings must be replaced if not within specified limits.

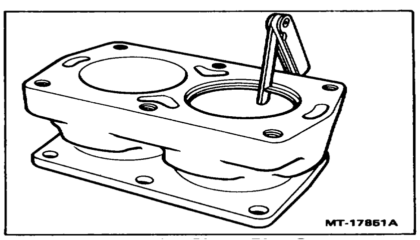


Figure 9 - Measuring Piston Ring Gap

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 (Figure 10). Refer to SPECIFICATIONS in this Section 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.

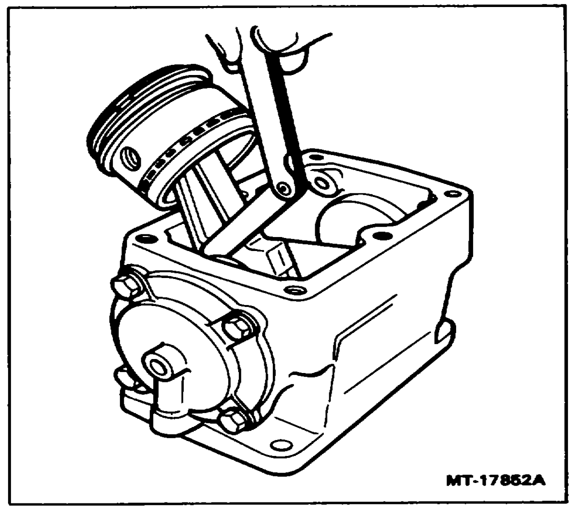


Figure 10 - Checking Connecting Rod Side Clearance

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 in.) or taper not more than .0025 cm (.001 in.) 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 ring are available in .0503 cm (.020 in.) oversize.

CRANKSHAFT

Bent or twisted crankshafts 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 in.) .0508 cm (.020 in.) 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 SPECIFICATIONS in this Section, 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.

AIR COMPRESSOR - MIDLAND BRAKE MODELS EL-1300, EL-1600

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 in 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 studs (if used) and replace any that are bent or damaged.

SEALS AND GASKETS

Replace all seals and gaskets. Never re-use any gaskets or seals.

ASSEMBLY

Apply a coat of engine oil to crankshaft, bearings, connecting rod bearings, pistons and cylinder block bore.

CRANKSHAFT AND BEARINGS

1. Position the crankcase in an arbor press supporting the crankcase on the rear end cap surface. Install the front bearing in the crankcase. Press the bearing into the crankcase so it extends outside the crankcase about .3929 cms (.135 in.) (Figure 8). Do not apply pressure to the inner race only.
2. Position the crankcase/bearing assembly in the arbor press supporting the assembly on the inner race of the bearing. Install the crankshaft into the bearing. Press the crankshaft into the bearing applying force to the rear of the crankshaft until the inner race of the bearing is seated firmly against the shoulder of the crankshaft. Care must be taken not to damage the oil sealing surface on the rear of the crankshaft.
3. With the assembly still in the arbor press, place the rear bearing on the crankshaft. Press the bearing onto the crankshaft and into the crankcase applying force to both the inner and outer race of the bearing until the inner race is seated firmly against the shoulder of the crankshaft.

CRANKSHAFT BEARING CAPS

1. Apply a thin coat of Loctite Gasket Eliminator (purple) around the perimeter of the front bearing cap oil seal. The coating must be light yet cover the seal fit area.
2. Press a new seal into front bearing cap. Lip of seal must face towards the crankcase when installed.

   The seal case must be flush to .0127 cm (.005 in.) below the front of the cap.
3. Position a new gasket over crankshaft between crankcase and bearing cap.
4. Position bearing cap over end of crankshaft taking care not to damage oil seal.
5. Pull bearing cap into place by alternately tightening the four bolts. Tighten bolts to specified torque listed in TORQUE CHART in this Section.
6. Position new gasket over crankshaft between crankcase and rear bearing cap.
7. 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.
8. Slide rear bearing cap over rear of ball bearing taking care that bowed washer or spring and seal do not fall out of cap.
9. Pull bearing cap into place by alternately tightening the four bolts. Torque bolts to specified torque listed in TORQUE CHART in this Section.

CYLINDER BLOCK

Place a new cylinder block to crankcase gasket on crankcase; then position the cylinder block on gasket. Install six bolts and lock washers. Tighten two center bolts to 10.847 N-m (8 Ib-ft) prior to tightening the four end bolts. Increase bolt torque to specified torque, tightening center bolts first, then the four end bolts.

PISTONS AND CONNECTING RODS

1. Position connecting rod in piston; then press piston pin in place. Install snap rings in piston at both ends of piston pin (Figure 7).
2. Install two compression rings in each of the two grooves and two oil rails and expander in bottom groove (Figure 7).

   Compression rings must be installed with surface marked "TOP" facing top of piston. Some compression rings may have dots to indicate top of ring.
3. 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 Figure 12. Also, make sure that the rod cap is installed on rod from which it was removed.
4. 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.

5. 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 11 and 12.
   Tighten connecting rod bolts according to listing In TORQUE CHART in this Section. Use a 12 point 5/16 in. socket on connecting rod bolts.

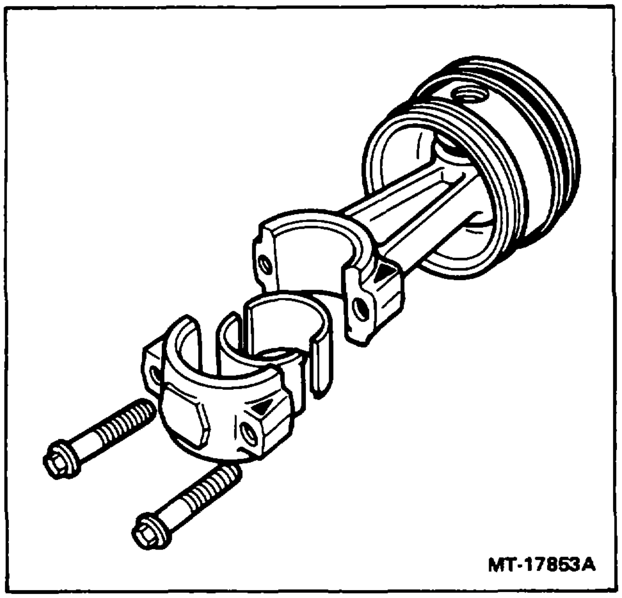


Figure 11 - Piston and Connecting Rod Assembly

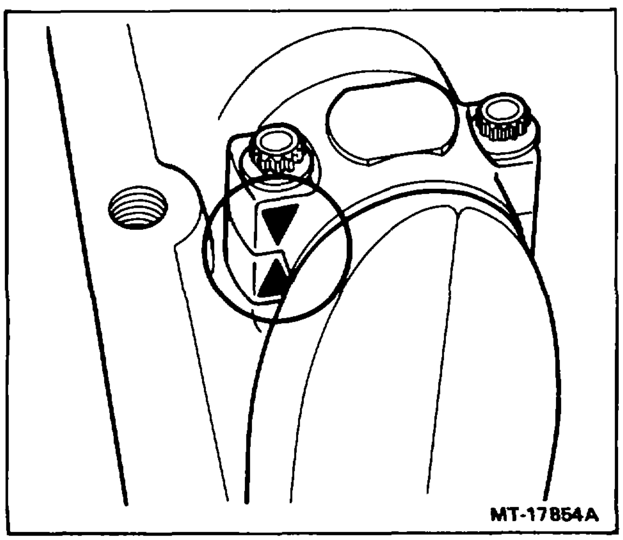


Figure 12 - Connectin

6. Install the second connecting rod assembly in the same manner.

CYLINDER HEAD

NOTE - Refer to Figure 5 during the following procedures:

1. Turn cylinder head upside down and insert new washers (Item 12), exhaust valve springs (Item 9), exhaust valves (Item 10), and exhaust valve seats (Item 11). Tighten exhaust valve seats to torque valve specified in TORQUE CHART In this Section.
2. With head still positioned upside down, Insert new washers (Item 12), inlet valve seats (Item 16), inlet valves (Item 13), inlet valve springs (Item 15) and inlet cages (Item 14). Inlet valves and springs must be centered to insure the valve is not tightened between inlet valve seat and cage. Tighten valve cage to specified torque valve using valve cage tool SE-2613 as shown in Figure 6. Refer to TORQUE CHART in this Section.

UNLOADER

1. Install new O-ring seals between flanges on unloader pins. (Refer to Figure 4.)
2. Form a 14mm (9/16 in.) ball of lubricant around O-ring 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.
4. Place unloader gasket on unloader cover. Assemble these two items as a unit compressing the unloader springs and hold until the unloader cover bolts and lockwashers or hardened plain washers are installed.
5. Tighten unloader cover bolts to about 1.1 N-m (10 lb-in) torque.

IMPORTANT - Unloader cover bolts should be tightened to torque valve after cylinder head bolts have been tightened to second step torque valve.

CYLINDER HEAD TO CYLINDER BLOCK

Position new cylinder head gasket on cylinder block. With gasket aligned, position cylinder head on block. Insert the longest head Volt through the unloader cover center hole; the other five head bolts through the remaining holes. Tighten head bolts in the sequence noted in Figure 13. This is a two step process: first, tighten to the first torque valve noted in TORQUE CHART; second, retighten to second valve noted in TORQUE CHART.

Tighten unloader cover bolts to torque valve listed in TORQUE CHART in this Section.

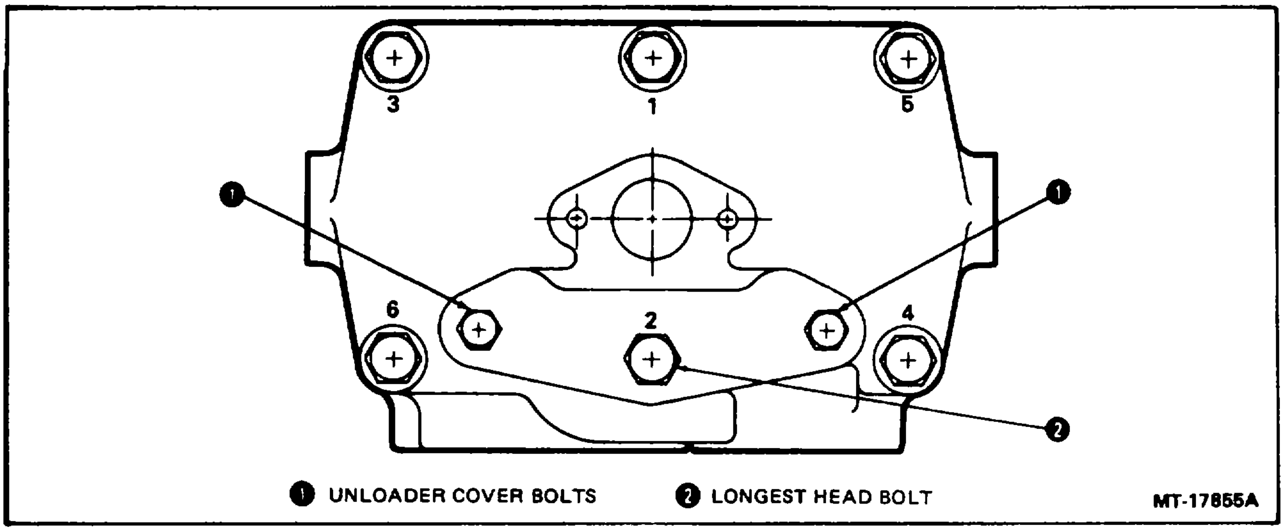


Figure 13 - Cylinder Head Bolt Tightening Sequence

SPECIFICATIONS

Type	**2-Cylinder**	
Capacity (at 1250 RPM)		
EL-1300	.36 m^3/min.	12.9 cu. ft./minute
EL-1600	.46 m^3/min.	16.1 cu. ft./minute
Air Pressure Setting		
Cut Out	861.75 kPa	(125 psi) Approx.
Cut In	710.0-744.5 kPa	(103-108 psi)
Cylinder Bore	68.840-69.850mm	(2.7495-2.7500 in.)
Piston and Connecting Rod Components:		
Piston Diameter Below Compression Rings	69.70-69.72mm	(2.744-2.745 in.)
Piston Pin Hole	14.26-14.27mm	(.5615-.5618 in.)
Rod Pin Diameter	14.27-14.28mm	(.5618-.5620 in.)
Connecting Rod Pin Hole	14.28-14.29mm	(.5622-.5624 in.)
Piston Rings:		
Compression Ring Gap	.051-.178mm	(.002-.007 in.)
Oil Ring Gap	.381-1.40mm	(.015-.055 in.)
Groove Clearance:		
Compression Ring	.0381-.114mm	(.0015-.0045 in.)
Oil Rings	.012-.114mm	(.0005-.0045 in.)
Cylinder Head Components		
Exhaust Valve Seat Valve Guide Diameter	29.08-29.24mm	(1.145-1.151 in.)
Top of Valve Seat to Seating Surface on Exhaust Valve	3.18-3.25mm	(.125-.128 in.)
Inlet Valve Spring Load @ 7.29mm (.287")	1.60-2.76 N•m	(.36-.62 lb.)
Unloader Spring Load @ 10.03mm (.395")	15.03-18.59 N•m	(3.38-4.18 lb.)
Exhaust Valve Spring Load @ 18.54mm (.73")	14.68-16.46 N•m	(3.30-3.70 lb.)
Exhaust Valve Stop Surface to Spring Seat Surface	18.29-18.80mm	(.72-.74 in.)
Inlet Valve Cage:		
Valve Guide Diameter	23.266-23.368mm	(.916-.920 in.)
Top of Cage to Valve Stop	3.33-3.51mm	(.131-.137 in.)
Inlet Valve Seat:		
Valve Seating Surface-to-Valve Cage Control Surface	0.596-0.673mm	(.0235-.0265 in.)
Unloader Pin Length	47.0-47.04mm	(1.850-1.854 in.)
Crankcase, Crankshaft and Bearing Cap		
Crankcase Bearing Bore	71.9938-72.0090mm 89.9973-90.0176mm	(2.8344-2.8350 in.) (3.5432-3.5440 in.)
Main Bearing (Sleeve Type)	55.0697-55.1078mm	(2.1681-2.1696 in.)
Ball Bearing:		
Outside Diameter	71.9861-71.9988mm	(2.8341-2.8346 in.)
Inside Diameter	35.0012-34.9885mm	(1.3780-1.3775 in.)
Outside Diameter	89.9998-89.9846mm	(3.5433-3.5427 in.)
Inside Diameter	53.9859-55.0012mm	(2.1648-2.1654 in.)
Crankshaft:		
Connecting Rod Journal Diameter	47.11-47.0mm	(1.855-1.850 in.)
Connecting Rod Journal Width	32.15-34.72mm	(1.265-1.367 in.)
Connecting Rod Bearing Clearance	0.012-0.053mm	(.0005-.0021 in.)
Connecting Rod Side Clearance	0.25mm	(.010 in.)
Main Bearing Journal Diameter	35.0114-34.9987mm 55.0139-54.9986mm	(1.3784-1.3779 in.) (2.1659-2.1653 in.)
Bearing Cap Seal Diameter	16.13-16.15mm	(.635-.636 in.)
Seal Outside Diameter	16.08-16.05mm	(.633-.632 in.)

TORQUE CHART

Location	Recommended Torque
Unloader Cover Bolts	11.3-15.3 N•m (100-135 lb-in)
Cylinder Head Bolts - First Step - Second Step	24.4-29.8 N•m (18-22 lb-ft) 36.6-44.7 N•m (27-33 lb-ft)
Bearing Cap Bolts	13.6-18.1 N•m (120-160 lb-in)
Cylinder Block to Crankcase	23.0-28.6 N•m (17-21 Ib-ft)
Connecting Rod Bolts	20.9-25.4 N•m (185-225 lb-in)
Exhaust Valve Seats	94.9-122.0 N•m (70-90 lb-ft)
Valve Cage	94.9-122.0 N•m (70-90 lb-ft)
Drive Nut (Pulley or Gear)	101.7-135.6 N•m (75-100 lb-ft)

SPECIAL TOOLS

SE-2613 Valve Cage Tool

BRAKES-AIR	GROUP 04, COMPONENTS revised pages to be inserted in your CTS 4001 Manual as follows: Replace COMPONENTS, CONTENTS page 1&2. Replace CHAPTER I pages 3-4 with new. Replace CHAPTER V complete.

COMPONENTS

IMPORTANT

MANUALLY OPERATED FRONT WHEEL LIMITING VALVE MUST NOT BE INSTALLED

ON CHASSIS EQUIPPED WITH FMVSS-121 AIR BRAKE SYSTEM.

CONTENTS

CONTENTS (Contlnued)

BRAKES-AIR

GENERAL

CONTENTS

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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 FMVSS 121 AIR SYSTEM (SECOND GENERATION), GENERAL INFORMATION for description of the dual air system used on the particular 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 section.

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 (apprbved 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.

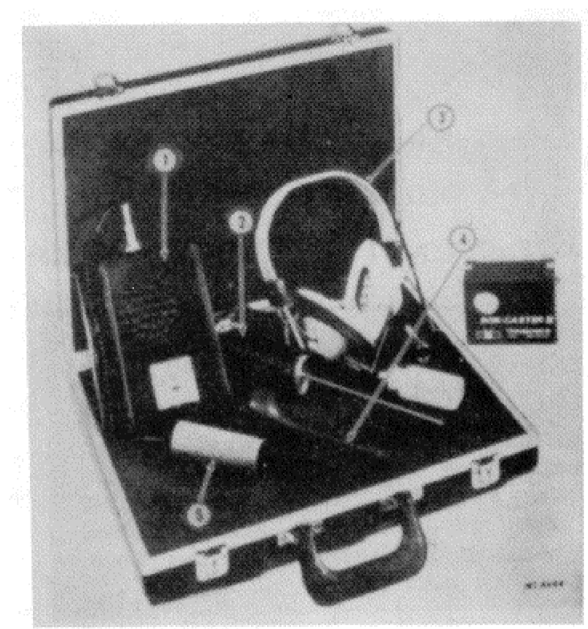

Fig. 1 Leak Defector Tester (SE-2326)

1 Amplifier
2 Contact Probe
3 Headphone
4 Sound Concentrator
5 Hand Probe

BRAKESAIR

CHAPTER I

GOVERNOR

CONTENTS

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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.

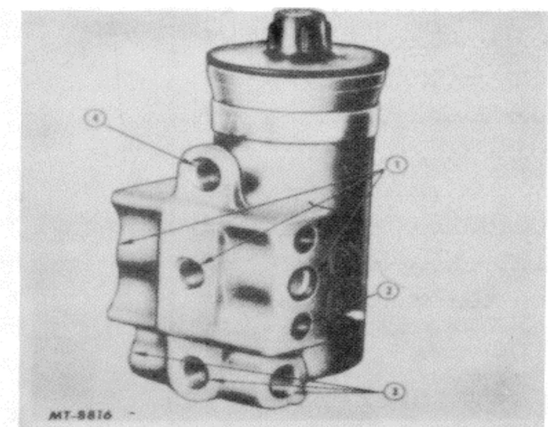

Fig. 1 Type D-2 Governor

1	Unloader Ports	3	Reservoir Ports
2	Mounting Holes	4	Exhaust Port

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.

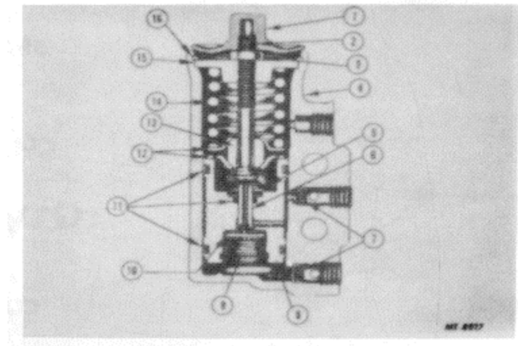

Fig. 2 Sectional View of Type D-2 Governor

1	Cover	10	Inlet and Exhaust Valve
2	Adjusting Screw	11	Grommets
3	Lock Nut	12	Lower Spring Seats
4	Body	13	Spring Guide
5	Exhaust Stem Spring	14	Pressure Setting Spring
6	Exhaust Stem	15	Upper Spring Seat
7	Filters	16	Retaining Ring
8	Piston		
9	Inlet-Exhaust Valve Spring		

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 pressure is 862 ± 35 kPa (125 ± 5 psi).

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 pressure is 690 to 717 kPa (100 to 105 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.

NOTE: 1/4 turn will change the setting approximately 28 kPa (4 psi). Any governor requiring more than a 360° adjustment should be cleaned and inspected.

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.

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 hex-shaped 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 intalled 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.

BRAKES-AIR

CHAPTER II
RESERVOIR, DRAIN COCK, SAFETY VALVE, PRESSURE GAUGE, LOW PRESSURE INDICATOR, STOP LIGHT SWITCH, RESERVOIR AUTOMATIC DRAIN VALVE

CONTENTS

CONTENTS (Continued)

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.

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.

MAINTINANCE

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.

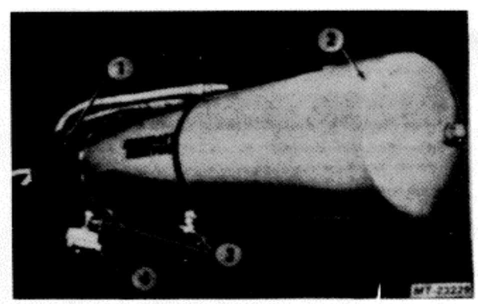

Fig. 1 Two Compartment Reservoir and Drain Cocks

1 Supply Reservoir
2 Secondary Reservoir
3 Drain Cocks
4 Automatic Drain Valve

SERVICE CHECKS

1. 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.

2. 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

DESCRIPIION

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.

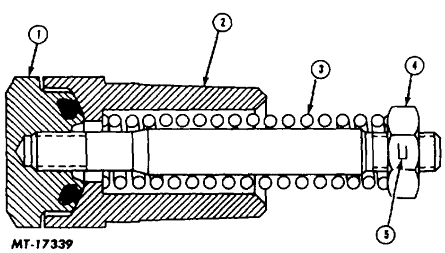

Fig. 2 Sectional View of Piston Type Safety Valve

1	Piston and Shaft Assembly	3	Spring
		4	Nut
2	Body	5	Stake Lock

MAINTENANC!

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

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

1. 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.

2. 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.

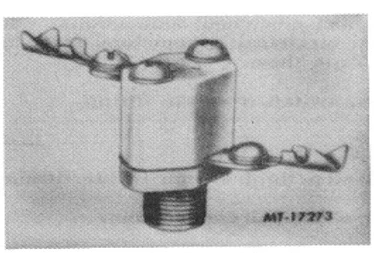

Fig. 4 Exterior View of Low Pressure Indicator

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.

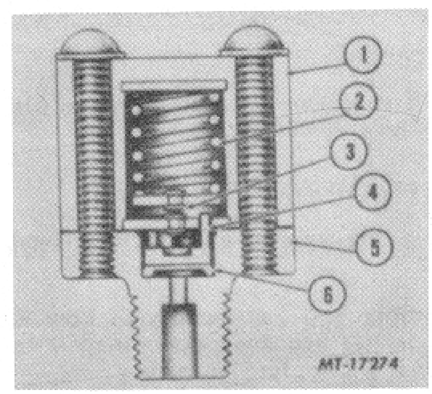

Fig. 5 Cross Sectional View of Low Pressure Indicator

1	Cover	4	Piston
2	Spring	5	Body
3	Contact Points	6	O-Ring Diaphragm

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

1. 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 electro-pneumatic 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.

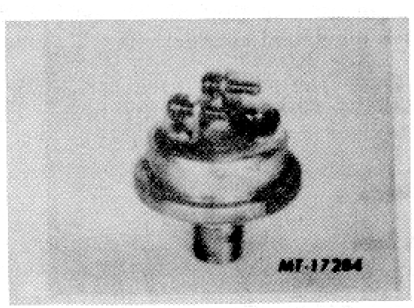

Fig. 6 Stop Light Switch

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.

MAINTENANCE

Every three months or every 40,000 km (25,000 miles, check all electrical connections.

Every year or 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.
3. Release brake valve and note that stop lights go 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

1. 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.
3. 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.

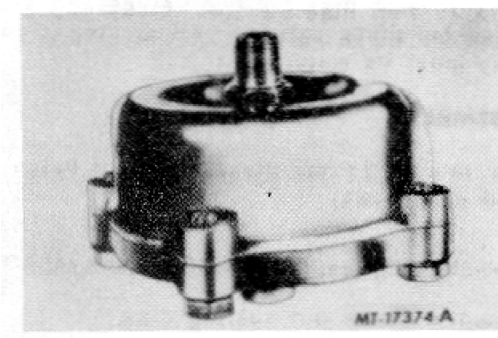

Fig. 7 Reservoir Automatic Drain Valve

OPERATION

With no air pressure in air system, the inlet and exhaust valves are closed (Fig. 8).

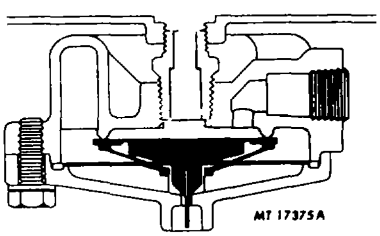

Fig. 8

When charging the air system, a slight pressure opens the inlet valve which permits air and contaminants to collect in sump (Fig. 9).

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. 10).CTS-4079

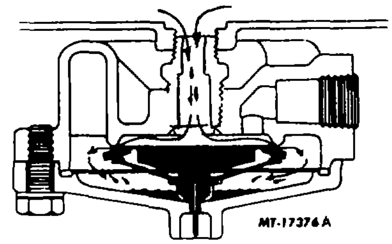

Fig. 9

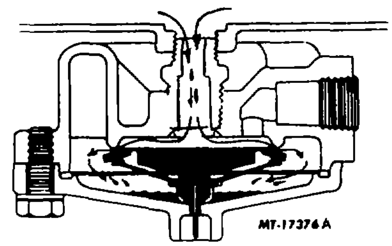

Fig. 10

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.

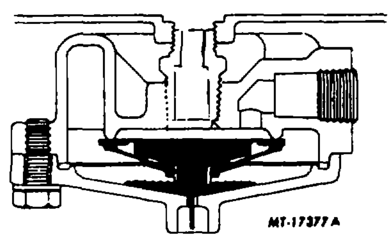

Fig. 11

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.
4. Remove automatic reservoir drain valve.

REINSTALL

1. 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 20- amp fuse for three valves. All electrical connections must be waterproof.
DISASSEMULY

Refer to Fig. 12 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.
6. If the automatic drain valve is equipped with a filter and retainer, they may be discarded if desired.

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.

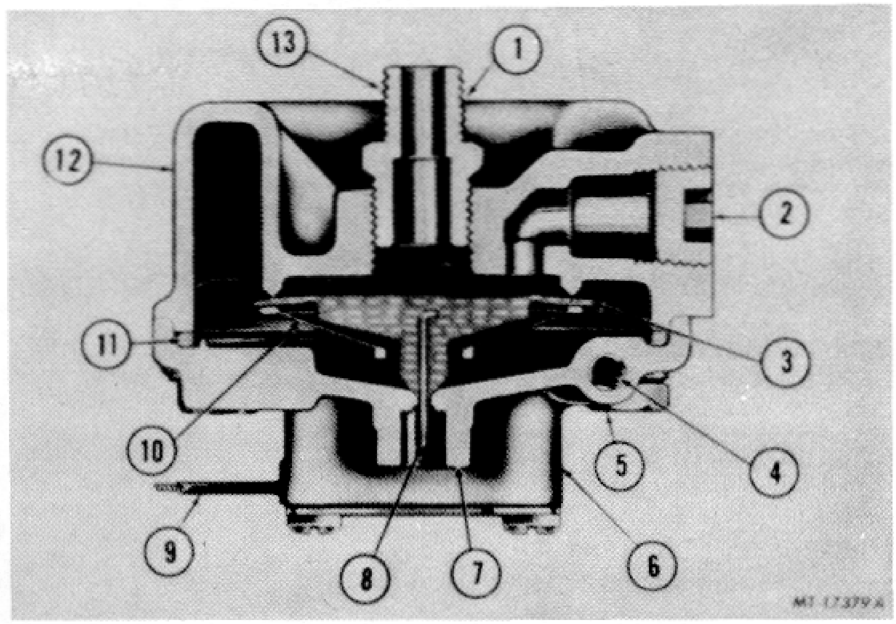

Fig. 12 Sectional View of Reservoir Automatic Drain Valve

1	Top Reservoir Port	8	Wire Stem
2	Side Reservoir Port	9	Electrical Lead Wire
3	Inlet & Exhaust Valve	10	Valve Guide
4	Heater Element	11	Sealing Ring
5	Cover	12	Body
6	Thermostat Housing	13	Adapter
7	Exhaust Port		

REASSEMBLY

For the assembly of valve, refer to Fig. 12 and proceed as follows:

Before assembling the valve, apply a light film of grease on inlet valve seat. <u>Do not apply oil to the inlet and exhaust valves</u>.

1. Place sealing ring in groove of cover.
2. 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.

CHAPTER III
CHECK VALVES, PRESSURE PROTECTION VALVE AND PRESSURE REDUCING VALVE

CONTENTS

CONTENTS (Continued)

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.

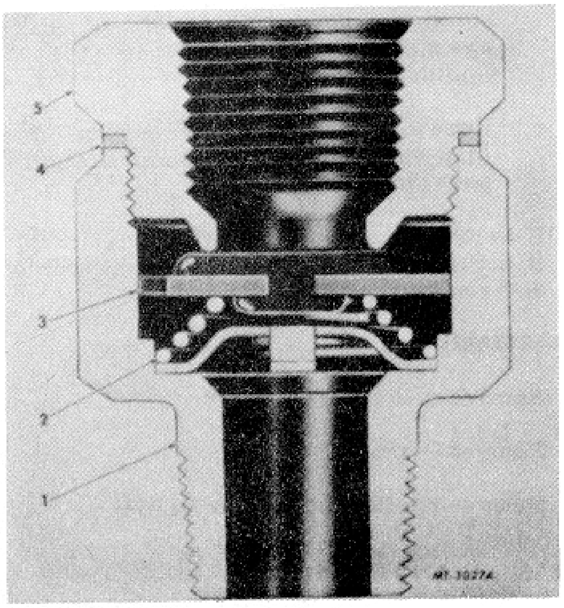

Fig. 1 Cross Sectional View of One- Way Check Valve

1BODY, Valve	4WASHER, Cap-to-Body
2SPRING	5CAP, Valve
3SEAL, 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.

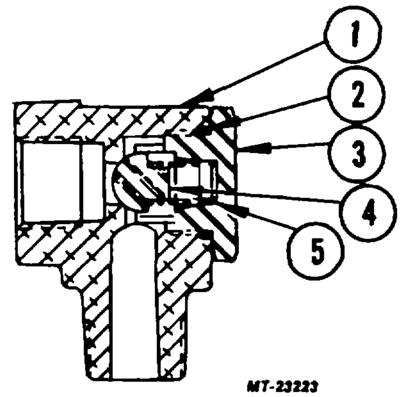

Fig. 2 90^{o} Angle Check Valve

1Body	4Valve
2"0" Ring	5Spring
3Cap	

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

1. 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.

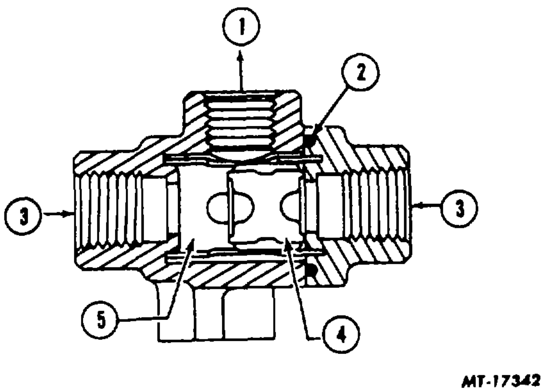

Fig. 3 Sectional View of Double Check Valve Shuttle Type

1	Delivery	4	Shuttle Valve
2	"O" Ring	5	Shuttle Guide
3	Supply		

OPERATION

As air pressure enters either end of the double .heck valve (inlet port) the movable shuttle responds to the air pressure and seals the line on opposite inlet port, but permitting air pressure to 'low 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.

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.

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.

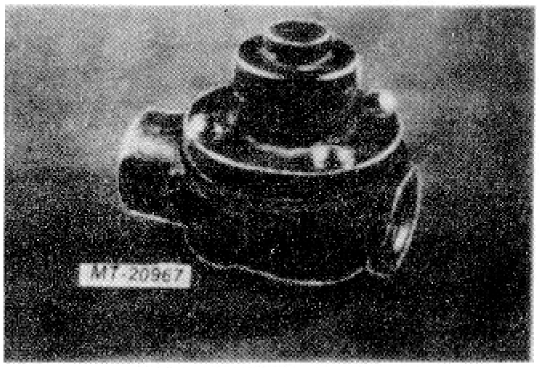

Fig. 4 Pressure Protection Valve

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. 5)

1. 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. MT-20968

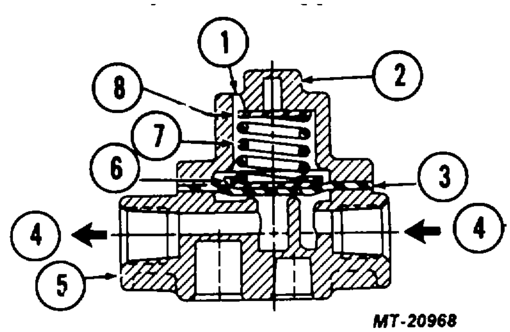

Fig. 5 Cross Section of Pressure Protection Valve

1	Vent Hole	5	Lower Body
2	Upper Body	6	Spring Cap
3	Diaphragm	7	Spring
4	Air Flow	8	Shim

2. 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

1. 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.
3. 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. 5)

1. 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 (I 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.

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. 6). 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.

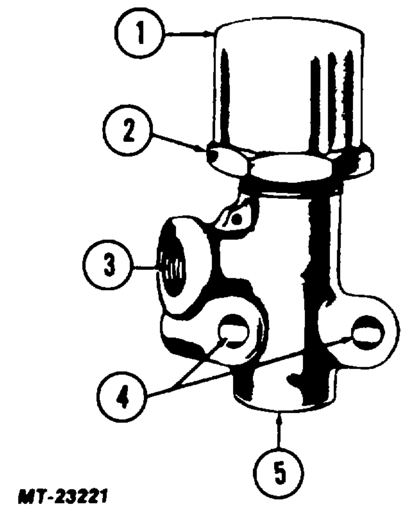

Fig. 6 Pressure Limiting Valve

1	Adjusting Cap	4	Mounting Holes
2	Lock Nut	5	Supply Port
3	Delivery Port		

OPERATION (Refer to Fig. 7)

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.

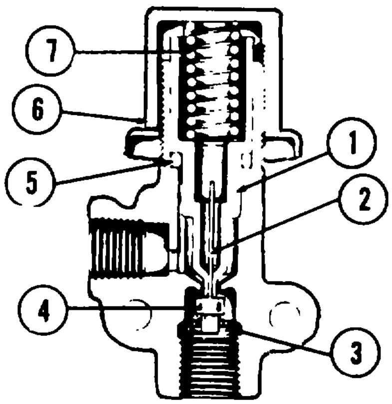

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Fig. 7 Cross Section of Pressure Limiting Valve

1	Piston	5 Piston "O" Ring
2	Valve Guide Wire	6 Exhaust Vent
3	Inlet Valve Spring	7 Pressure Regulating Spring
4	Inlet & Exhaust Valve	

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 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 reassemble of Pressure Limiting Valve is not recommended as it is serviced as a complete assembly.

INVERSION VALVE

DESCRIPTION

The inversion valve is a Bendix, TR-3 valve, which is a pilot operated, non-graduated two way valve. The valve will be found in the cruise control system where it functions as an on-off air control valve.

When operating the vehicle with the cruise control in cruise mode, air will pass through the valve. When the service brakes are applied through the foot (brake) valve or the hand control valve the inversion valve will exhaust air in the cruise system, thus releasing the cruise control system.

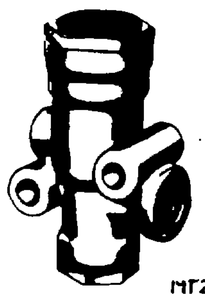

Fig. 8 Emergency Relay Valve

The TR-3 type valve has a separate control port and supply port; and depending upon the piping of the vehicle, the control port can either be piped to a separate air supply or can be piped so that the control and air supply air pressure are from a common air supply. In the application of cruise control system the supply port will be connected to the solenoid control assembly, the control port will be connected to the tractor protection valve and the delivery port will be connected to the air cylinder assembly. For complete operational description of the cruise control system refer to CRUISE CONTROL in ELECTRICAL GROUP.

OPERATION

Refer to Fig. 9 for numbers and letters in parenthesis.

With no air pressure at the control port (D) the piston spring (11) forces the piston (9) against the inlet valve (7) closing the exhaust passage in the hollow piston stem. The inlet valve (7) is open allowing air passage from the solenoid valve through the supply port (C) and out the delivery port (B).

When the service brakes are applied through the brake valve or hand control valve the air

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pressure will enter the control port (D) pushing piston (9) away from its seat and at the same time forcing the piston away from the inlet valve (7) which is held closed by the valve return spring (4). At this time the delivery line to the air cylinder is vented to atmosphere through the hollow exhaust stem in the piston (9) and out the exhaust port (A), releasing the cruise control. The inlet valve is also closed off at this time sealing the supply from the solenoid valve assembly.

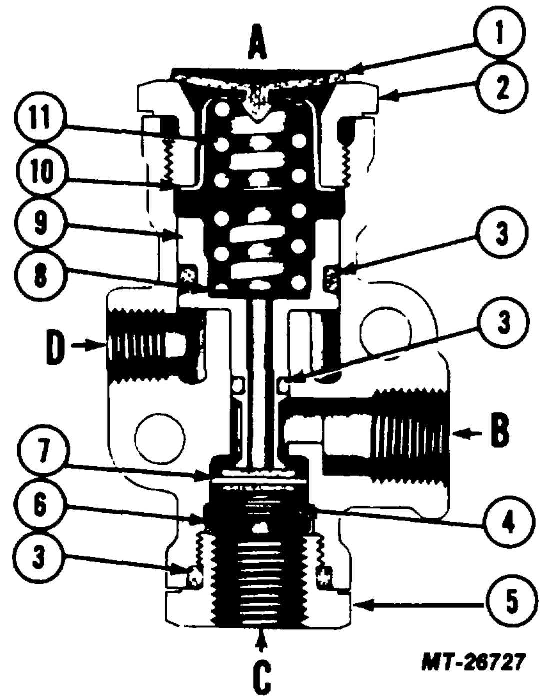


Fig. 9 Crow Section of Emergency Relay Valve

A.	Exhaust Port
B.	Delivery Port
C.	Supply Port
D.	Control Port
1.	Diaphragm
2.	Exhaust Nut
3.	O-Ring
4.	Valve Spring
5.	Cap
6.	Valve Stop
7.	Valve
8.	Shim
9.	Piston
10.	Diaphragm Retainer
11.	Piston Spring

MAINTENANCE

Once each year or every 160,000 km (100,000 miles) perform the LEAKAGE TEST If the valve failed the leakage test it must be replaced.

LEAKAGE TEST

To gain access to the inversion valve on some series of vehicles the driver's seat must be removed and the floor panel under the seat must be removed.

1. Set parking brake or block wheels to prevent vehicle from moving.
2. Remove the air line at the control port, supply port and delivery ports.
3. Connect the air line from control port (from tractor protection valve) to the supply port. Plug the delivery port.
4. With 689-861 kPa (100-125 psi) in air system, apply the brake valve or hand control valve.
5. Apply soap solution to the supply cap nut control port and exhaust port. There should be no air leakage at the supply cap nut and a very slight leakage is permissible at the exhaust and control ports. Excessive leakage at the control port would indicate the O-ring on piston stem is faulty and excessive leakage at the exhaust port would indicate that the piston stem exhaust seat or inlet valve is faulty. Release the brake valve or hand control valve.
6. Disconnect the line at the supply port and remove plug from delivery port. Reconnect the air line from tractor protection valve to the control port.
7. Apply either the brake valve or hand control valve.
8. Apply soap solution to the exhaust port and supply port. Excessive leakage at exhaust port would indicate the piston O-ring is faulty and if air leakage at supply port is noted, the O-ring on piston stem is bad. A slight leakage is permissible.
9. If valve passes the leakage test connect the two remaining air lines. The air line from the air cylinder is connected to the delivery port and the air line from the solenoid control assembly is connected to the supply port. If the valve failed the leakage test it must be replaced.

REMOVE AND REINSTALL

On some series of vehicles the inversion valve is located below the floor panel under the driver's seat. To gain access to the valve the seat and floor panel must be removed. Be sure to set the parking brake.

1. Disconnect air lines at valve.
2. Remove mounting bolts.
3. Transfer fittings to new valve.
4. Remount valve to holes in holes provided.
5. Reconnect air lines as follows:
   Air line from tractor protection valve to control port.
   Air line from solenoid control assembly to supply port.
   Air line to air cylinder is connected at delivery port.

SERVICE MANUAL

BRAKES-AIR

CHAPTER IV
BRAKE VALVE

CONTENTS

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 the relay piston. The secondary circuit is that portion between the relay piston and exhaust cavity.

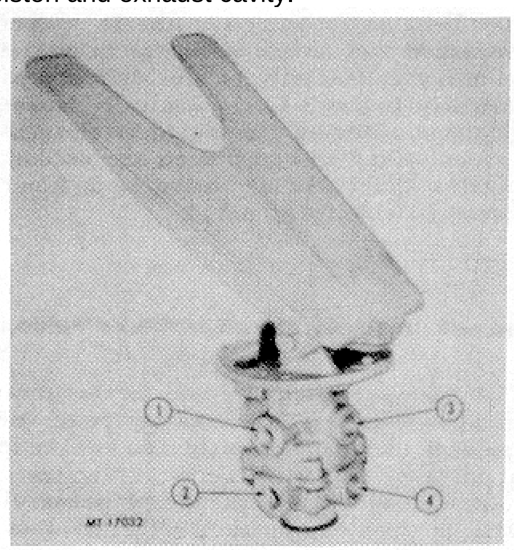


Fig. 1 Treadle Type Brake Valve

1 Primary Delivery
2 Secondary Delivery

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.

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.

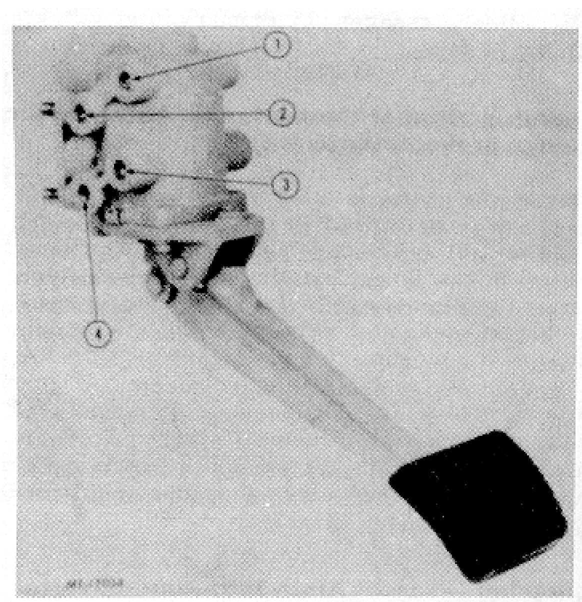


Fig. 2 Suspended Type Brake Valve

3 Secondary Supply
4 Primary Supply

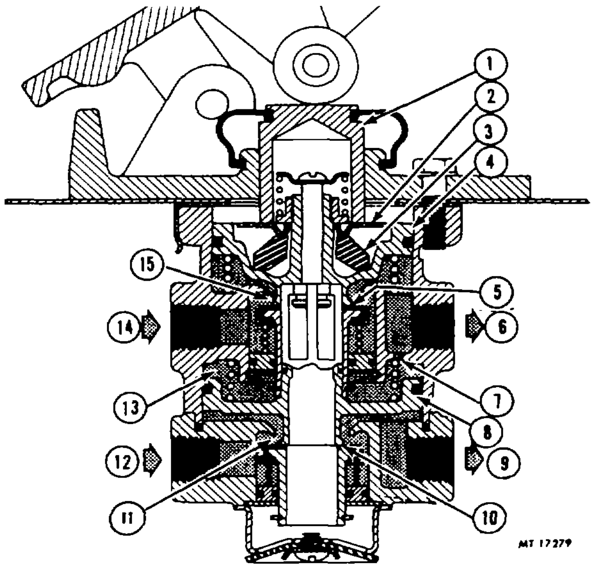


Fig. 3 Brake Valve Applied - Normal Operation

1 Plunger
2 Spring Seat
3 Rubber Graduating Spring
4 Primary Piston
5 Primary Exhaust Valve Closed
6 Primary Delivery
7 Two Bleed Passages
8 Relay Piston
9 Secondary Delivery
10 Secondary Exhaust Valve Closed
11 Secondary Inlet Valve Open
12 Secondary Supply
13 Relay Cavity
14 Primary Supply
15 Primary Inlet Valve Open

Applying Normal Operation - Secondary Circuit Portion of 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 put 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."

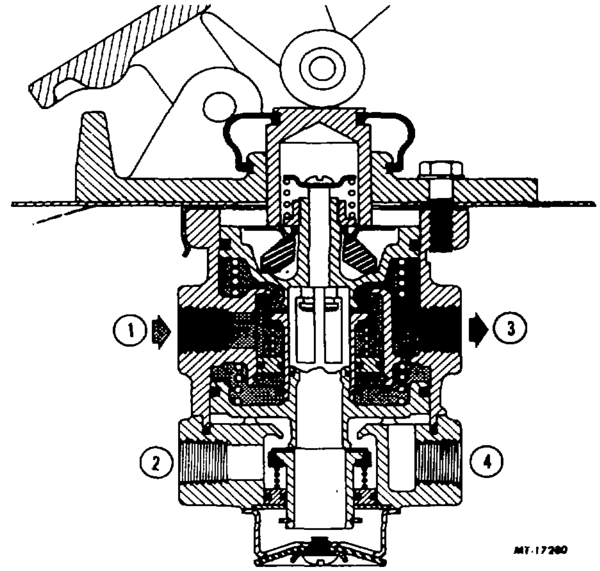


Fig. 4 Brake Valve Applied - Loss of Air In Secondary Circuit

1 Primary Supply
2 No Air In Secondary Circuit
3 Primary Delivery
4 Secondary Delivery

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.

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.

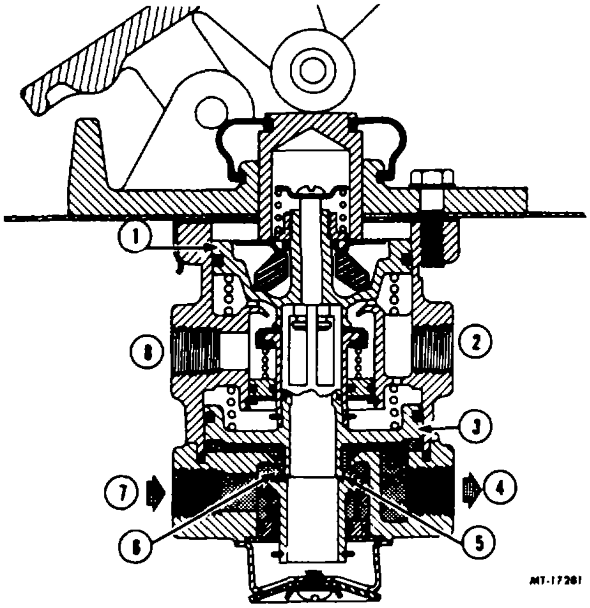


Fig. 5 Brake Valve Applied - Loss of Air In Primary Circuit

1 Primary Piston
2 Primary Delivery
3 Relay Piston
4 Secondary Delivery
5 Secondary Exhaust Valve Closed
6 Secondary Inlet Valve Open
7 Secondary Supply
8 No Air in Primary Circuit

Balanced - Secondary Circuit of Brake Valve (Fig. A)
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 .

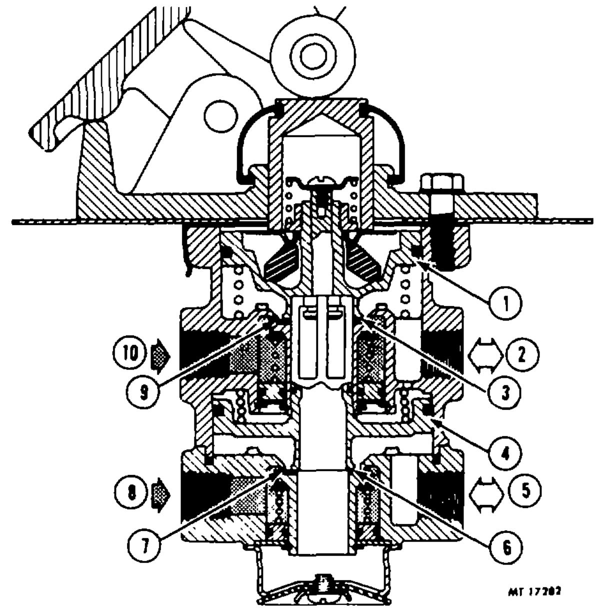


Fig. 6 Broke Valve In Balanced Position

1 Primary Piston
2 Primary Delivery
3 Primary Exhaust Valve Closed
4 Relay Piston
5 Secondary Delivery
6 Secondary Exhaust Valve Closed
7 Secondary Inlet Valve Closed
8 Secondary Supply
9 Primary Inlet Valve Closed
10 Primary Supply

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.

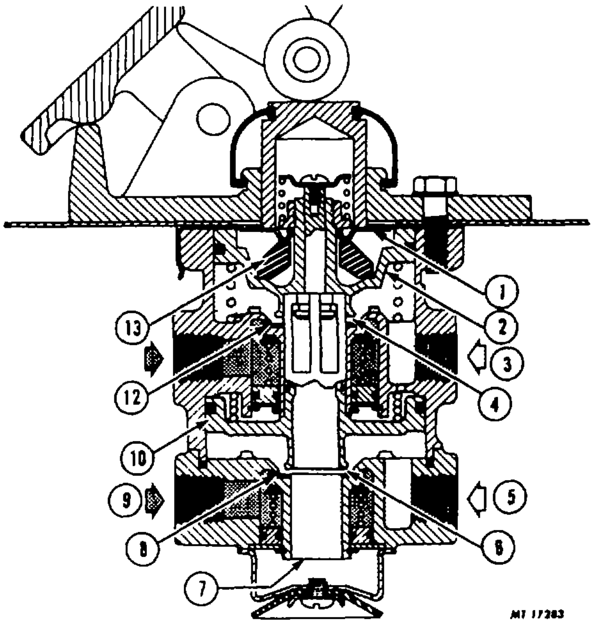


Fig. 7 Brake Valve Releasing

1 Spring Seat
2 Primary Piston
3 Primary Delivery
4 Primary Exhaust Valve Open
5 Secondary Delivery
6 Secondary Exhaust Valve Open
7 Exhaust Port
8 Secondary Inlet Valve Closed
9 Secondary Supply
10 Relay Piston
11 Primary Inlet Valve Closed
12 Primary Supply
13 Rubber Graduating Spring

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 160,000 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.

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.
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.

4. Remove fittings from valve. Mark these fittings also.
5. Remove valve from chassis.
a. Suspended Pedal Valves

   Remove nuts on exterior side of dash and remove valve assembly.
b. Treadle Type Valves

   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.

1. 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).
4. 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.
6. 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.
11. 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.

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 inspection.

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 torque’s specified are assembly torque’s and can be expected to differ after assembly is accomplished. Do not retorque after initial assembly.

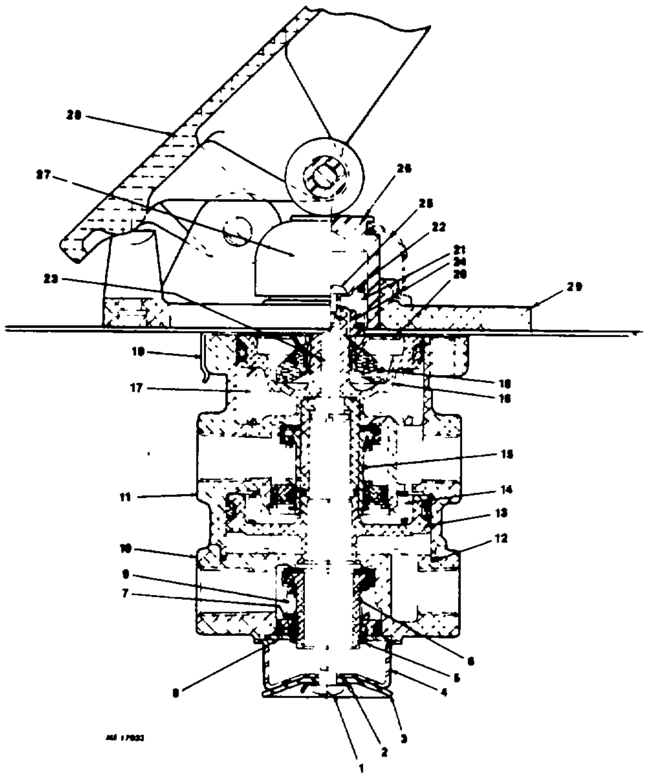


Fig. 8 Sectional View of E6 Brake Valve

1	SCREW
2	WASHER, Diaphragm
3	DIAPHRAGM, Exhaust
4	COVER, Exhaust
5	RING, Retainer
6	VALVE, Secondary & Exhaust
7	RETAINER, "O" Ring
8	WASHER
9	SPRING, Return
10	BODY, Lower Valve
11	BODY, Upper Valve
12	RING, Seal
13	PISTON, Relay
14	SPRING, Relay Piston
15	VALVE, Primary Inlet & Exhaust
16	PISTON, Primary
17	SPRING, Primary Piston Return
18	SPRING, Rubber
19	RETAINER, Primary Piston
20	SEAT, Spring
21	SPRING, Stem
22	GUIDE, Stem Spring
23	STEM
24	NUT, Spring Seat
25	SCREW, Spring Guide (Not Used)
26	PLUNGER
27	BOOT
28	TREADLE
29	PLATE, Mounting

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 0-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).

9. 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 lockwashers.

17. 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).
19. Test the rebuilt E6 dual brake valve by performing operation and leakage tests outlined in SERVICE CHECKS.

DISASSEMILY

Suspended Pedal Type Valve (17))

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).
5. Apply firm pressure on spring seat (6) which will compress primary piston spring (11). Locking groove (20) 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.
6. 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.
9. 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

REASSEMBLY

Suspended Pedal Type Valve (17)

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.

1. 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 goove 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.

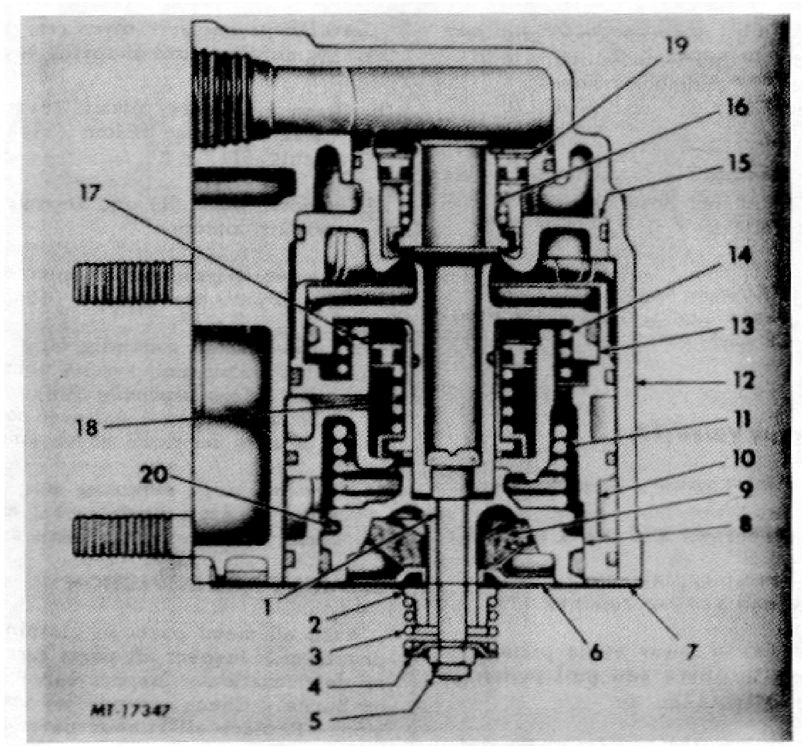


Fig. 9 Sectional View of E7 Brake Valve

1	STEM	11	SPRING, Primary Piston Return
2	NUT, Spring Seat	12	BODY
3	SPRING, Stem	13	PISTON, Relay
4	GUIDE, Stem Spring	14	SPRING, Relay Piston Return
5	NUT, Lock	15	PISTON, Upper Static
6	SEAT, Spring	16	VALVE, Secondary Inlet & Exhaust
7	RETAINER	17	RING, Retaining
8	PISTON, Primary	18	VALVE, Primary Inlet & Exhaust
9	SPRING, Rubber	19	RING, Retaining
10	PISTON, Lower Static	20	GROOVE, Locking

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).
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 (20) in primary piston.

9. 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. Do not retorque nut.
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), compensatory 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.

Application of Secondary Section - Normal Operation

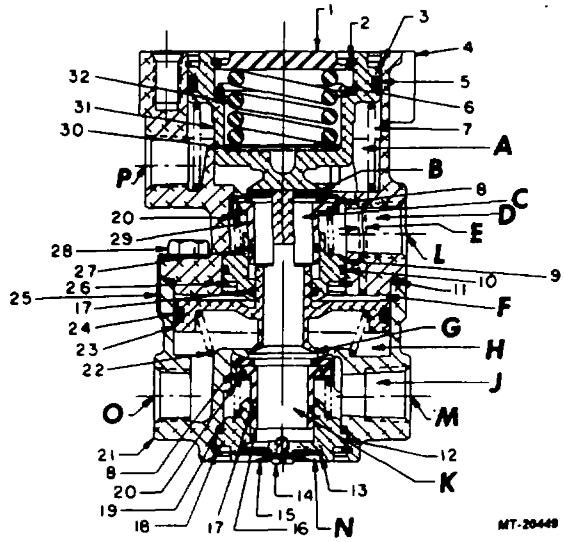
When the primary delivery port is pressurized, air passes through the bleed hole "E" into the control portion of the secondary section "F." The air pressure causes the secondary piston (23) to move and its exhaust seat "G" seals against the rubber face of seal assembly (16). Further piston movement causes 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.

Application - Loss of Secondary Section Air Pressure

When air pressure is lost in the secondary section. the primary section functions as described in the "normal operation" of the primary section.

Application - Loss of Primary Section Air Pressure

When air pressure is lost in the primary section, depressing the valve actuator (treadle or pedal) causes the plunger to exert force against n the spring retainer (1), compensatory 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



A Primary Delivery Cavity
B Primary Piston Exhaust Seat
C Primary Exhaust Cavity
D Primary Reservoir Pressure
E Bleed Hole
F Secondary Control Cavity
G Secondary Exhaust Seat
H Secondary Delivery Cavity
J Secondary Reservoir Pressure
K Secondary Exhaust Cavity
L Primary Reservoir Port
M Secondary Reservoir Port
N Exhaust Port
O Secondary Delivery Port
P Primary Delivery Port

1	RETAINER, Spring	17	O-RING
2	RING, Retaining	18	RING, Retaining
3	RING, Retaining	19	O-RING
4	BODY, 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

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 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 SPECIFI-CATIONS.

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 valve 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.
4. Remove fittings from valve. Mark these fittings also.
5. Remove valve from chassis.
6. 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.

1. Mark relative location of primary and secondary valve bodies (21 and 4) for alignment purposes at reassemble.
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 aid 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).
3. Install new O-ring (17) onto valve (16) and place seal retainer (8) over tube and around valve seal.

4. 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.
7. 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.

BRAKES - AIR
CHAPTER V
QUICK RELEASE VALVES
AND
DIFFERENTIAL QUICK RELEASE VALVE

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

DESCRIPTION

Quick release valves are used to release air from air brakes at the brake chamber. This makes the release of brakes quicker than a system where the chamber air has to flow back through the brake piping to the foot valve. There are two types of quick release valves, the basic type and the differential type.

These valves are usually mounted on the frame close to the brake chambers they control. 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. In most cases it also functions as a tee and connects two air brake chambers to the line from the foot valve.

The valves that are used by International Harvester are supplied by Bendix and by Midland.

BENDIX QR-1 TYPE QUICK RELEASE VALVE

The Bendix valve can be distinguished by having a cast body and cover (Figures 1 and 4).

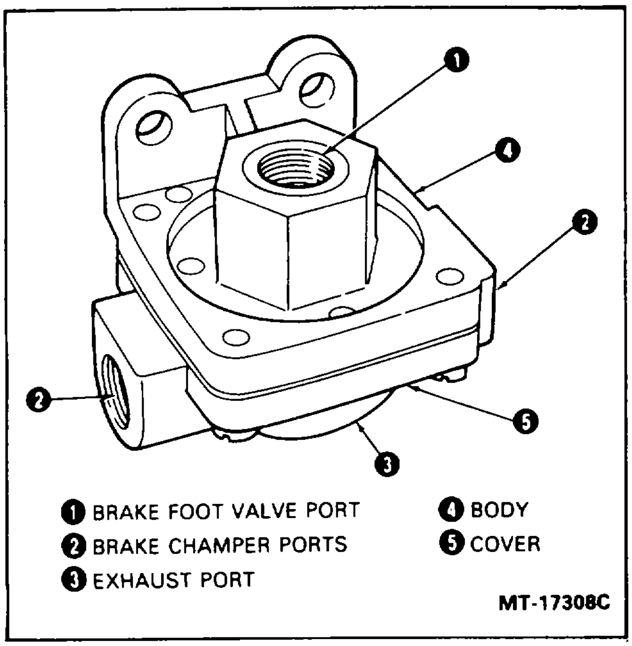


Figure 1 - Bendix QR-1 Quick Release Valve

The brake foot valve port is in the body and the other ports are in the cover.

MIDLAND TYPE QUICK RELEASE VALVE

The Midland valve can be distinguished by having a cast or plastic body and stamped cover (Figures 2 and 5). The brake foot valve port and the brake chamber ports are in the body. The exhaust port is a set of holes pierced in the center of the stamped cover.

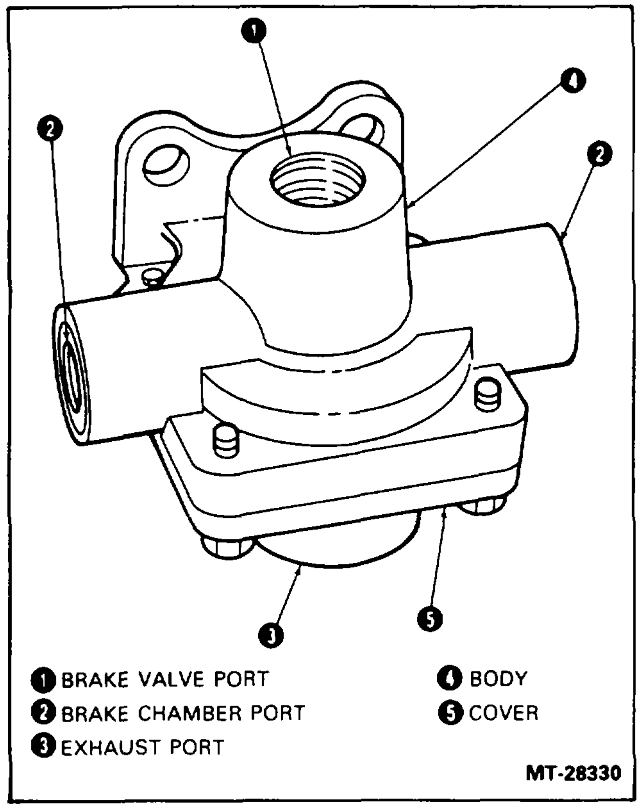


Figure 2 - Midland Quick Release Valve

MIDLAND DIFFERENTIAL QUICK RELEASE VALVE

The Midland differential quick release valve can be distinguished by having a cast or plastic body and cover like the Bendix valve, but having the brake chamber ports in the cover (Figures 3 and 6).

OPERATION

QUICK RELEASE VALVE

When a brake valve application is made, air pressure enters the top (brake valve) port of the valve (Figures 4 and 5). This will move the diaphragm down closing the exhaust port. At the same time, the air pressure forces the edges of the diaphragm down. The air will then flow to the brake chambers.

When 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. This will allow the diaphragm to raise, opening the exhaust port. It will then allow the brake chamber pressure to release through the exhaust port.

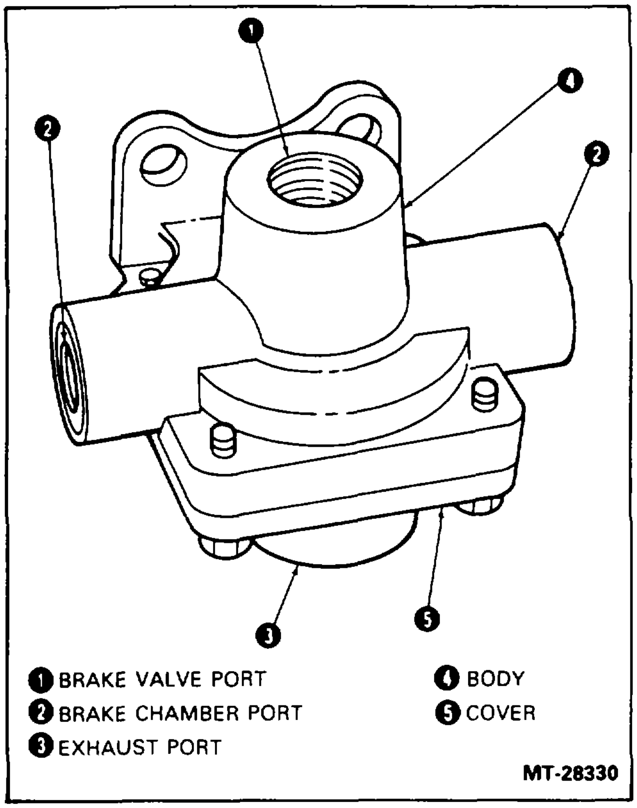


Figure 3 - Midland Differential Quick Release Valve

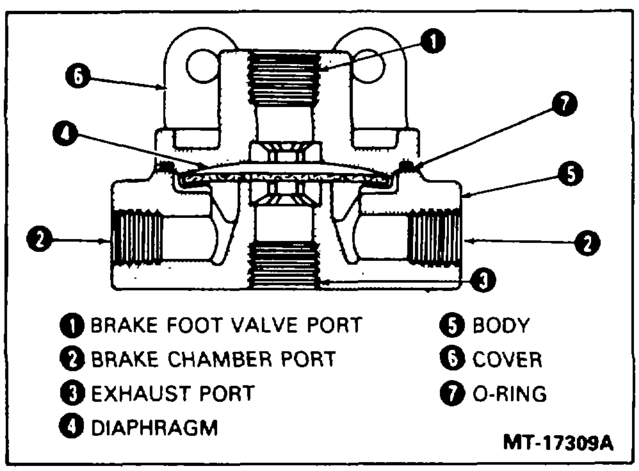


Figure 4 - Quick Release Valve (Basic) (Bendix QR-1)

NOTE - In some special applications, a spring and spring seat will be found In quick release valves.

DIFFERENTIAL QUICK RELEASE VALVE

The differential quick release valve operates identically to the quick release valve except that the air pressure at the brake foot valve port (Figure 6) must rise to the pressure level set by the spring in the valve before air can flow to the brake chamber(s).

The air pressure in the brake chamber is always less than the pressure in the air line of the foot valve by the amount it takes to operate the differential valve.

In IH trucks this valve is found on the CO and COF 9670 and 9370 and is mounted on all axles. It is set at 41 kPa (6 psi) + 10 kPa (1-1/2 psi) by the spring selected and is not adjustable.

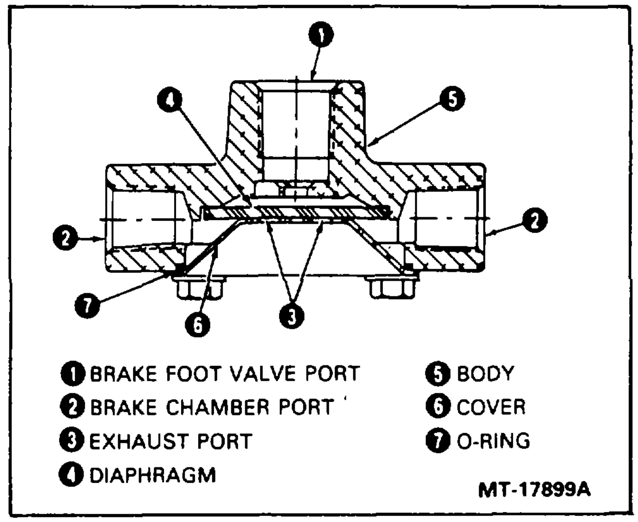


Figure 5 - Quick Release Valve (Basic) (Midland)

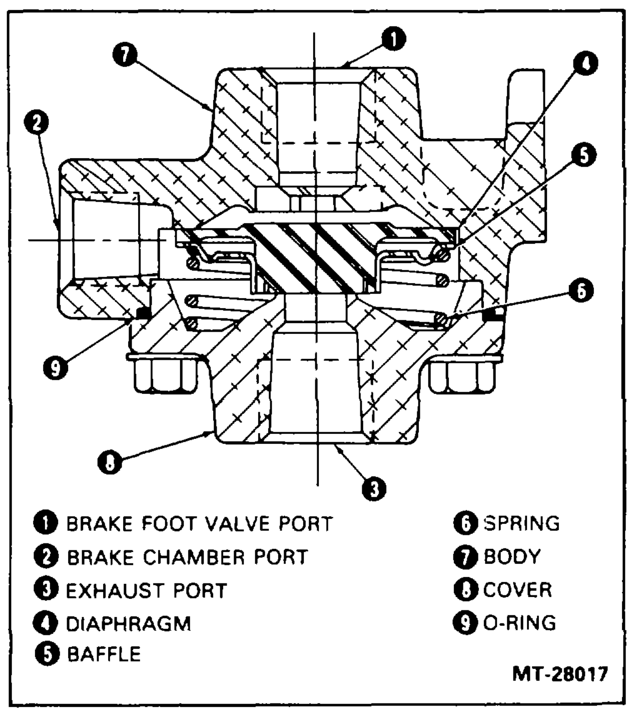


Figure 6 - Differential Quick Release Valve (Midland)

All of these valves are serviced in the same manner, with some minor exceptions that are noted.

SERVICE CHECKS

OPERATION TEST

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.

Pressure Test-Differential Quick Release Valve

Install pressure gages on the air line from the brake foot valve and on one of the lines to the brake chamber. Both gages should have the same scale. The IH special service equipment duplex gage (SE-2325) or gages reading from 900 kPa (125 psi) to 1400 kPa (200 psi) may be used. The most convenient places to connect are at the quick release coupling (glad hand) of the trailer service brake for the foot valve pressure and the air line port on the brake chamber for its pressure. Apply the brakes. Read both gages with the brakes applied. Subtract the brake chamber reading from the foot valve reading. To eliminate gage error, switch the gages and repeat the procedure. Add the results of the two subtractions and divide by 2. The answer should be 41 kPa (6 psi) + 14 kPa (2 psi). If the results are outside that range check for leaks and/or repair or replace the differential quick release valve.

Leakage Test

Leak Detector Tester (SE-2326) may be used to deter mine 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 mm (1") soap bubble in 6 seconds is not permissible. Repair or replace valve if excessive leakage is found.

REMOVAL

1. Disconnect air lines from quick release valve or differential quick release valve.
2. Remove mounting bolts and valve.

INSTALLATION

1. Mount quick release valve or differential quick release valve with mounting bolts and lockwashers. Make sure that its exhaust port is pointing down.
2. Connect the brake valve line to the top port and the brake chamber lines to the side ports.
3. Make sure that the exhaust port is not restricted.
4. After the valve (new or rebuilt) is installed, perform tests as outlined under OPERATION TESTS.

DISASSEMBLY

1. Remove four capscrews and valve cover.
2. Remove diaphragm (and spring and baffle of differential quick release valve).
3. Remove cover O-ring.

CLEANING AND INSPECTION

1. Clean all parts in good cleaning solvent.
2. Inspect diaphragm, especially the lower part that contacts the exhaust seat and cover O-ring, for wear or deterioration. Replace if necessary.
3. 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.

The diaphragm should be replaced if worn or deteriorated. There are some valves for which service repair kits are not available. If inspection of a valve reveals worn parts, the valve will have to be replaced as a unit.

REASSEMBLY

1. Position diaphragm in valve body. (On differential quick release valve, first assemble baffle to diaphragm and Install spring on top of baffle.)
2. Place O-ring in groove 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.).

NOTE - In some special applications, a spring and spring seat will be found In quick releases valves.

MAINTENANCE

Every year or 160,000 km (100,000 miles), remove the quick release valve or differential quick release valve, disassemble it and clean all parts.

BRAKESAIR
CHAPTER VI
RELAY VALVE

CONTENTS

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 anti-lock control.

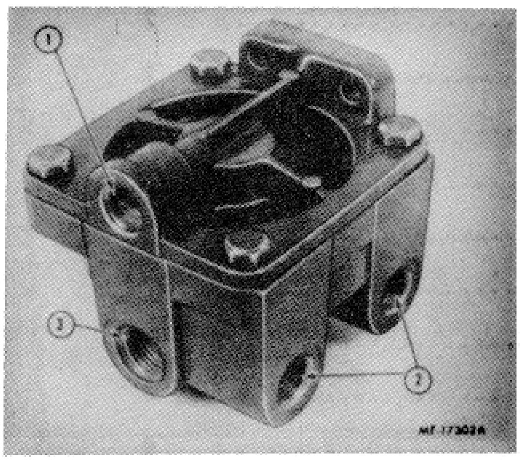


Fig. 1 Midland-Ross Relay Valve

1 Control Port
2 Delivery Ports
3 Reservoir Port

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.

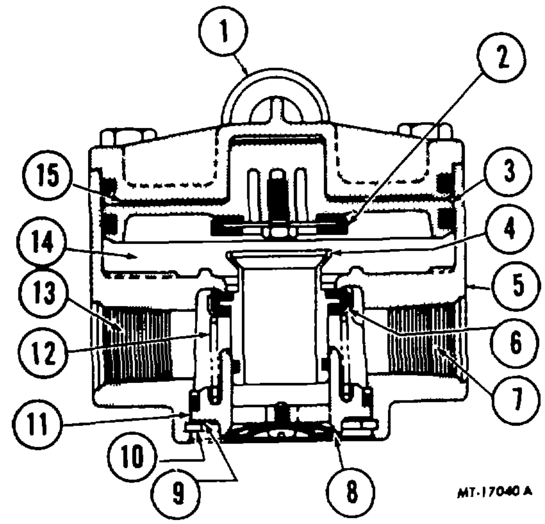


Fig. 2 Cross Section of Midland-Ross Relay Valve

1 Control Port
2 Exhaust Valve Assy.
3 Piston
4 Modulation Tube
5 Valve Body
6 Inlet Valve Assy.
7 Reservoir Port
8 Exhaust Port
9 Washer
10 Retaining Ring
11 Exhaust Valve Body
12 Exhaust Valve Spring
13 Reservoir Port
14 Cavity "B"
15 Cavity "A"

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 Tests

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

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.
4. 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.
2. Remove valve cover, piston assembly and piston spring, if equipped, from valve body.
3. 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.
6. 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 O-ring surfaces A rust 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 SPECIFICATIONS.

1. Install exhaust port diaphragm, washer and screw to exhaust valve body. Tighten screw 1.7 - 2.3 N.m (15-20 in lbs) torque.
2. Install inlet valve seal and O-ring on modulation tube. Place seal retainer over tube and around valve seal.
3. Carefully place modulation tube assembly into valve body so that inlet valve seal rests on body seat.
4. Install exhaust valve spring over tube to rest on seal retainer.
5. Position exhaust valve body O-ring over body.
6. Align exhaust valve body to spring, push body into relay valve body firmly and hold to prevent spring from pushing exhaust body out.
7. 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.
10. 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.

BRAKES-AIR
CHAPTER VII
INVERSION VALVE

CONTENTS

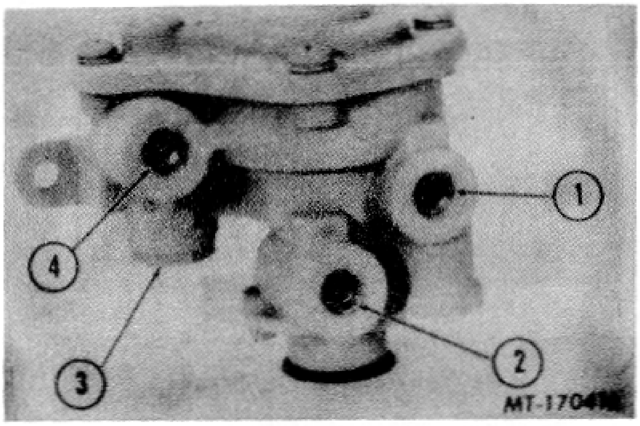


Fig. 1 Inversion Valve, Type SR-1

1Delivery Port
2Supply Port
3Control Port
4Reservoir Port

BENDIX SR-1 TYPE

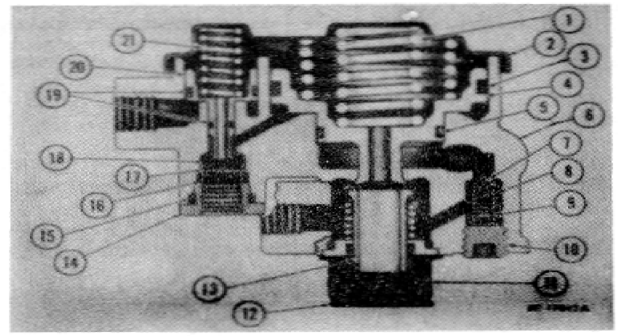
DESCRIPTION

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.

The secondary (front) brakes cannot supply enough braking effort alone to stop the vehicle quickly to meet the FMVSS 121 requirements for emergency stopping.

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.



1Piston Spring
2Cover
3Large O-Ring
4Piston
5Small O-Ring
6Body
7Check Valve
8Check Valve Spring Guide
9Check Valve Spring
10Pipe Plug
11Exhaust Cover
12Diaphragm
13 Inlet & Exhaust Valve
14Cap Nut
15O-Ring
16Valve Stop
17Valve Spring
18Valve
19O-Rings
20Piston
21Piston Spring

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.

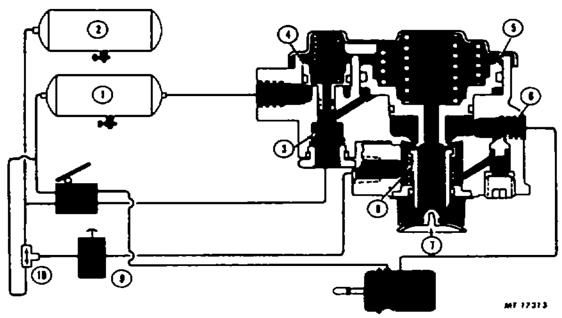


Fig. 3 Initial Air System Charge Below 55 PSI

1Primary Reservoir
2Secondary Reservoir
3Inlet & Exhaust A
4Piston A
5Piston B
6Check Valve
7Exhaust
8Inlet & Exhaust B
9Spring Brake Control Valve
10Double Check Valve

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 slightly 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 ac-
tuating 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.

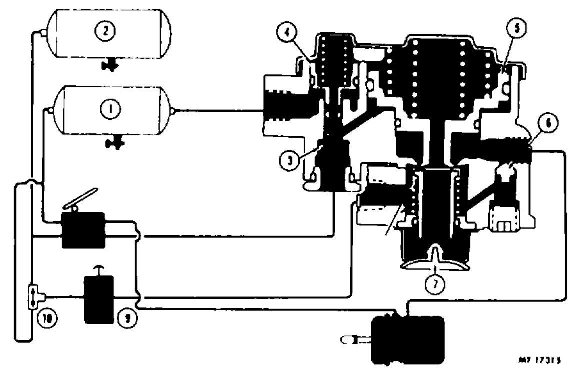


Fig. 4 Air System Fully Charged

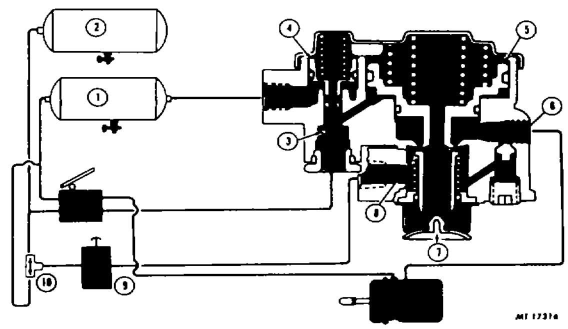


Fig. 5 Normal Broke Application, Primary and Secondary Systems Charged

1Primary Reservoir
2Secondary Reservoir
3Inlet & Exhaust A
4Piston A
5Piston B
6Check Valve
7Exhaust
8Inlet & Exhaust B
9Spring Brake Control Valve
10Double Check Valve

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.

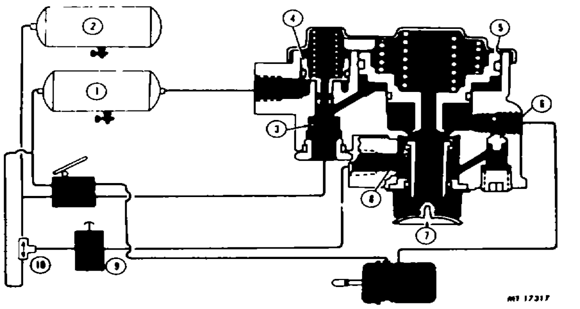


Fig. 6 Brake Application, Loss of Air in Secondary System

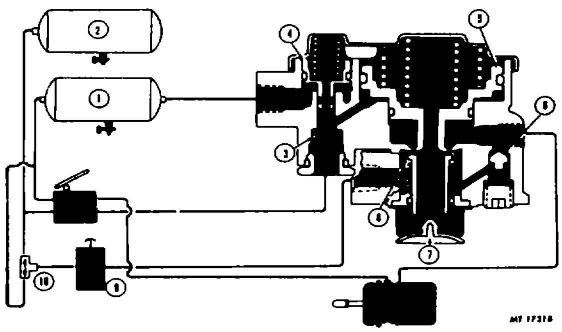


Fig. 7 Brake Application, Loss of Air In Primary System

1Primary Reservoir
2Secondary Reservoir
3Inlet & Exhaust A
4Piston A
5Piston B
6Check Valve
7Exhaust
8Inlet & Exhaust B
9Spring Brake Control Valve
10Double Check Valve

Brake Application with Loss of Air In Primary Systom (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 arid 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.

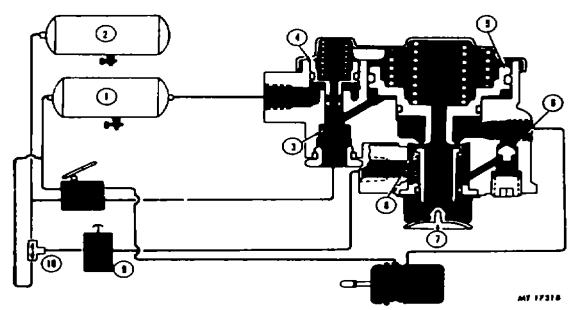


Fig. 8 Parking Broke Application

1Primary Reservoir
2Secondary Reservoir
3Inlet & Exhaust A
4Piston A
5Piston B
6Check Valve
7Exhaust
8Inlet & Exhaust B
9Spring Brake Control Valve
10Double Check Valve

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.

1. 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.

2. 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.

3. Remove the two mounting bolts from valve and remove valve.

INSTALL

1. Install inversion valve using the two mounting bolts.

2. Connect air lines. Make sure they are installed at the same ports, 3. Before releasing vehicle for service, perform SERVICE CHECKS as outlined.

DISASSEMBLY (Refer to Fig. 2)

1. Remove socket head pipe plug at check valve.

2. 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.
10. Remove small piston and small and large O-ring,
11. Remove large piston and large and small O-ring 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. Do not retorque after initial assembly torques fall.

1. Assemble check valve, valve spring guide and valve spring and insert them in body.
2. Apply a pipe sealant to the socket head pipe plug and install it in body. Tighten to 15-19 N•m (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 N•m (20-30 inch-pounds) of torque.
6. Place inlet exhaust valve in body and install valve spring and valve stop.
7. Install O-ring on the cap nut and install the cap nut in body. Tighten to 12-13 N•m (100125 inch-pounds) 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 N•m (50-80 inch-pounds).

Be sure inversion valve is checked as outlined in SERVICE CHECKS before chassis is returned to service.

BRAKES-AIR

CHAPTER IX

SPRING BRAKE, TWO WAY AND MODULAR CONTROL VALVES

CONTENTS

CONTENTS (Continued)

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.

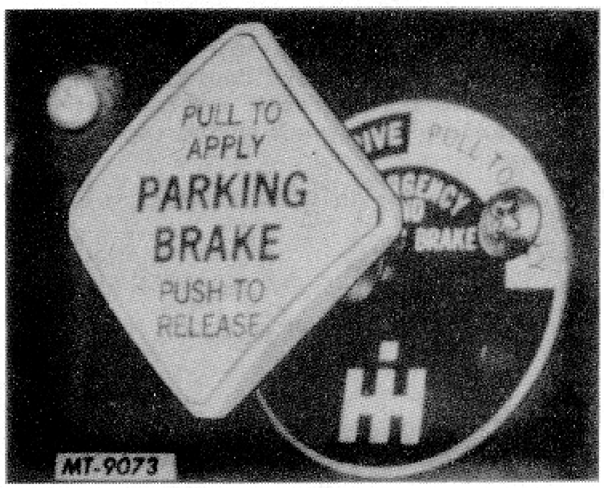


Fig. 1 Spring Brake Control Valve

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.

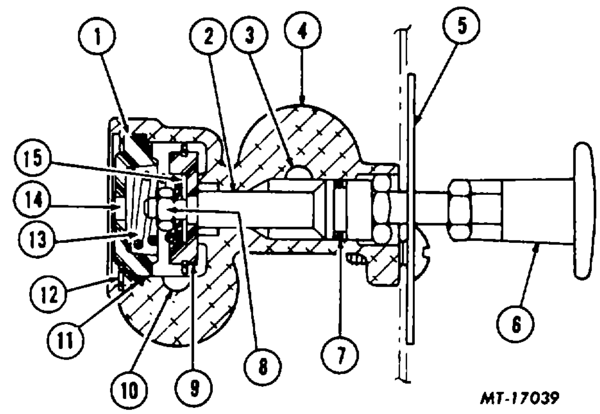


Fig. 2 Cross Section of Spring Brake Control Valve

1	End Cap	9	Valve Assembly
2	Piston	10	Outlet
3	Inlet	11	"O" Ring
4	Body	12	Snap Ring
5	Name Plate	13	Spring
6	Knob	14	Exhaust
7	"O" Ring	15	Washer
8	Torque Nut to 12 to 17 Inch lbs.		

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 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.

1. 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.
2. 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.
5. 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.

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.

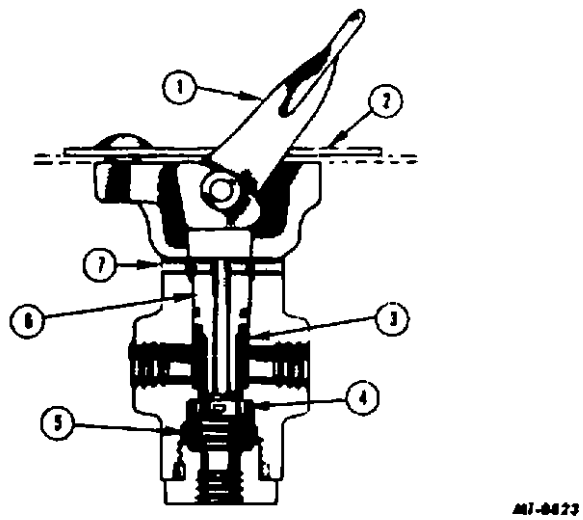


Fig. 3 Lover-Operated Two-Way Control Valve

1Lever
2Dial
3Plunger Return Spring
4Inlet & Exhaust Valve
5Inlet Valve Spring
6Plunger
7Exhaust Port

OPERATION

Applying

When the lever is actuated in the delivery position, the 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.

SEURVICE CHECKS

Operation Test

Plug one delivery port and install an air pressure test gauge in remaining port. Install second CTS-4079 C ir 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

1. 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.

3. 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.

4. 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.

2. Apply a small amount of the lubricant listed in LUBRICANT SPECIFICATIONS, Item 1, 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, Item 1, 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. 4) 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).

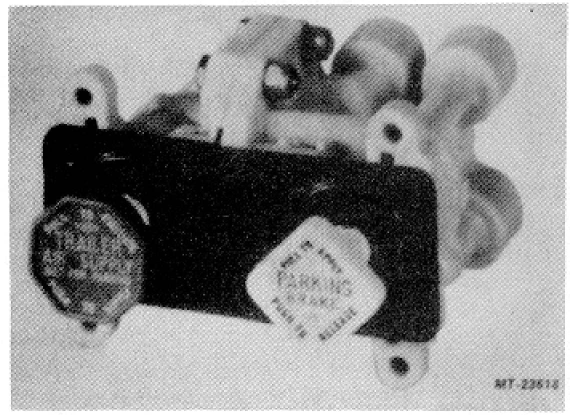


Fig. 4 Modular Control Valve

The bodies for the module, as well as "spool" inserts, are molded of a non-metallic, noncorrosive 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.

5. including the auxiliary air delivery port.

The trailer air supply valve or tractor protection control (red knob) (see Fig. 4) 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 ±27.6 kPa (40 ± 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.

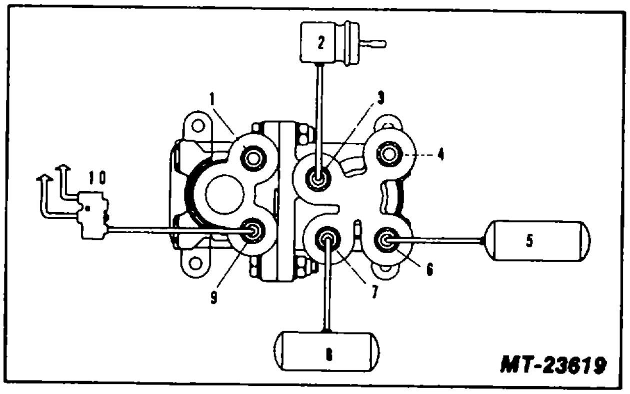


Fig. 5 Typical Air System Schematic with Modular Control Valve

1Exhaust Port
2Spring Brake Chamber
3Delivery-Tractor Port
4Auxiliary Air Delivery
5Secondary Reservoir
6Reservoir #2 Supply Port
7Reservoir #1 Supply Port
8Primary Reservoir
9Delivery-Trailer Port
10Tractor Protection Valve

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. 6). When system pressure reaches 448 kPa (65 psi), the red knob (trailer supply) may be pushed in (Fig. 7) and should stay in, charging the trailer system and releasing the trailer brakes. The yellow knob (system park) may now be pushed in (Fig. 8) which will supply air to the tractor spring brakes, releasing them.

System Park (Fig. ***6)***

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.

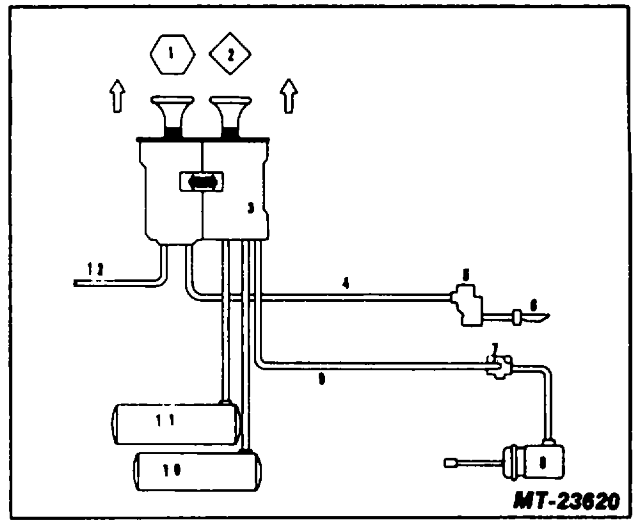


Fig. 6 Total Vehicle Parked

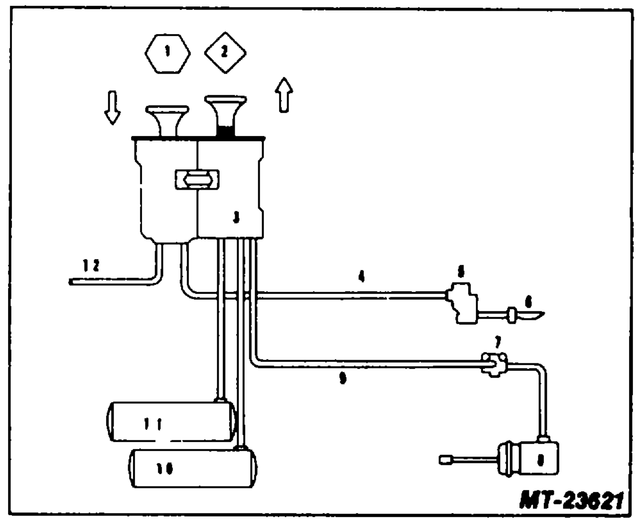


Fig. 7 Charge Trailer with Tractor Parked

Legend for Figs. 6, 7, 8 & 9

1Trailer Supply
2Parking (Spring) Brake
3Modular Control Valve
4Trailer Emergency
5Tractor Protection Valve
6Trailer Emergency
7Quick Release Valve
8Spring Brake Chamber
9Tractor Spring Brake Control
10Secondary Reservoir
11Primary Reservoir
12Exhaust

Trailer Charge (Fig. 7)

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. 8), and supply pressure to the push-pull valves is reduced to 276 ± 27.6 kPa (40 ± 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 ± 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.

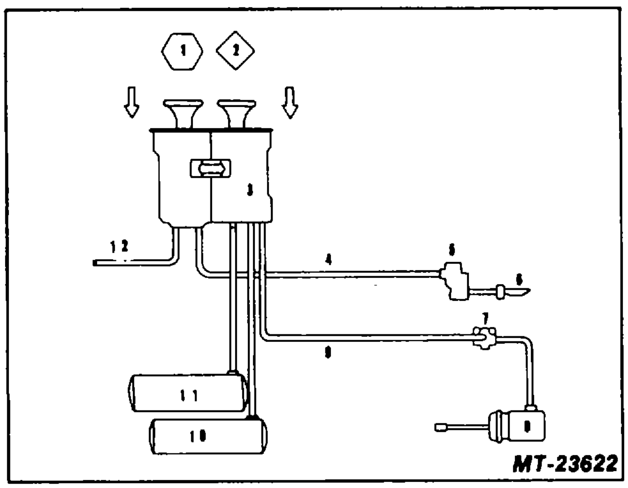


Fig. 8 Normal Operating Position

Normal Run Position (Fig. 8)

With both knobs pushed in, air is now being supplied to the trailer and to the tractor spring brakes; all brakes are released.

Actuation or Trailer Park or Emergency Brakes (Fig. 9)

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.

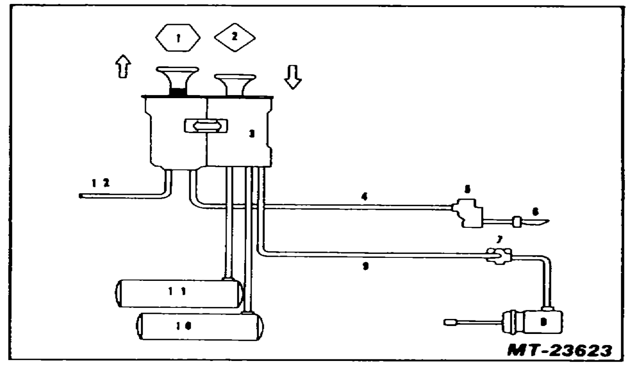


Fig. 9 Park Trailer with Tractor Released or Bobtail Tractor

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 listed 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.

1. With both control knobs out, charge the air brake system to 448 kPa (65 psi), and check for leakage. No leakage permitted.

2. 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. Push the yellow knob in. 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 $\pm$ 27 kPa (40 $\pm$ 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 $\pm$ 27.6 kPa (30 $\pm$ 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 $\pm$ 27.6 kPa (25 $\pm$ 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.
6. 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 yellow knob. Delivery pressure should equal the pressure in the primary reservoir. Reduce the pressure in the primary reservoir. Delivery pressure and primary reservoir pressure should descend together to 724-621 kPa (105-90 psi) at which point the dual cir, lit 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 CTS-4079 C 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

1. Assemble fittings in rear of valve. Apply a non-hardening 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).

4. 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. 10 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.

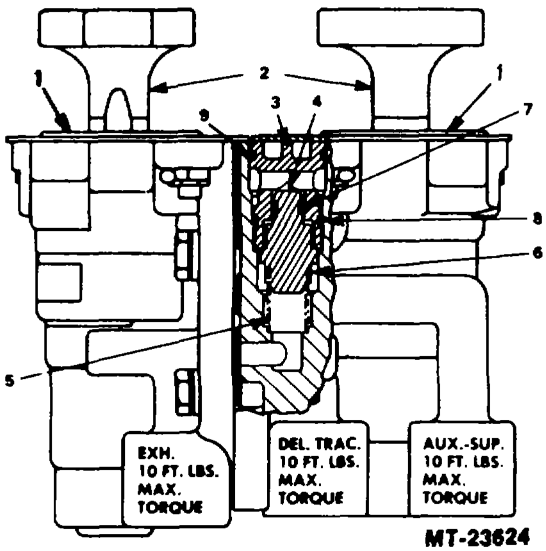


Fig. 10

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
5. Spring Return	

3. 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 i 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, Item 3.

1. Place the shuttle return spring (5) in the dual circuit supply valve bore in the body.

2. Install O-rings (6) & (7) on the shuttle (4), and (8) and (9) on the valve spool (3).

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.

5. 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.

6. 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.N•m (25 in. lbs.

8. 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.

BRAKES-AIR

CHAPTER XI

TRACTOR PROTECTION VALVE AND MANIFOLDED TRACTOR PROTECTION VALVE

CONTENTS

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.

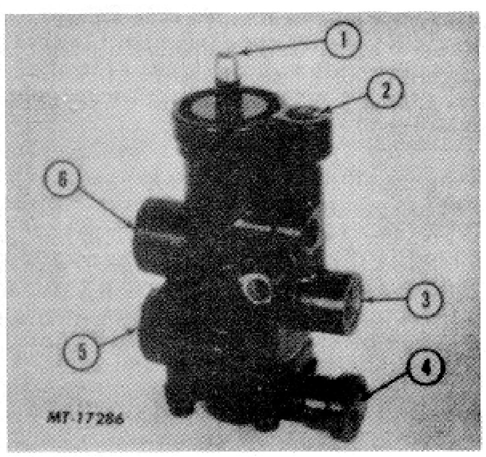


Fig. 1 Tractor Protection Valve

1 Exhaust Port	4 Tractor Service
2 Control Port	5 Trailer Service
3 Tractor Emergency	6 Trailer Emergency

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 two-way 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 (bobtailed). Refer to Fig. 2 for numbers and letters 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 (F) to trailer service port (E). Exhaust valve assembly (5) is seated against valve body (20) closing off passage of air through valve from tractor emergency (G) to trailer emergency port (D). The control port kH) and cavity "A" are vented to exhaust through the two-way air control valve on instrument panel. Both trailer emergency and service ports (D and E) 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 (H) and enters cavity WA. Air pressure above 345 kPa (50 psi) acts against piston (17) to move it towards spring (19). Piston seats against valve face of assembly (5). Further movement pushes exhaust valve assem-

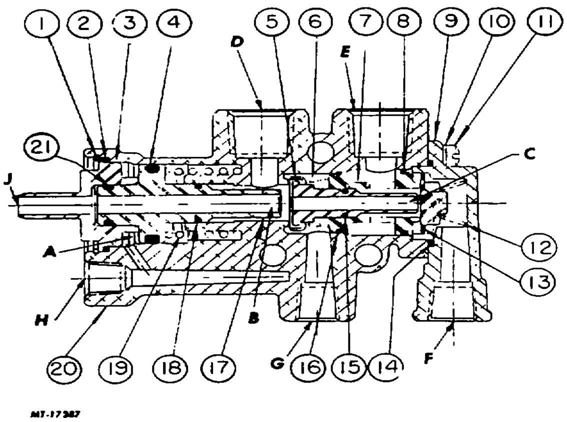


Fig. 2 Tractor Protection Valve

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 Assembly	15	SEAL, O-Ring
		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

bly (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 (J).

Air upstream from tractor protection valve is exhausted through foot valve or hand control valve.

If tractor brake system pressure drops to 172276 kPa (25-40 psi), spring force (19) moves piston (17) towards exhaust port (J). 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 (E).

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 (E) and emergency (D) or exhaust (J) 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 (F), trailer service (E), 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 (E and D). Connect manifolded fixture to control port (H) and tractor emergency port (G). Open manual valve to allow 345379 kPa (50-55 psi) air pressure build up to both ports. Shut off manual valve. Pressure build up at trailer emergency port (D) should have occurred. Gauge at trailer service port (E) must not show pressure. Permissible leakage at exhaust port is a 25 mm (1") diameter bubble in six (6) seconds.

During next check, 379-414 kPa (55-60 psi) air pressure needs to be maintained at control port (H) and tractor emergency port (G).

Connect air line with gauge and shut-off valve to tractor service port (F). 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 (3) seconds. Disconnect air pressure to tractor service port (F). Trailer service port pressure must exhaust to zero.

Begin with manifold pressure supplying both control and tractor emergency ports (G and H) 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 (D) should have exhausted to zero. While maintaining steady pressure of 138-172 kPa (20-25 psi) at control port (H) and tractor emergency port (G), connect air to tractor service. Open manual valve to build up 345 kPa (50 psi) pressure. Gauge at trailer service (E) 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 O-ring 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 of 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 <u>Item 3</u> 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-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.

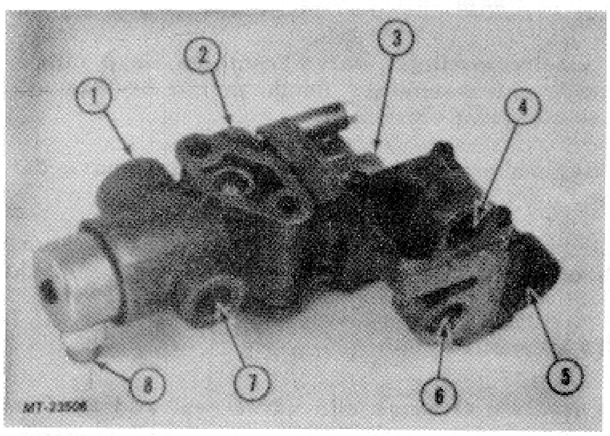


Fig. 3 Midland Ross Manifold Tractor Protection Valve

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 Trailer Supply (red) knob at the instrument panel. When the Trailer Supply Control is opened (knob pushed in), air pressure is supplied to the emergency port to open the tractor protection valve. Pulling the Trailer Supply 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 Supply 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 "0" kPa or psi pressure.

During normal tractor operation without trailer, the Trailer Supply Control knob is "out" and the "service" passage at the tractor protection valve is closed. The Trailer Supply 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 Supply Control (red) 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 and letters in parenthesis throughout this text which applies to the Midland-Ross manifolded tractor protection valve.

Fig. 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 (H and I) to trailer service port (M). Cavity "B" is vented to exhaust through the Trailer Emergency Control (not shown) located in cab dash panel. The trailer service port (M) 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 "J" to trailer emergency port "L"). 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 (G). 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 (M) to trailer brakes. The air supplied by the hand control valve enters the service port (G) 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 (H). 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 (I). 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 (K). 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 207-276 kPa (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 (M).

he 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" kPa ("0" psi), trapping applied service brake pressure in trailer service port (M). 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.

MAINTENANCE

Once each year or’ every 160,000 km (100),00t) miles) remove, disassemble and clean all part4. All rubber parts must be replaced.

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 Test

1. Disconnect hand control (G) and trailer service air (M) lines, Trailer Emergency Control valve pulled out (no air to Trailer Emergency).
2. 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 (G), trailer service port (M) and exhaust port (K) 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 (H and I).
4. Apply hand control valve. Total leakage measured at foot valve ports (H and I), trailer service port (M) 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 (G) and trailer emergency port (L).
6. Install a pipe plug in trailer emergency port (L).
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 (M) and exhaust (K) ports should not exceed 82 cm3 (5 cu.

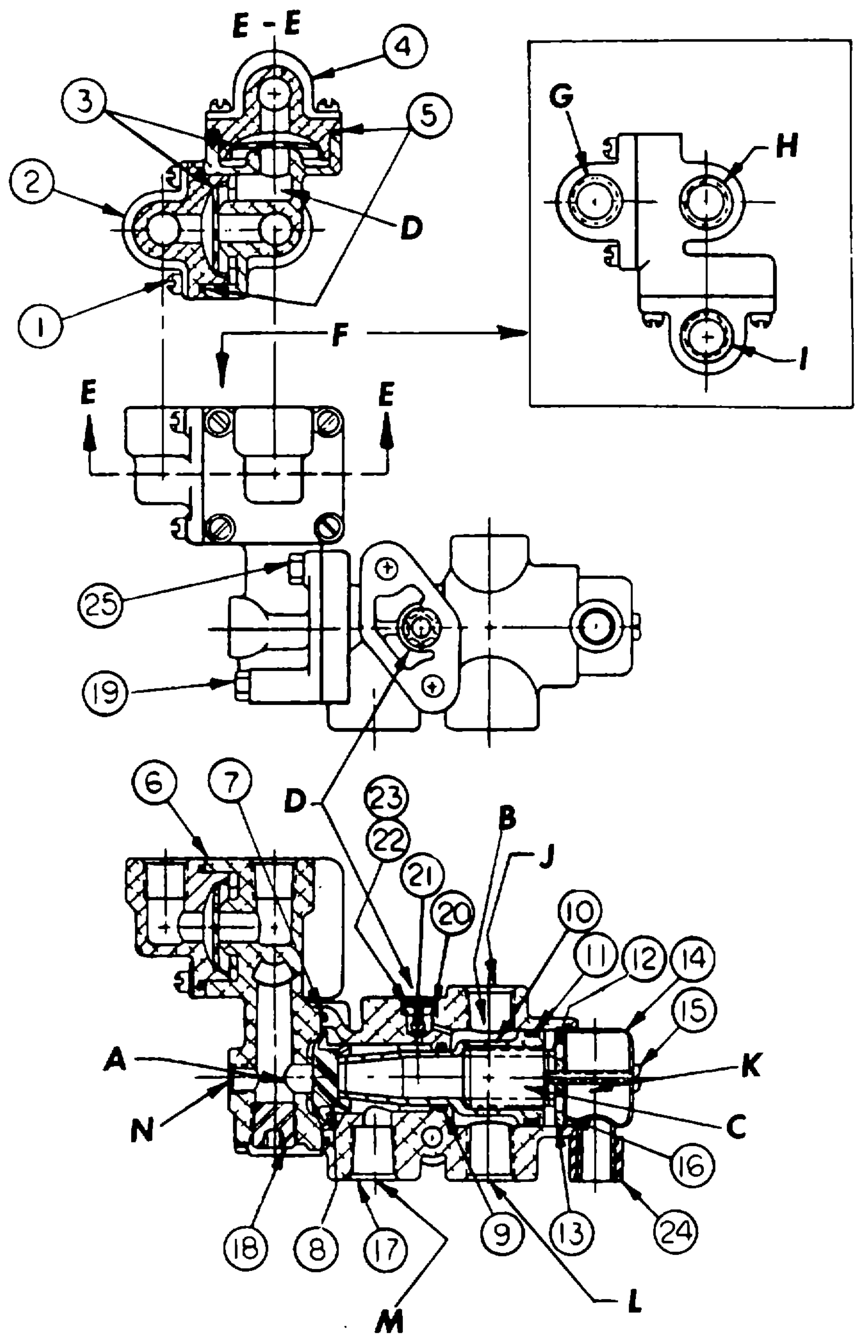


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Fig. 4 Midland-Ross Manifolded Tractor Protection Valve

1	Screw	7	"0" 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						

CROSS SECTION ALTERED TO SHOW BLEED-BACK FEATURE AT ITEM "D" 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 (L). If valve passes leakage check, the performance check should be made.

Operation Tests

1. Install a duplex gauge or two single air gauges at trailer service and emergency ports (M and L).
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 (M) 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 (M).
6. Release hand control valve and apply brake (foot) valve. Pressure at trailer service port (M) should be within 35 kPa (5 psi) of air gauge at instrument panel.
7. Replenish air systems to 689-861 kPa (100125 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 (M) 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).
10. Apply brake (foot) valve, pull Trailer Emergency (red) knob out. The duplex gauge connected to trailer service port (M) should record the same value (689-861 kPa or 100125 psi) as gauge at instrument panel. Gauge connected at trailer emergency (L) 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

1. Pull park brake control on instrument panel out, to set parking brake. Be sure trailer emergency control is pulled out.
2. Bleeding air system is not required since there will be no air supplied the manifolded tractor protection valve with 'he 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.

1. 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 exhaust 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 disc (3).

9. 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.

2. 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 N•m (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.

6. 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.-1.808 N•m (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.

BRAKES-AIR

CHAPTER XII

FLEXIBLE HOSE, NYLON TUBING, RIGID PIPING AND FITTINGS, TRAILER BRAKE HOSE AND COUPLINGS

CONTENTS

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.

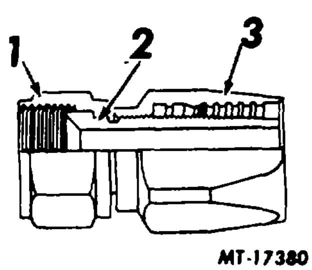


Fig. 1 Flexible Hose Fitting

1Nut
2Fitting
3Hose Socket

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 INSTRUCTION

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.

1. 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.

3. 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.

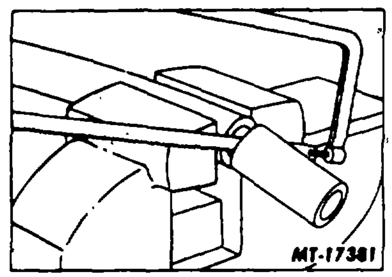


Fig. 2

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).

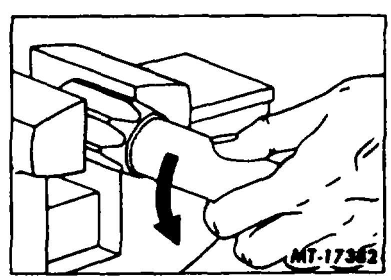


Fig. 3

7. Reposition hose and socket in the vise as shown in Fig. 4. Lubricate hose socket and fitting threads.

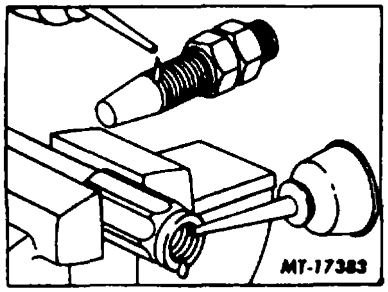


Fig. 4

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.

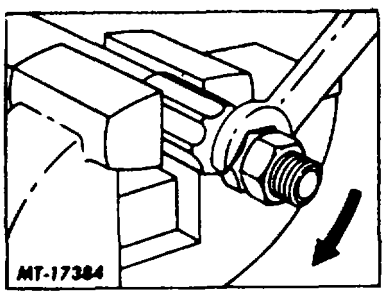


Fig. 5

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 temperatures 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 air brake system 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 (Fig. 6). Either nut may be satisfactorily used on’ the nylon lines.

> If copper tubing is being substituted for nylon tubing, the short tube nut 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.
3. 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 until it bottoms.

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.

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.

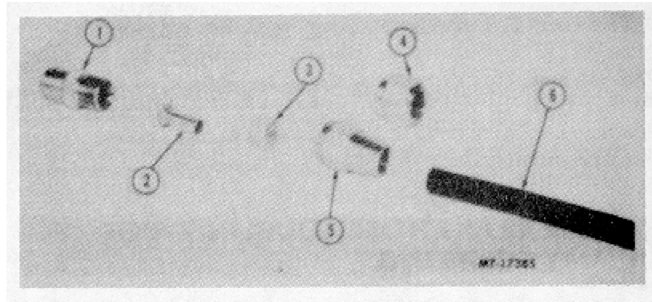


Fig. 6 Nylon Tubing Assembly

1 Fitting
2 Tube Support or Insert
3 Sleeve
4 Short Nut
5 Long Nut
6 Nylon Tubing

1. Do not use nylon tubing for any application which would cause it to be exposed to temperatures below -40 degrees C or +I 11 degrees C (-40 degrees F or above +200 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.
4. Observe extreme care when welding near nylon tubing. Hot slag or spark will damage the tubing.
5. Protect nylon tubing from battery acid.

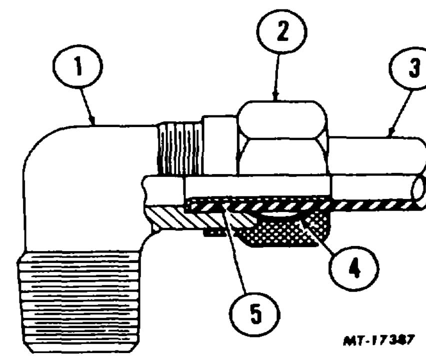


Fig. 7 Nylon Tubing Assembly Cross Section

1 Fitting
2 Short Nut
3 Nylon Tubing
4 Sleeve
5 Tube Insert or Support

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 couplings 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

1. At least once a year or if leaking, the hose coupling should be disassembled, cleaned and serviced.

2. Remove old packing ring by prying out with a screwdriver. Be sure packing ring groove is thoroughly cleaned.

3. Install new packing ring by partially collapsing it with the fingers, (Fig. 8) and entering one side of flange in groove in coupling.

4. Work the remaining part of the packing ring into place with a blunt nosed screwdriver or similar tool (Fig. 9). Exposed face 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 tractor and trailer. Hose lines or couplings at the rear of tractor are marked by tags identifying them as "SERVICE" or "EMERGENCY".

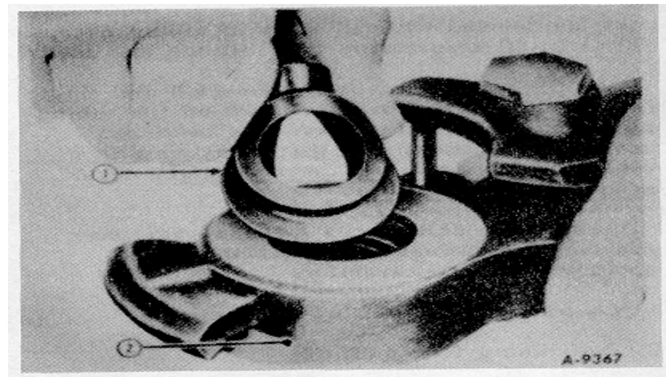


Fig. 8 Installing Packing Ring In Hose Coupling

1Packing Ring
2Hose Coupling

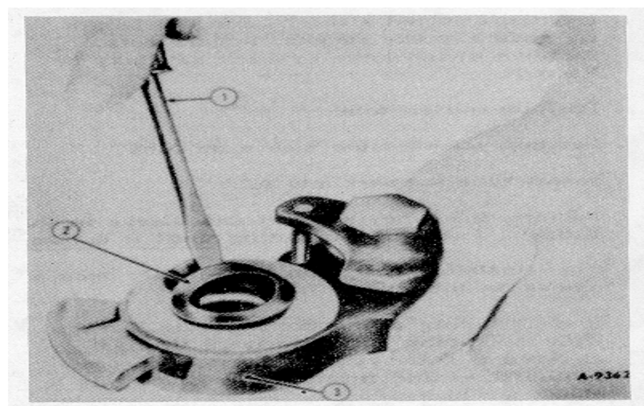


Fig. 9 Using Screwdriver to Complete Packing Ring Installation

1Blunt Nosed Screwdriver
2Packing Ring
3Hose Coupling

Test

1. 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.

2. 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.

BRAKES-AIR

CHAPTER XIII

ALCOHOL EVAPORATOR

CONTENTS

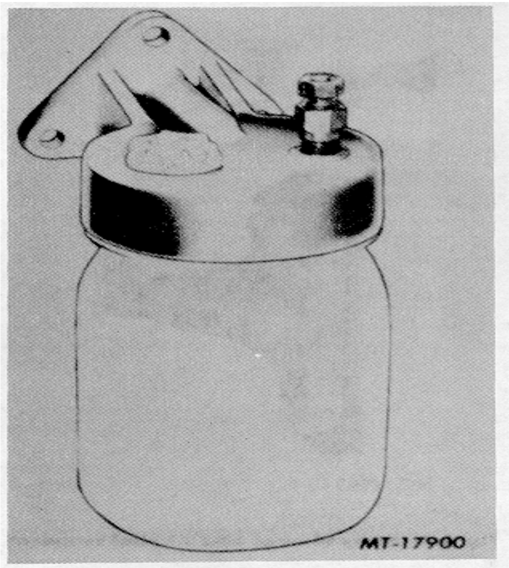


Fig. 1 AE-1 Alcohol Evaporator

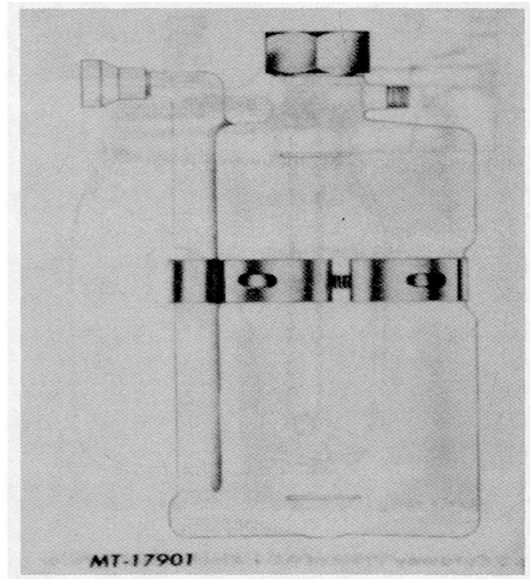


Fig. 2 AE-2 Alcohol Evaporator

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.

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.

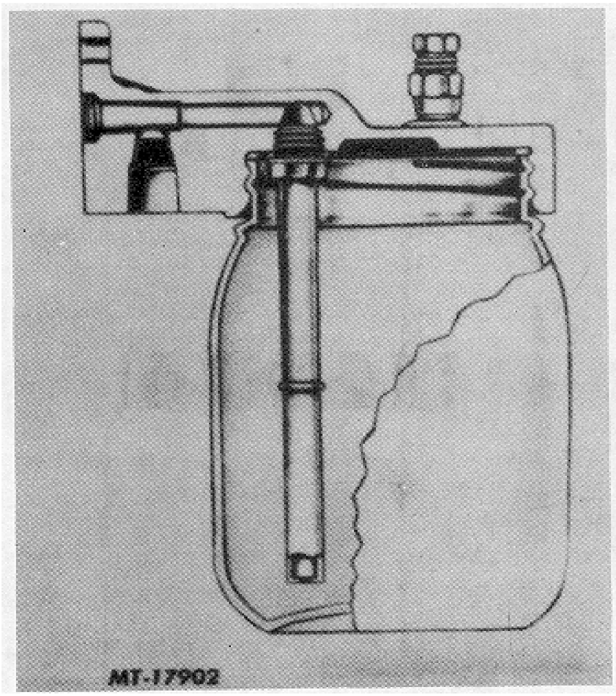


Fig. 3 Cutaway View of AE-1 Alcohol Evaporator

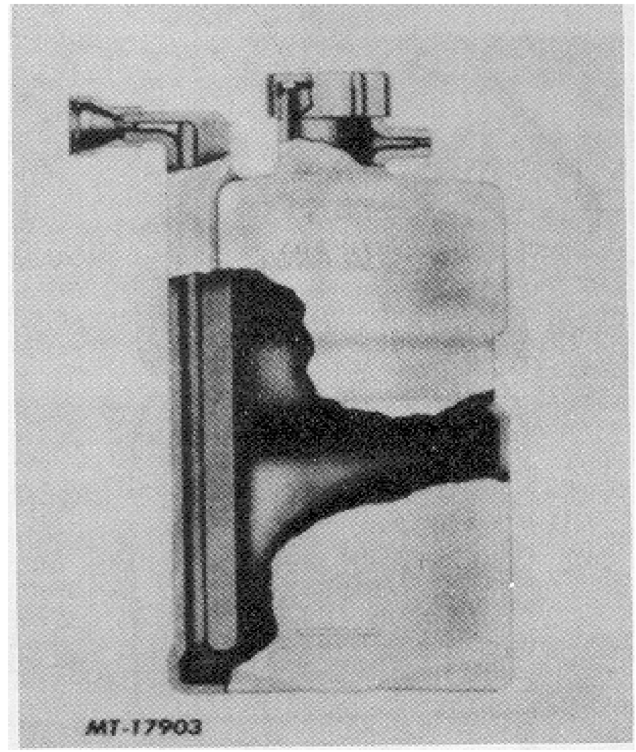


Fig. 4 Cutaway View of AE-2 Alcohol Evaporator

CONSUMP"ION OF ALCOHOL

Complaints of inoperative alcohol evaporator or excessive use of alcohol can be traced to either 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 ii 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 .

Example: of 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

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

1. 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.

2. 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 SERVICABILITY

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 first 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.

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.

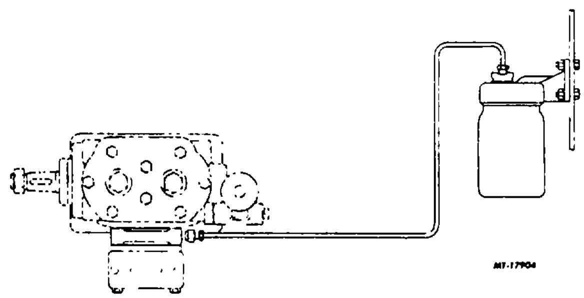


Fig. 5 Standard Kit (AE-1 Alcohol Evaporator Illustrated)

Engine Air Cleaner Induction (Fig. 6 and Fig. 71

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 aspirated (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.

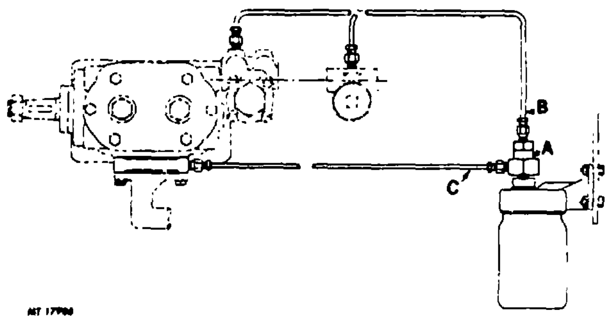


Fig. 6 Engine Air Cleaner Induction (Tu-Flo 400, 500, 600 Installation Illustrated) AE-1 Alcohol Evaporator

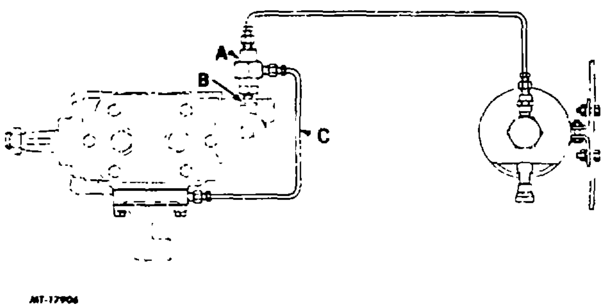


Fig.7 Engine Air Cleaner Induct on (u-Flo 400, 500, 600 Installation Illustrated AE-2 Alcohol Evaporator

Supercharged Compressor Induction (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.

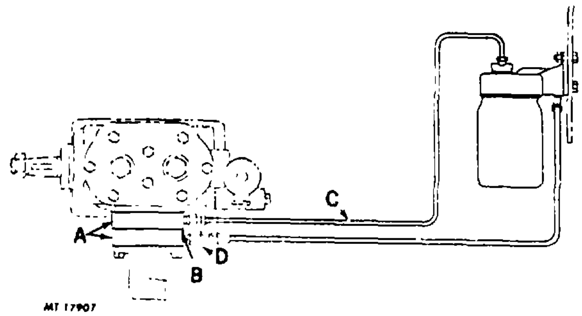


Fig. 8 Supercharged Compressor Induction (Tu-Flo 400, 500, 600 Installation Illustrated) AE-1 Alcohol Evaporator

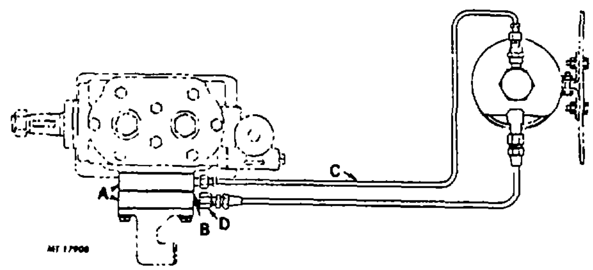


Fig. 9 AE-2 Alcohol Evaporator

Turbocharged Compressor Induction (Fig. 10)

This kit is used when the compressor in let 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.

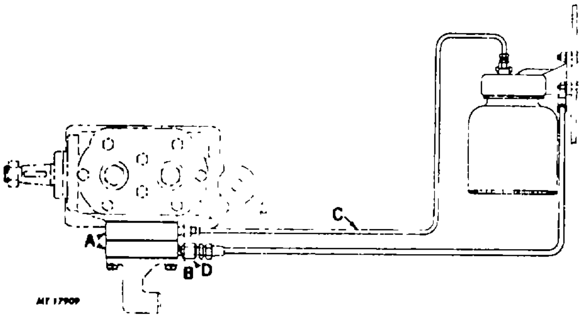


Fig. 10 Turbocharged Compressor Induction (Tu-Flo 400, 500, 600 installation Illustrated) Available Only With AE-1 Alcohol Evaporator (Metal Can)

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 clogged (Standard Engine Air Cleaner Induction Kit).	Clean or replace filter material.
	Leaky fittings, lines, jar cover 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.
	Check valve stuck in closed position (Engine Air Cleaner Induction Kit only.)	Replace necessary parts or complete check valve.

(*) Proof that evaporator is functioning can be determined by:

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 490 C, 1200 F).	Relocate alcohol evaporator.
	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 combinations (with brakes released).
	Choke fitting not used (supercharged 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.

BRAKES-AIR

CHAPTER XIV

AIR DRYER

CONTENTS

CHAPTER XIV

CONTENTS (Continued)

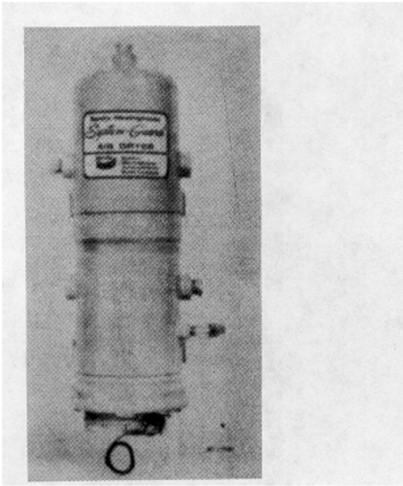


Fig. 1 AD-1 Air Dryer

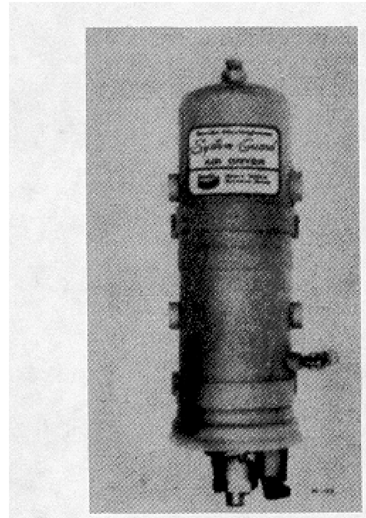


Fig. 2 AD-2 Air Dryer

BENDIX AD1 & 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.

The safety valve protects against excessive pressure build-up 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 kg. (1 lb.) have about 186,000 $_{m2}$ (two million square feet) of absorptive area made up of a large number of submiscroscopic 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 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 100 C and 320 C (500 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.

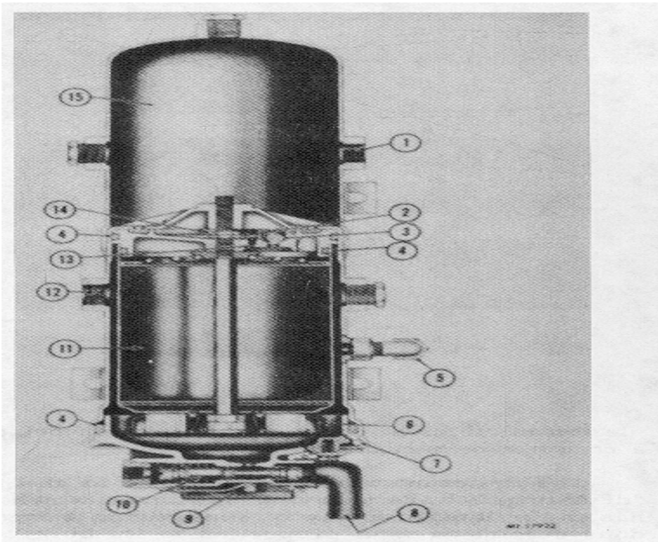


Fig. 3 Sectional View of AD-1 Air Dryer

1. Outlet
2. Nut
3. Check Valve
4. “O” Ring
5. Safety Valve
6. Oil filter
7. Retaining Ring
8. Exhaust Deflector
9. Heater
10. Purge Valve
11. Desiccant
12. Inlet
13. Purge Orifice
14. Jam Nut
15. Purge Volume

Charge Cycle (Fig. 5)

With the compressor in its "loaded" or compressing cycle, air from the compressor enters the air dryer through the 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.

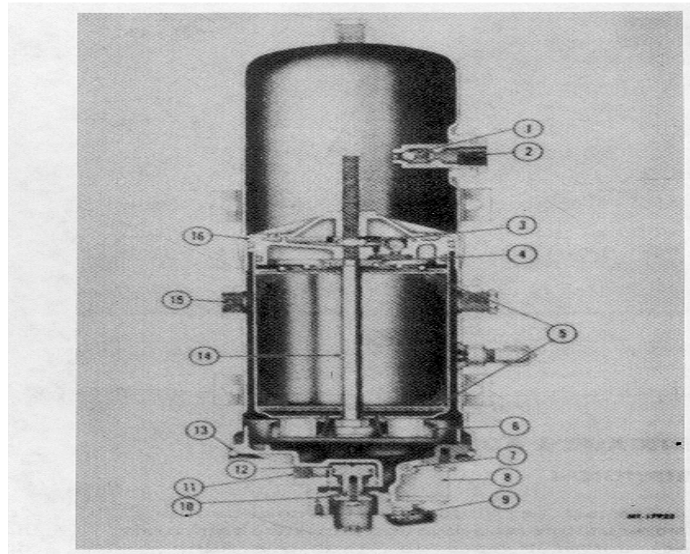


Fig. 4 Sectional View of AD-2 Air Dryer

1. Check Valve
2. Outlet
3. Lock Nut
4. Spring Retainer
5. Perforated Plate
6. Oil Filter
7. Heater
8. Thermostat Enclosure
9. Electrical Terminal
10. Purge Valve
11. Control Port
12. Purge Valve Piston
13. Retaining Ring
14. Cartridge Bolt
15. Inlet
16. Desiccant Sealing Plate

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.

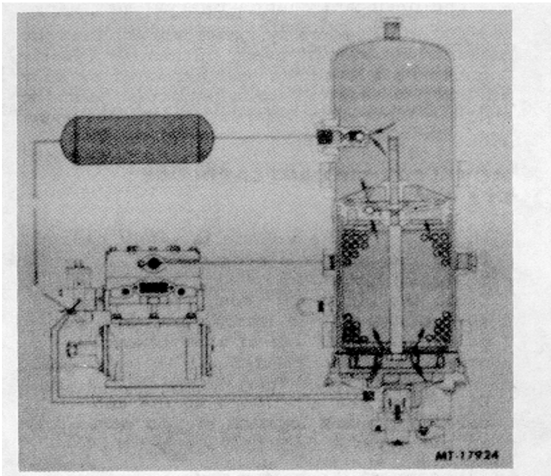


Fig. 5 AD-2 Operational Charge Cycle

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-1 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 to atmosphere. With 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.

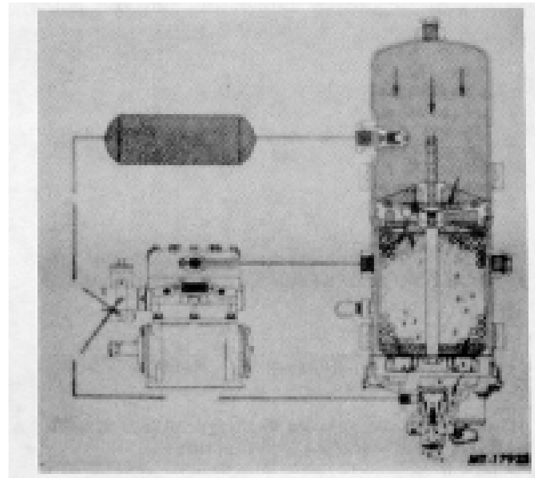


Fig. 6 Operational Purge Cycle

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 $_{m2}$ (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 170 C (300 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 cartridge 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 noncompressing 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 cut-out 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 100 C (500 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°).

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 retaining 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 Art 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).

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.

Fig. 7 Installing Check Valve

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.

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.

Prior to installing the new replacement cartridge in the air dryer, the following steps must be as follows:

1. Carefully remove the lock nut from the cartridge bolt using an 11/16" open end or box wrench. Care must 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.

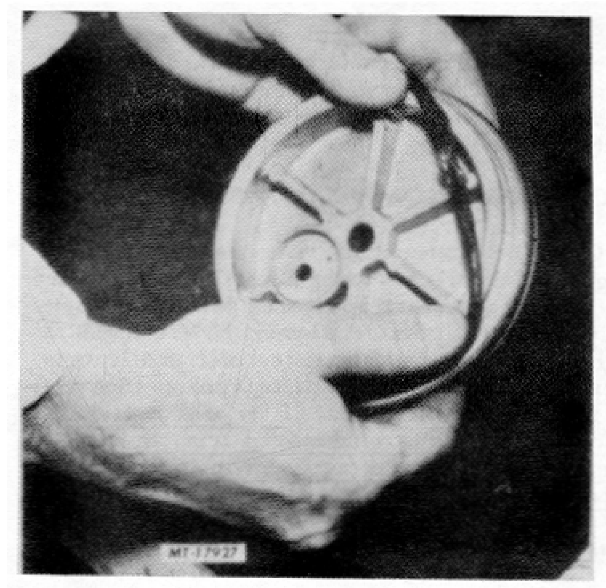


Fig. 8 Installing O-Rings

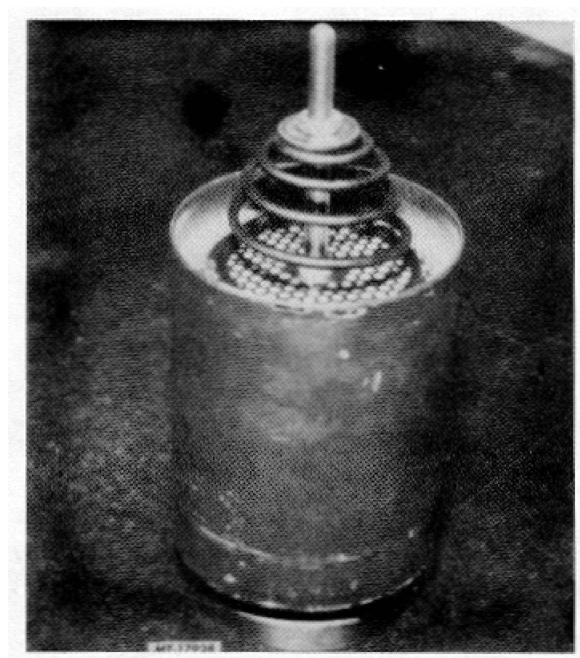


Fig. 9 Replacement Desiccant Cartridge

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 shoulders 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. <u>If an old revision desiccant cartridge is removed from the air dryer, it should be replaced with a complete currently revised desiccant cartridge</u>.

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).

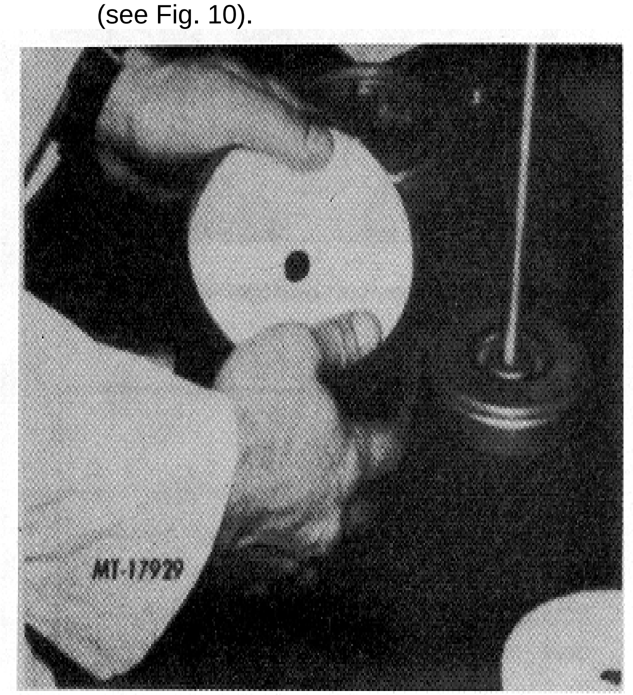


Fig. 10 Installing Felt Cloth In Cartridge

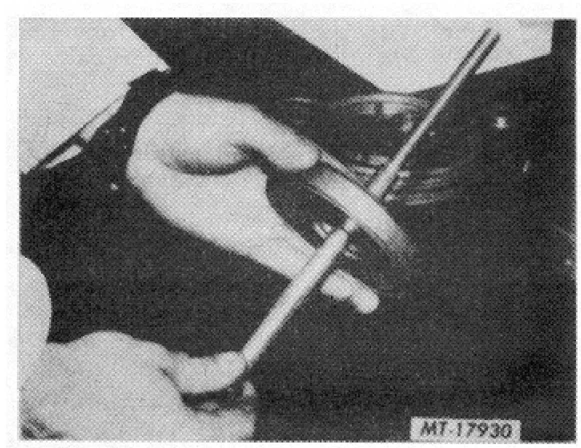


Fig. 11 Installing 011 Filter Separator

2. Slide oil filter separator over the cartridge bolt with the gasket surface next to the shell (Fig. 11).
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).

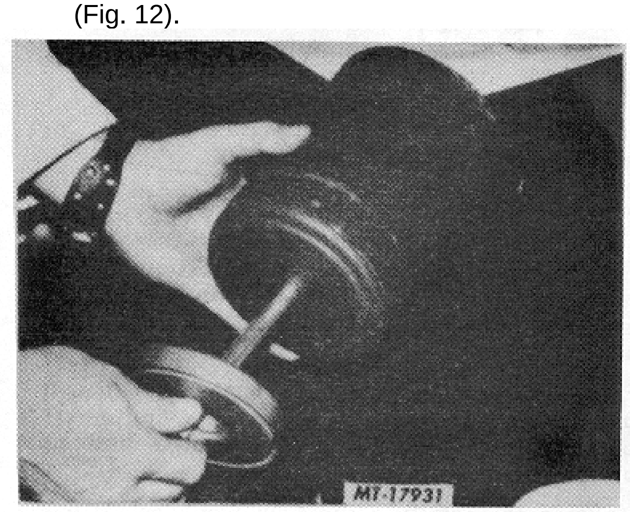


Fig. 12 Installing Cartridge Bolt

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).
5. Level the desiccant material and install second perforated plate, felt cloth down. Make sure the shoulder of the bolt is centered and extends slightly above the top of the perforated plate (Fig. 14).

   If the shoulder of the bolt does not extend above the perforated plate, tap the side of the desiccant container.

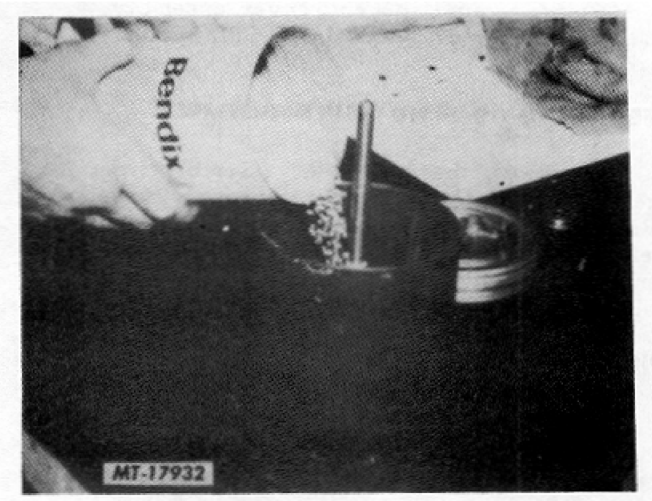


Fig. 13 Installing Desiccant

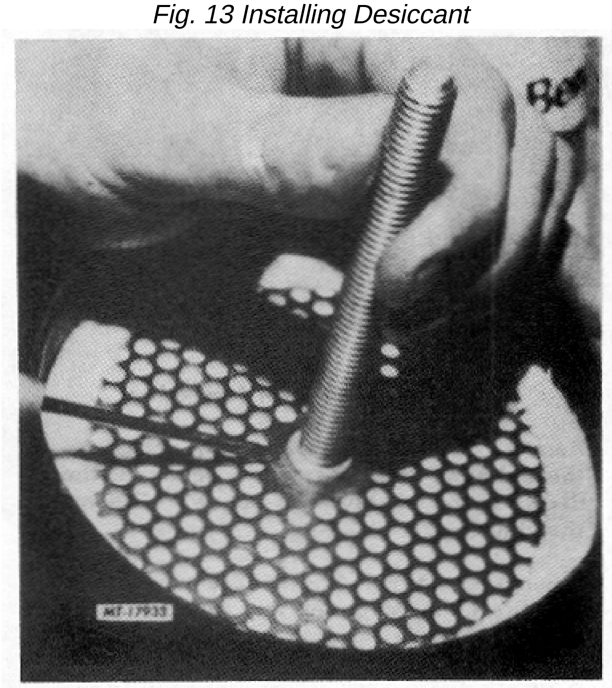


Fig. 14 Installing Second Perforated Plate

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).

8. Install the previously rebuilt desiccant sealing plate on the cartridge bolt so that the ball check retaining clip can be seen.

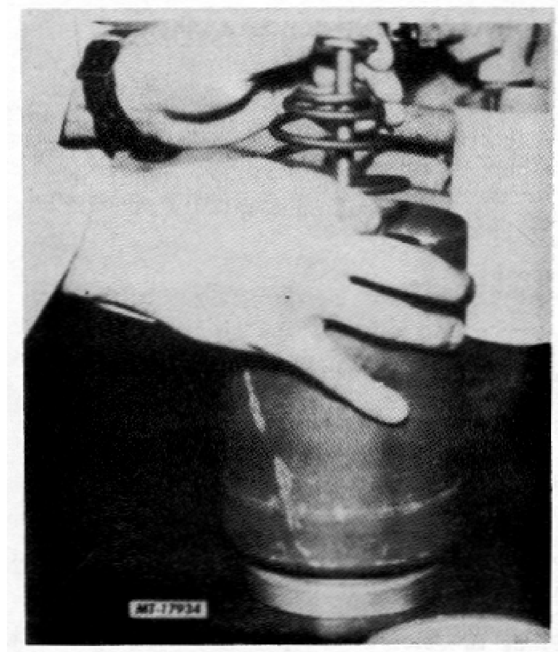


Fig. 15 Positioning Spring Retainer On Spring

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.

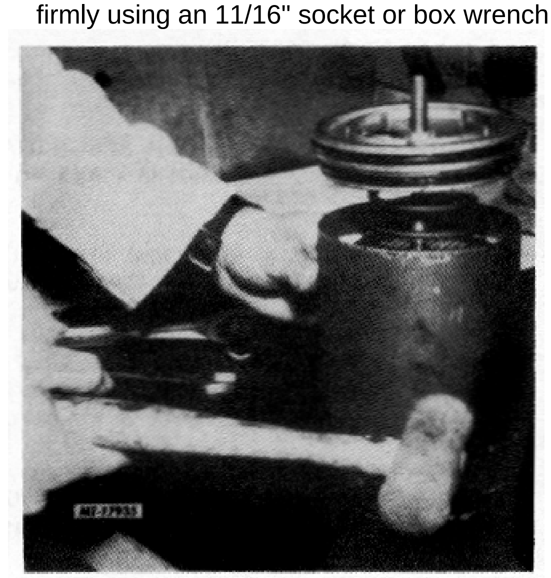


Fig. 16

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 SPECIFICA-TIONS, 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.

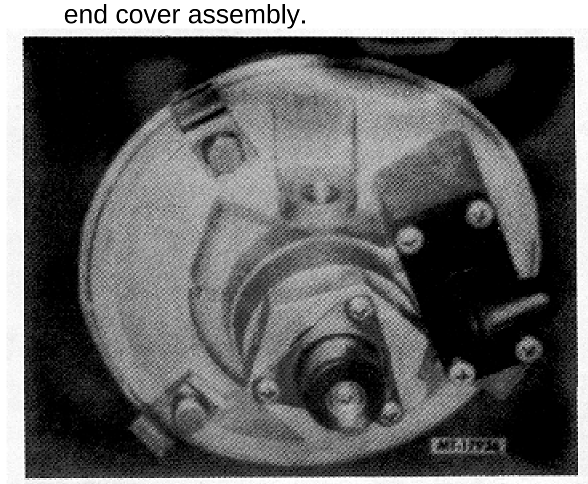


Fig. 17 AD-2 End Cover Assembly

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.

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. Do not remove the thermostat cover. Should this assembly become defective, the end cover must be replaced.

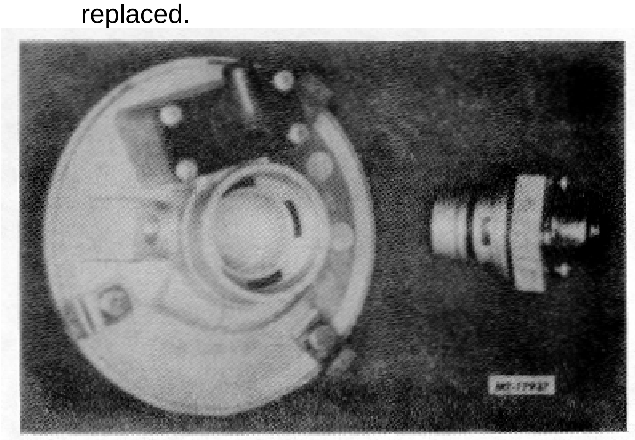


Fig. 18 AD-2 End Cover Assembly with Purge Valve Assembly Removed

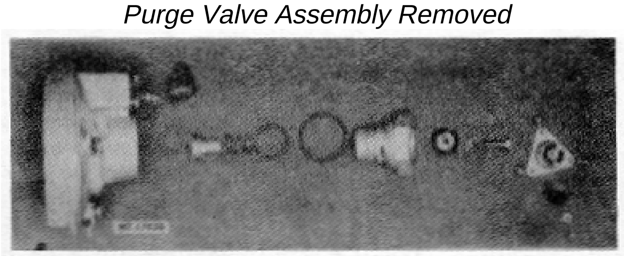


Fig. 19 Purge Valve Assembly Disassembled

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 0- 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 0- 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.

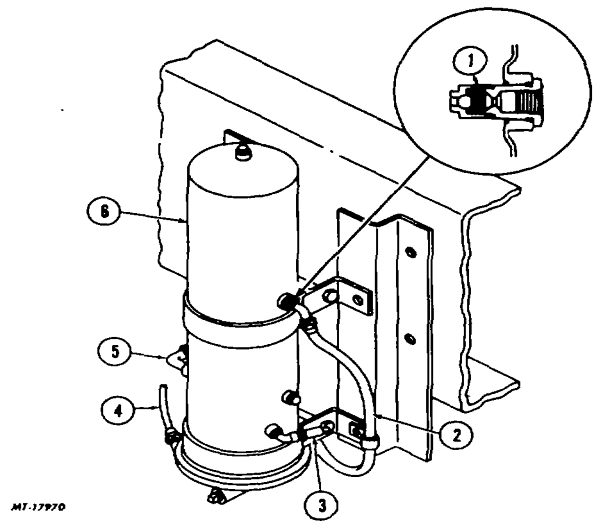


Fig. 20 Typical Air Dryer Installation

1 Check Valve Assy.
2 Supply to Air Reservoir
3 Pressure Relief Valve
4 Governor Control Line
5 Air Source From Compressor
6 Air Dryer Assembly

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.

CR BRAKEMASTER 62 & 68 MODELS DISCRIPTION

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 1490 C (3000 F) and by the time it reaches the Brakemaster unit, the temperature will drop to about 600 C (1400 F).

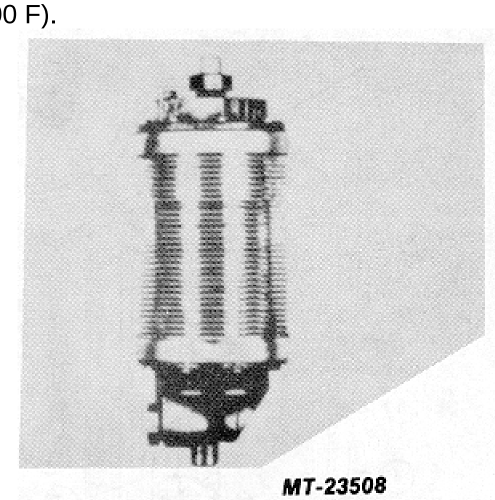


Fig. 21 CR Brakemaster Model 62

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

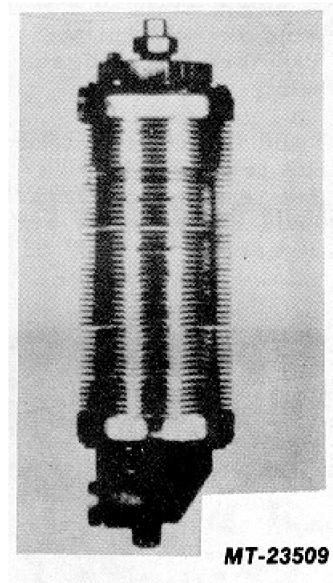


Fig. 22 CR Brakemaster Model "8

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 be very warm and 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 660 C or 1500 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 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.

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.

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 prevents bodily injury since nut is spring loaded.

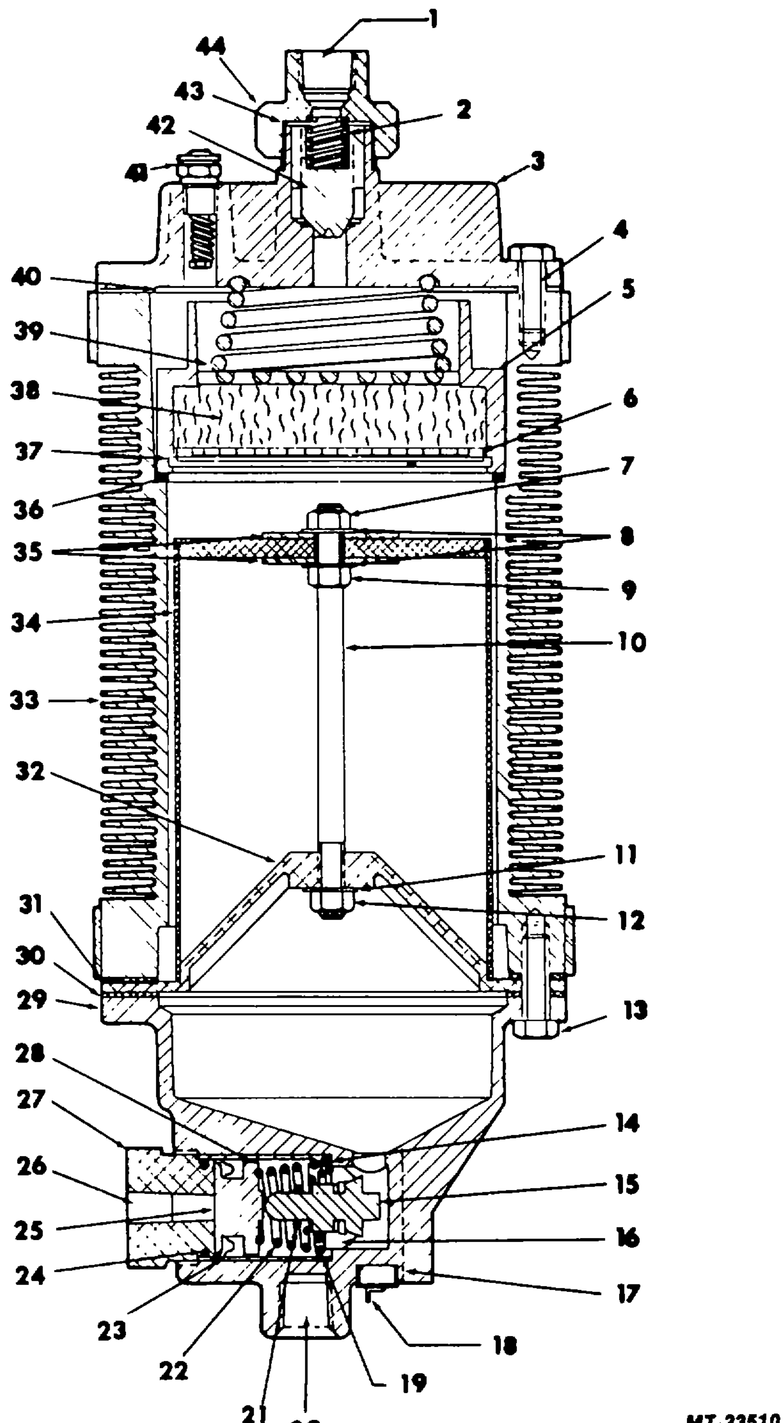


Fig. 23 Cross Section of CR Brakemaster Heat Exchanger

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"-16x1l"
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

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.

6. 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).

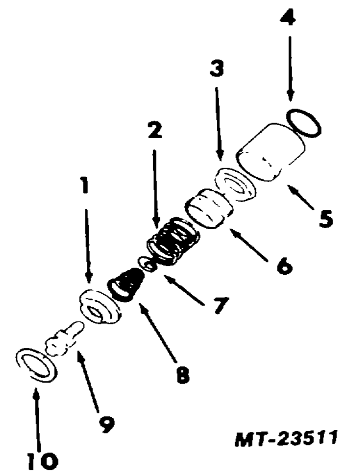


Fig. 24 Contents of Unloader Valve Kit

1	Ring Seat	6Piston
2	Spring, Large	7Ring, Retaining
3	Cup, U	8Spring, Small
4	Ring, 0	9Spindle, Unloader
5	Sleeve	10Gasket (2 Req’d.)

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 Item 1 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 (l") 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.

21. 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.

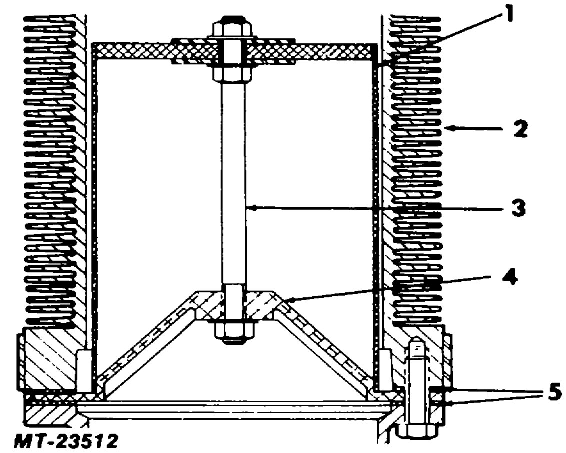


Fig. 25 Contents of Deflector Kit

1 Deflector
2 Body Tube
3 Rod, Support Assy. (Refer to
4 Plate, Mounting
5 Gaskets

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.

7. 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.

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).
5. 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.

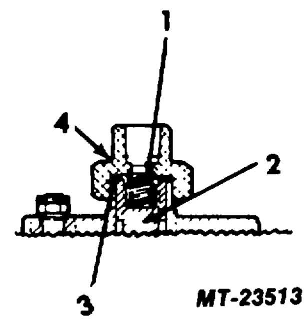


Fig. 26 Check Valve Assembly

1	Spring	3	Gaskets
2	Spindle	4	Nut

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.
9. 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 <u>not</u> <u>be</u> removed from the top cap. If the safety valve was removed, apply non-hardening 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.).

4. Remove spring (Item 39 in Fig. 23).
5. 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.
6. 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.
9. Wash strainer (5) and filter cup (3) in cleaning solvent.
10. 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 <u>three full turns</u> before load on cap is removed. Cap screws should be equally spaced. Then thread remaining screws into place.

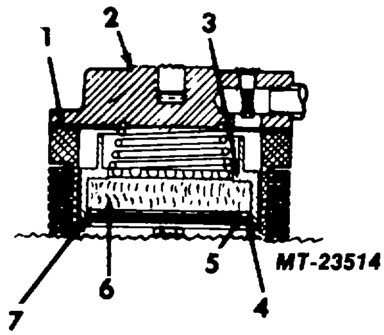


Fig. 27 Servicing Filter Assembly

1	Gasket	5	Strainer
2	Top Cap	6	Filter
3	Filter Cup	7	Packing Ring
4	V Spring		

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.

Servicing Thermostatically Controlled Cartridge Type 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.

1. Refer to the General Instructions.
2. Disconnect the electrical line from the CR BRAKEMASTER heater.
3. Remove old cartridge type heater by loosening set screw for heater on bottom cap.
4. 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.

5. 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.

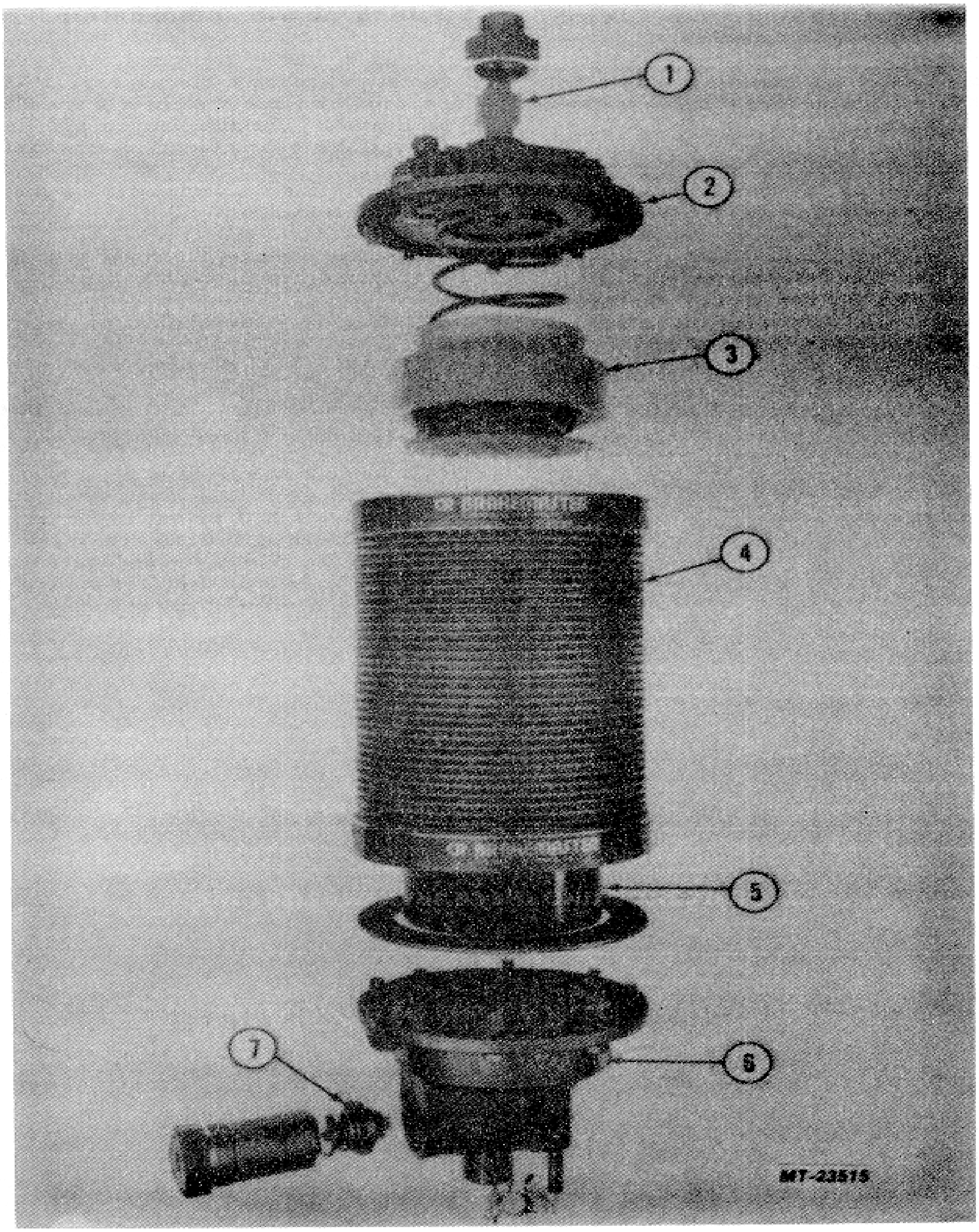


Fig. 28 Exploded View of CR Brakemaster Heat Exchanger

1 Check Valve Assembly
2 Top Cap
3 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.	1. Inlet side of compressor connected to outlet side of turbocharger. 2. Check valve at outlet port stuck open.	Consider changing compressor inlet connection. Consult vehicle manufacturer. Clean or replace check valve assembly.
System air pressure bleeds off rapidly when air using equipment is not being operated.	1. Leak in air line connection(s). 2. Leak in air line or reservoir. 3. Check valve at outlet port stuck open.	Tighten or replace fittings. Repair or replace faulty item(s). Clean or replace check valve assembly.
Compressor runs continuously (will not go into stand-by mode).	1. Leak in air line connections. 2. Leak in air line or reservoir. 3. Compressor defective. 4. Unloader valve stuck open. 5. Compressor capacity too low for vehicle.	Tighten ori- replace fittings. Repair or replace faulty item(s). Rebuild or replace compressor. Clean or replace unloader valve assembly. Install larger compressor.
Compressor goes into "stand-by" mode but cycles rapidly.	1. Leak in air system. 2. Check valve in CR Brakemaster outlet port stuck open. 3. Defective seal in unloader. 4. 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.	1. Unloader valve stuck open 2. Seat of unloader valve chipped or nicked. 3. Piece of dirt or foreign material stuck in unloader valve.	Rebuild unloader valve. Replace seat assembly. 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. 2. Line between compressor and exchanger blocked. 3. Check valve in outlet port stuck closed. 4. Pressure sensing device defective. 5. Blockage in air line between compresor and sensing device (Note: If safety valve of exchanger opens, blockage is after unit).	 Replace line or remove blockage. Clean outlet and replace check valve. Replace Remove blockage.

TROUBLE SHOOTING THE CR BRAKEMASTER UNIT (Cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
Does not cool air (initial installation).	1. Mounted in location where it cannot be cooled by ambient air. 2. Mounted too near heat producing equipment or too near other heat dissipating equipment. 3. Copper tubing from compressor to inlet too short.	Relocate unit. Relocate unit. Increase length of copper tubing.
Does not "unload" when compressor goes into stand-by mode.	1. UNL port of governor not connected to unloader port or line broken. 2. Components of unloader valve worn. 3. Ice formed in area of unloader valve. 4. Heater inoperative.	Connect or repair line. Rebuild unloader valve. Shorten line (24" min. allowable length) and/or install heater. Replace heater or check electrical connections.
Safety valve opens.	1. Check valve in outlet stuck closed. 2. Obstruction in air line beyond heat exchanger. 3. Compressor governor valve defective. 4. Safety valve defective.	Clean outlet and replace check valve assembly. Remove obstruction. Replace. Replace.
Water exhausted by unit contains excessive oil and/or soot. No water exhausted during unloading cycle.	1. Compressor rings defective. 1. Insufficient water in ambient (inlet) air. 2. Not cooling air sufficiently to condense water.	Rebuild or replace compressor. 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.	1. Covered with dirt or paint. 2. Deflector damaged or broken.	Steam clean and/or remove paint. Replace deflector assembly.
Water exhausted is brownish or brown particles are exhausted.	1. Broken or damaged deflector.	Replace deflector assembly.

BRAKES - AIR

FOUNDATION BRAKE - AIR

CAM-ACTUATED TYPE

CONTENTS

CONTENTS (Continued)

DESCRIPTION

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. Although the slack adjusters, cam and followers are not directly known as components of the foundation brakes, they will be covered herein.

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.

Refer to BRAKE ADJUSTMENT for detailed adjustment procedures.

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 system 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.

Periodic checking of push rod travel or brake adjustment is essential for good braking. Push rod travel should be checked every 6,000 km (4,000 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 mn (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.

<u>These instructions apply to manual adjustment type slack adjusters.</u>

1. 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 (Fig. 1).

   Fig. 1 illustrates the locking sleeve in its disengaged position. Be sure sleeve is <u>held in</u>, disengaging the adjusting screw when making adjustments.

   Use either an open or socket wrench when making adjustment. Make certain locking sleeve is <u>held in</u>, thereby disengaging the locking mechanism. <u>Never use a wrench on the sleeve portion</u>.

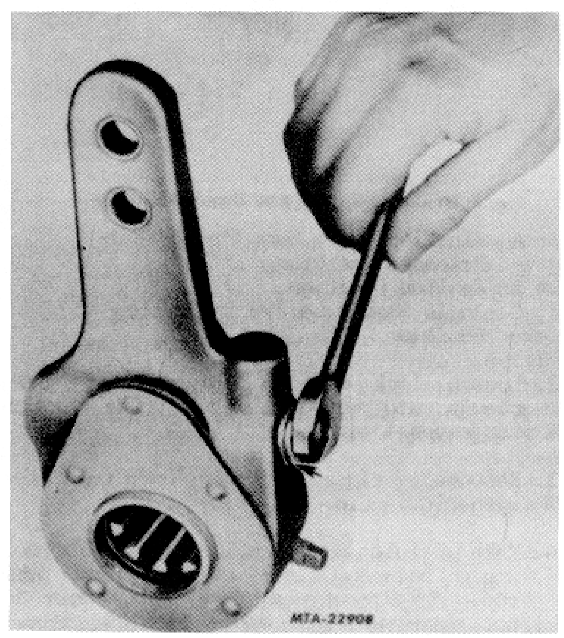


Fig. 1 Slack Adjuster Locking Sleeve on Adjusting Nut

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.

5. 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 (Fig. 2), then maximum force against slack adjuster cannot be obtained. Readjust push rod as follows:

1. Disconnect slack adjuster and push rod. Do this carefully because slack adjuster may be turned toward brake chamber with considerable pressure.

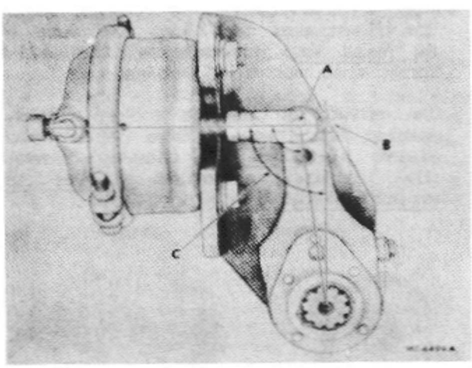


Fig. 2 Brake Chamber and Slack Adjuster

A Slack Adjuster More Than 90° in Released Position
B Applied Position
C Angle Should be 90° in Applied Position

2. 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.

4. 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 near 90 degree position (Fig. 2).

MANUAL 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 near 90 degrees as described in BRAKE ADUSTMENT.

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

1. 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.

2. 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 permissable. 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 five months or 26,000 km (16,000 miles). Refer to LUBRICATION Section 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 cam actuated types 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:

Remove Wheel, Hub and Drum

Brake Groups with Backing Plate

Brake Groups with Spider (Cast Type Mounting Bracket)

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.

Remove Wheel, Hub and Drum

1. Position vehicle on floor stands.
2. 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. 3).
4. Remove brake drum assembly as determined by the type of drum mounting. Two variations will be found in drum-to-hub mounting.

   a. Inboard mounted drum will be secured to the hub assembly on the brake group side of hub. This type of mounting will apply to all cast wheels and some disc wheels. With this type of drum mounting, the wheel, hub and drum is removed as one assembly (Fig. 4).

   b. Outboard mounted drums will be secured between the wheel and hub. This mounting will only apply to some disc wheel installations.

   When outboard mounted drum brake groups are serviced, the wheels are removed, then the drum can be removed without disturbing the hub assembly (Fig. 5). This will eliminate wheel bearing repacking and adjustment.

Further identification and service procedures will be found in the Wheels, Rims and Tires section.

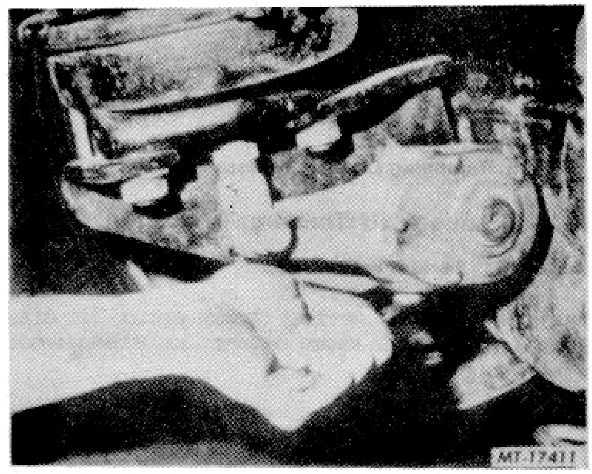


Fig. 3 Backing Off Brake Adjustment

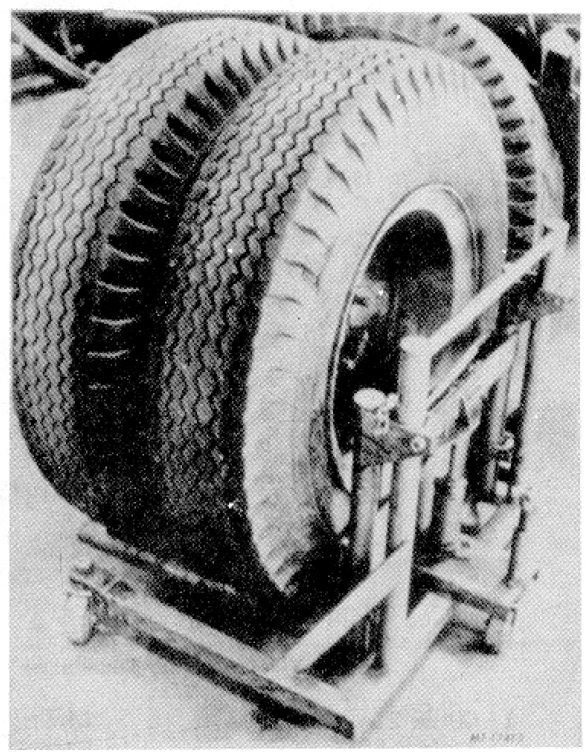


Fig. 4 Using Wheel Dolly to Remove Wheel, Hub and Drum Assembly

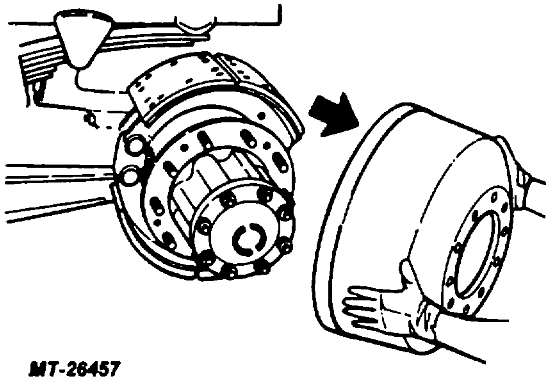


Fig. 5 Removing Outboard Mounted Drum

Brake Groups with Backing Plate (Fig. 6)
Rockwell "T" Series Brake Group

The Rockwell “T” series brake group is disassembled it the same manner as the Wagner brake group.

Wagner Broke Group

1. 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 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. The roller retainers (if equipped) must be disconnected prior to removing the rollers.

2. 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.

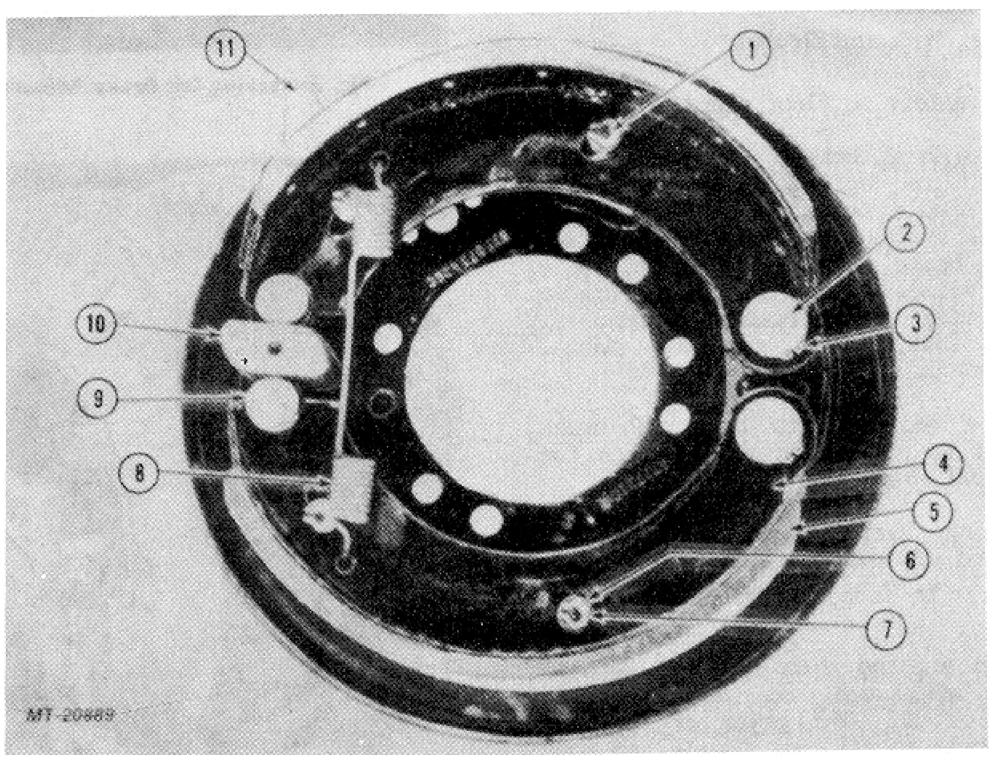


Fig. 6 Wagner Foundation Brake Group with Backing Plate

1	Guide Pin	5	Lining	9	Roller
2	Anchor Pin	6	Washers	10	Camshaft Assembly
3	Anchor Pin Retainer	7	"C" Washer	11	Brake Chamber Bracket
4	Shoe	8	Return Spring		

4. Lift brake shoes from anchor pins and guide pins.

5. 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 previously done so.

Vehicles with automatic slack adjusters, refer to the brake manual section which applies to Automatic Slack Adjusters.

7. Mark position of manual 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.

9. 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.

Brake Groups with Spider

Three basic variations will be found in brake groups which use spiders.

1. Eaton brake groups (Fig. 7) use a fixed anchor pin with open end shoes at anchor end.

2. Rockwell "P" Series brake groups (Fig. 8) have removable anchor pins which utilize brake shoes with closed anchor pin openings (holes).

3. Rockwell "Q" Series brake groups (Fig. 10) have removable anchor pins with bushings and open end anchor location on brake shoes.

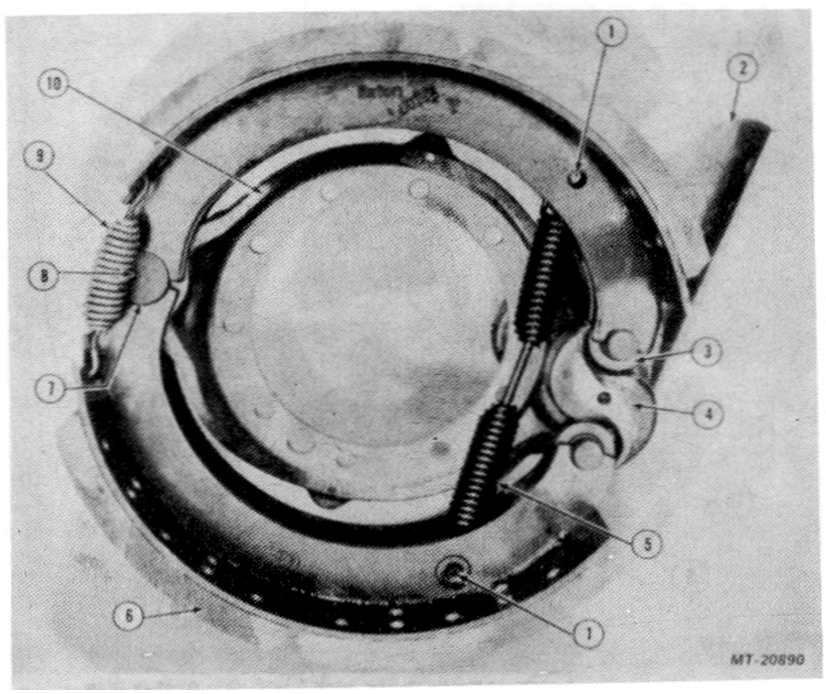


Fig. 7 Typical Brake Group with Fixed Anchor Pins

1	Link	5	Return Spring	8	Anchor Pin, Fixed Type
2	Brake Chamber Bracket	6	Lining (Blocks)	9	Shoe Retaining Spring
3	Roller Assembly	7	Open Anchor Pin Hole	10	Spider
4	Camshaft Assembly				

Eaton Brake Group (Fig. 7)

Remove brake shoes as follows:

1. Remove dust shields.

2. With a bar, pry each shoe one at a time away from the cam and lift out the rollers and pins.

3. With the rollers removed, the shoe return spring will be loose and can be slipped off the links between the shoe webs.

4. Let lower shoe hang down.

5. Lift off the lower shoe by unhooking it from the two retaining springs.

6. Remove the two retaining springs and upper shoe.

7. Mark position of slack adjuster in relation to camshaft also noting the position of adjusting screw. Adjusting screw may be either facing toward or away from brake chamber mounting surface.

8. Disconnect clevis pin connecting brake chamber push rod to slack adjuster.

9. Remove lock ring retaining slack adjuster to end of camshaft. Note location of spacer washers for reassembly purposes.

10. Remove slack adjuster from camshaft.

11. Push or tap camshaft from spider and camshaft bracket.

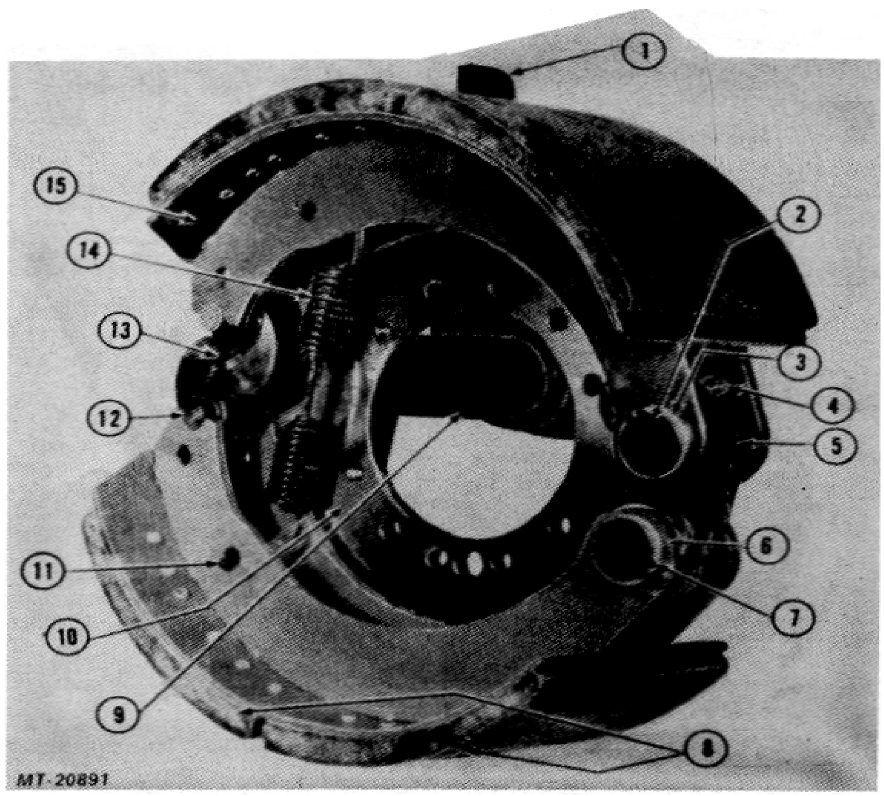


Fig. 8 Typical Brake Group with Removable Anchor Pins

1	Brake Chamber Bracket	6	Closed Anchor Pin Hole	11	Link
2	Removable Anchor Pin	7	Anchor Pin Retainer	12	Roller
3	Seal Retainer	8	Lining (Blocks)	13	Camshaft Assembly
4	Lock Bolt	9	Camshaft Bracket	14	Return Spring
5	Lock Wire	10	Spider	15	Shoe

Rockwell "P" Series Brake Group (Fig. 8)

Remove brake shoes as follows:

1. Remove brake dust shields.

2. With a bar, pry each shoe one at a time away from the can and lift roller assemblies from end of shoes.

3. After the rollers are removed, the shoe return spring will be loose and can be slipped off the links between the shoe webs.

4. Remove anchor pin retainers (lock rings), seal retainers and felt seals.

5. Cut lock wire and remove anchor pin lock bolt (Fig. 9). The anchor pin can then be removed. As the pins are forced out, the shoes will be free.

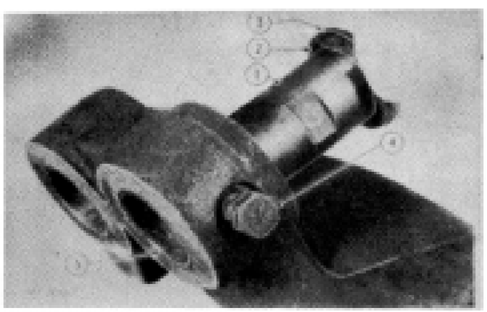


Fig. 9 Brake Spider with Removable Anchor Pins

1	Anchor Pin	4	Lock Bolt
2	Felt Seal	5	Bushing
3	Retainer		

Vehicles with automatic slack adjusters, refer to the brake section which applies to automatic slack adjusters.

6. 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.

7. Remove clevis pin connecting brake chamber push rod to slack adjuster.

8. Remove lock ring retaining slack adjuster to end of camshaft. Note location of spacer washers for reassembly purposes.

9. Remove slack adjuster assembly from camshaft.

10. Push or tap camshaft from spider and camshaft bracket.

Rockwell "G" Series Brake Group (Fig. 10)

Remove brake shoes as follows:

1. Disconnect lower and upper Cam roller retainers (Fig. 11).

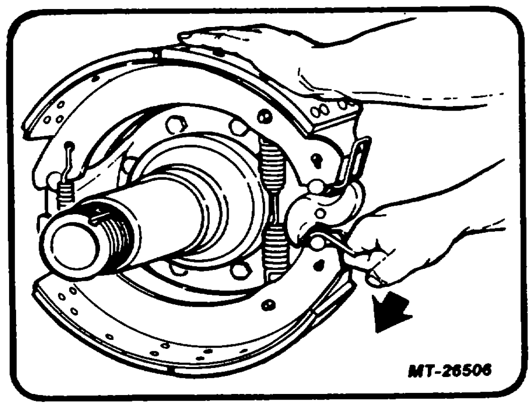


Fig. 10 Disconnecting Roller Retainer

2. Press down on the lower brake shoe and remove the lower cam roller (Fig. 12).

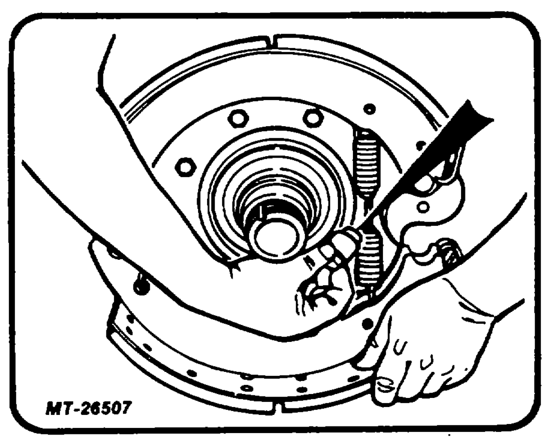


Fig. 11 Removing Lower Cam Roller

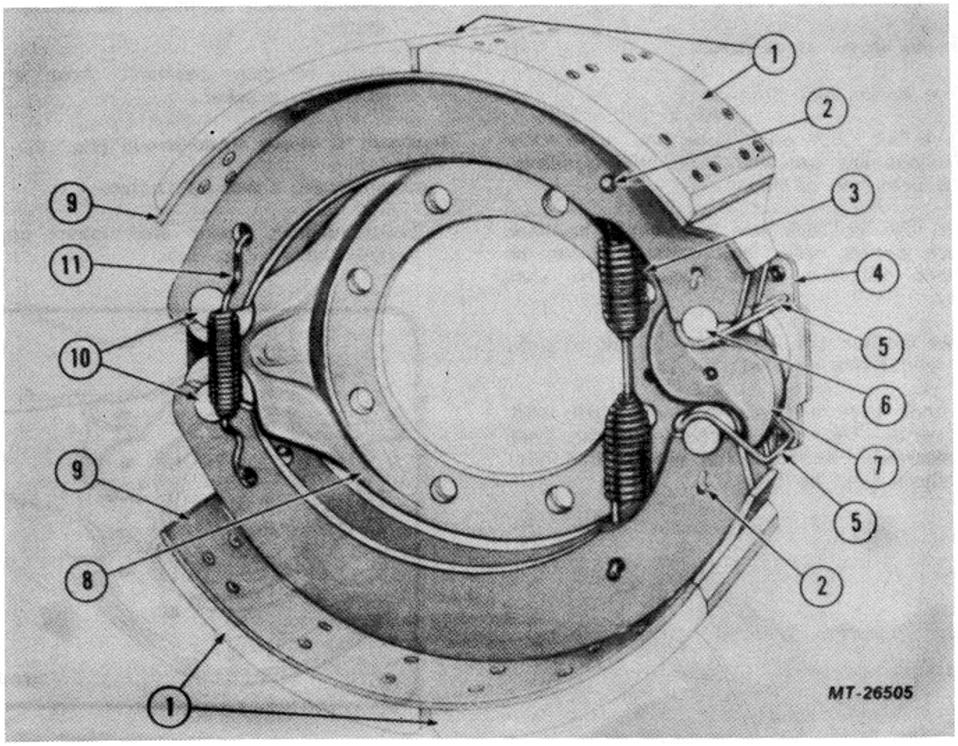


Fig. 12 Typical Brake Group with Removable Anchor Pins

1	Lining (Blocks)	5	Roller Retainer	9	Shoe
2	Link	6	Roller Assembly	10	Anchor Pins
3	Return Spring	7	Camshaft Assembly	11	Shoe Retaining Spring
4	Camshaft Bracket	8	Spider		

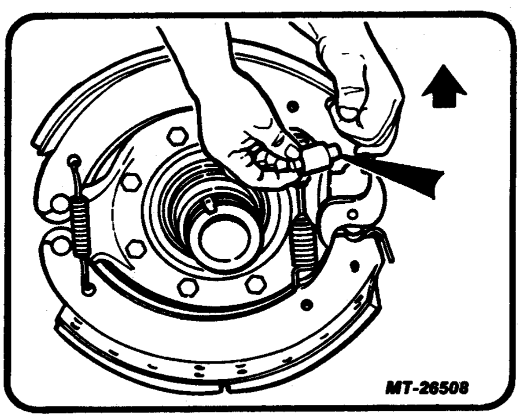


Fig. 13 Removing Upper Cam Roller

3. Lift top shoe and remove the remaining cam roller assembly (Fig. 13).

4. After removing roller assemblies, the shoe return spring will be loose and can be slipped from the links between shoe webs (Fig. 14).

5. Swing lower shoe back about 180° to relieve the tension on the retainer springs (Fig. 15). Then remove the inboard and outboard retainer springs (Fig. 16).

6. Remove lower shoe (Fig. 17). Then remove upper shoe.

7. Mark position manual of slack adjuster to camshaft also noting position of adjusting screw. The adjuster screw may be facing toward or away from brake chamber mounting surface.

8. Remove clevis pin connecting the brake chamber push rod to slack adjuster.

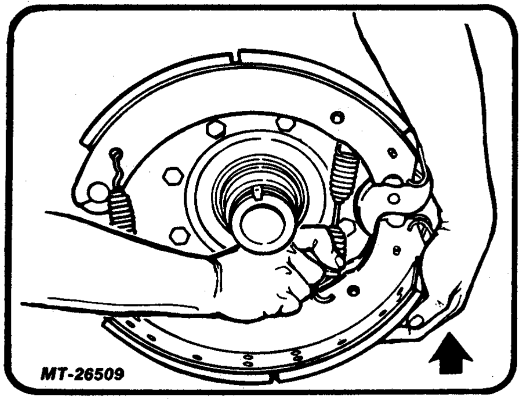


Fig. 14 Remove Shoe Return Spring

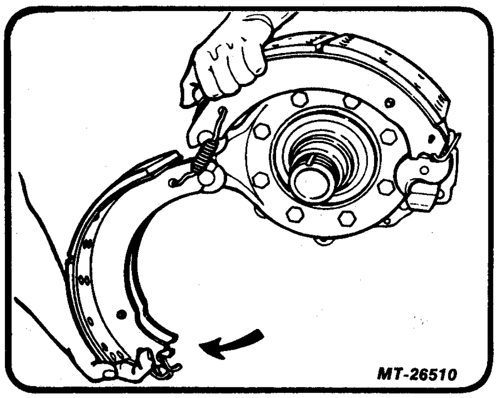


Fig. 15 Rotate Lower Shoe Approximately 180°

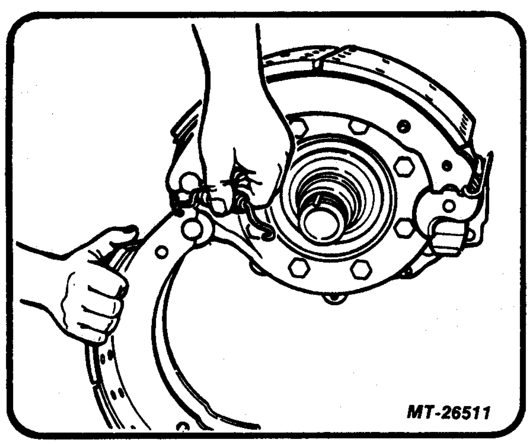


Fig. 16 Removing Retainer Springs

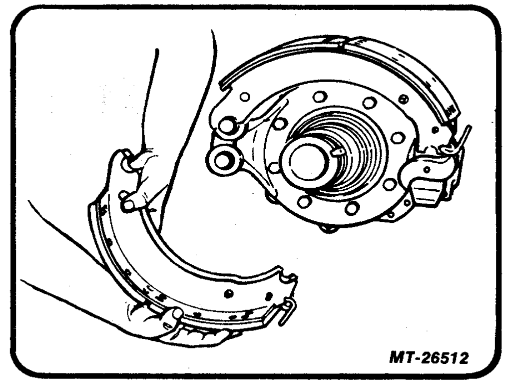


Fig. 17 Removing Lower Shoe

9. Remove lock ring from end of camshaft. Note location of spacer washers for reassembly purposes.

10. Remove slack adjuster from camshaft.

11. 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.

CAUTION

Because studies have indicated that exposure to excessive amounts of asbestos dust may be a potential health hazard, OSHA has set maximum limits of levels of airborne asbestos dust to which workers may be exposed. Since most automotive friction materials normally contain a sizable amount of asbestos, it is important that people who handle brake linings be aware of the problem and know the precautions to be taken.

OSHA standards should be consulted with respect to mandatory requirements as well as for suggested procedures to minimize exposure.

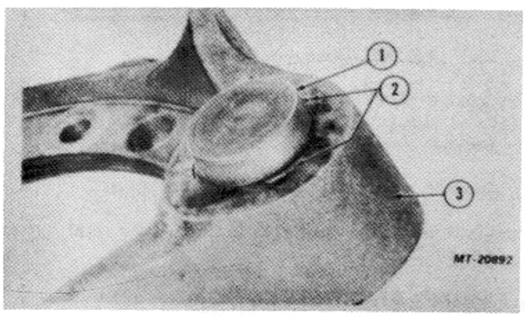
Drum, Shoe and Lining

Refer to the service manual section pertaining to reconditioning drums and shoes.

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, section, Brakes, for type of lubricant.

If anchor pins are worn, they must be replaced. Anchor pins may be replaced on all brake groups except Eaton (Fig. 18). Eaton anchor pins are staked in place and are replaced with spider.



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 end Dust Shields

Inspect backing plates and dust shields. If bent or twisted, they must be replaced.

Spider

Inspect spider for damage. If any cracks are found, the spider must be replaced.

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 section for type of lubricant.

For detailed servicing instructions pertaining to camshaft and bushings, refer to SERVICING BRAKE GROUP COMPONENTS in this section.

REASSEMBLY

The reassembly instructions contained herein have been arranged as follows:

Install Wheel, Hub and Drum
Brake Groups with Backing Plate
Brake Groups with Spiders

Install Wheel, Hub and Drum

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 RECONDITIONING BRAKE DRLUS AND SHOES section.

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 ’ORQUE 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.

Brake shoes with combination brake blocks sets of semi-metallic and organic lining must be installed as shown in Figures 19 and 20.

The brake blocks on each shoe consist of one semi-metallic material (shaded area) and one block of organic material (unshaded area).

The semi-metallic material is identified by the metal particles embedded in the brake block. The organic material will not have the visable metal particles.

Brake Groups with Backing Plate

Rockwell “T” Series Brake Group

The Rockwell “T” Series brake group will be reassembled in the same manner as the Wagner

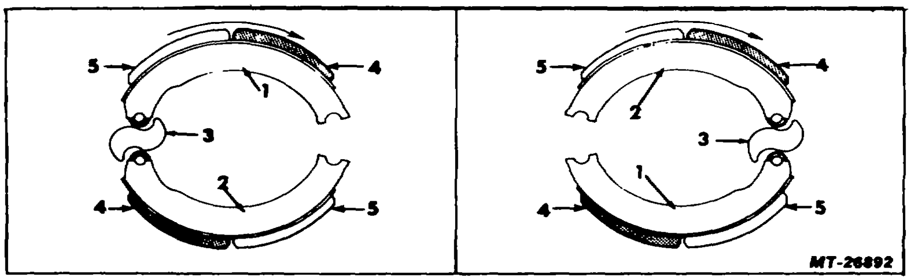


Fig. 19 Right Wheel Rotation (Arrow)

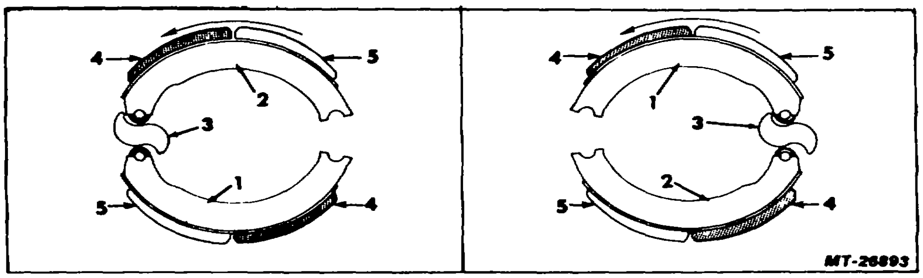


Fig. 20 Left Wheel Rotation (Arrow)

1	Primary (Forward) Shoe	3	Cam	5	Organic Brake Block
2	Secondary (Reverse) Shoe	4	Semi-Metallic Brake Blockbrake group.		

brake group.

Wagner Brake Group (Fig. 6)

1. Lubricate camshaft bushings prior to installing camshaft. Refer to LUBRICATION section Brakes for type of lubricant.

2. Install camshaft assembly. Make sure spacer washers are reassembled in same relative position from which they were removed.

3. Assemble the brake shoe rollers to the shoes, if equipped with retainers.

4. Assemble guide pin washers and position shoes over anchor pins and guide pins.

5. Assemble anchor pin washers and guide pin washers.

6. Install guide pin "C" washers and anchor pin retainer rings.

7. Install brake shoe return springs.

8. Pull each shoe back and insert rollers. Installing rollers after shoe return springs are installed requires less effort than installing brake shoe return springs after the rollers are in place. However, if the rollers have retainers they must be assembled to shoes as stated in step 3.

9. Reassemble slack adjusters on camshaft aligning scribe marks and positioning spacer washers in reverse sequence when adjuster was removed.

   a. Use spacer washers 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.

10. Reinstall slack adjuster retaining ring.
11. Reinstall wheel and drum assembly and adjust wheel bearings.
12. Adjust brakes as instructed elsewhere in this section.

Brake Groups with Spiders

Three variations will be found in brake groups with spiders.

Eaton (Fig. 7) with fixed anchor pin and open end shoes.

Rockwell "P" Series (Fig. 8) with two removable anchor pins and closed ends on shoes.

Rockwell "Q" Series (Fig. 12) with two removable anchor pins and open ends on shoes.

1. Lubricate camshaft bushings with lubricant listed in LUBRICATION section, Brakes.
2. Install camshaft assembly being sure spacer washers are assembled in reverse sequence when removed.
3. Install anchor pins if removed (Rockwell "P" and "Q" Series brake groups).

   "P" Series - Position shoes in place on spider then push the pin through shoe and into spider. Repeat anchor pin installation on remaining shoe. Install felt seals, seal retainers and lock rings on anchor pins. Also be sure return spring links 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.

   "Q" Series - Anchor pins are held in place by the shoes, eliminating snap rings, felts and set screws.

4. 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.
6. Pry each shoe (one at a time) away from cam and install rollers. If rollers have retainers, be sure they are hooked on the roller assemblies.
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 pay of 1.59 mm (.062”) with retaining 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. Make sure that the retaining ring is of correct thickness. Two variations of ring grooves will be found; namely 1.5875 mm (1/16”) and 3.1750 mm (1/8”). The proper ring thickness must be used in the camshaft groove.
9. Install brake chamber if removed.
10. Reinstall wheel and drum assembly and adjust wheel ring.
11. Adjust brakes as outlined in BRAKE ADJUSTMENT instructions.

SERVICING FOUNDATION BRAKE COMPONENTS

DRUM AND SHOES

For complete details covering servicing of brake drums and shoes, refer to the section covering RECONDITIONING DRUMS AND SHOES.

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.

If fixed anchor pins (Fig. 18) become worn, the complete spider replacement will be necessary.

Anchor pins in spiders which are removable (similar to that shown in Fig. 9) 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 SEALS

The camshaft is actuated by movement of slack adjuster. The rotating movement of cam forces shoe rollers 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.

Removal of brake chamber bracket will be required to replace the bushings in some instances.

To check bushings to determine if replacement is required, insert the camshaft in the bushing and check side play. If more than .5080 mm (.020") on Wagner or Eaton brakes or .7620 mm (.030") on Rockwell brakes, the bushings need replacing.

Install new bushings with a suitable tool like that shown in Fig. 21.

Apply IH 251 HET grease or equivalent NLGI #2 multi-purpose lithium grease to outside diameter of bushings to assist in pushing them into position.

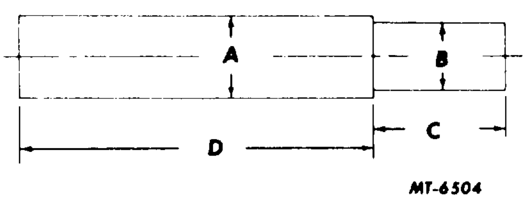


Fig. 21 Recommended Type of Camshaft Bushing Removing Tool

A Bushing Outside Diameter
B Bushing Inside Diameter
C Bushing length
D Suitable Length

Install new seals with lip of seal toward slack adjuster (Fig. 22).

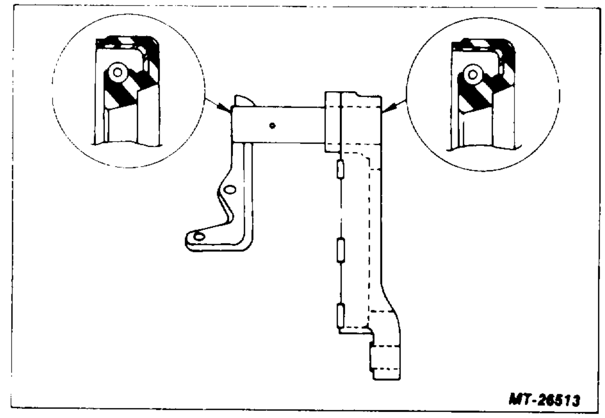


Fig. 22 Brake Chamber Bracket Seal Installation

BRAKE CHAMBERS

Brake chambers (Fig. 23) 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. 23) 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 assebly and non-pressure 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. 23).

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.

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

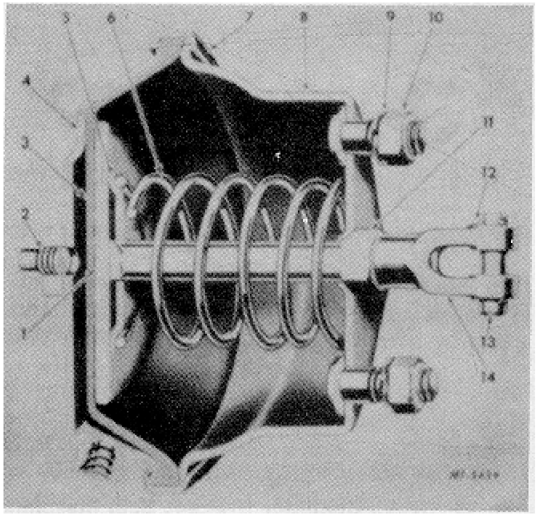


Fig. 23 Brake Chamber (Cross Sectional View)

1	Rod, Push	8	Plate, Nonpressure
2	Plug	9	Washer, Lock
3	Diaphragm	10	Nut
4	Plate, Pressure	11	Nut, Lock
5	Retainer, Spring	12	Pin, Cotter
6	Spring	13	Pin, Clevis
7	Clamp	14	Yoke, Clevis

particular spring brake chamber involved.

Remove

Disconnect air line and push rod yoke. Remove nuts from mounting studs and remove chamber.

Install

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 ADJUS). 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. 23.

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 once each year or every 160,000 km (100,000 miles) regardless of condition.
3. 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.
6. Install clamp (7) with bolts and nuts and tighten nuts to 17 N.m (150 in. lbs.) torque. Remove vise grip pliers.

7. 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 6,000 km (4,000 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.

Once each year, or every 160,000 (100,000 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. 2).

SLACK ADJUSTERS
Slack adjusters provide a method of adjusting brakes to compensate for brake lining wear and also serve as a lever during braking operation (Fig. 24).

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 position of lever arms in relation to brake camshaft.

Information pertaining to automatic slack adjusters will be found elsewhere in the BRAKE section of the Service Manual.

Remove
1. Remove cotter key and clevis pin from slack adjuster and push rod clevis

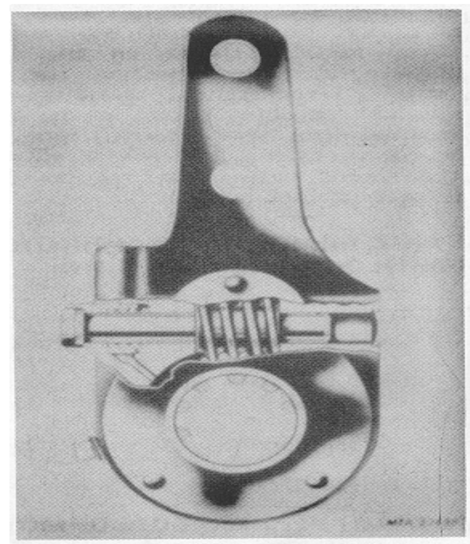


Fig. 24 Section View of Slack Adjuster

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.

Be sure that the spacer washers are installed to provide a maximum end play of 1.59 mm (.062") with retaining ring installed.

Two variations of snap ring grooves will be found; namely a 1.5875 mm (1/16") and 3.1750 (1/8"). The correct thickness of the retaining ring must be used when installing the slack adjuster.

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 Size	Newton-meters (N.m)	Foot Pounds (ft. lbs.)
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 Size	Newton-meters (N.m)	Foot Pounds (ft. lbs.)
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	
Bolt Size	Newton-meters (N.m)	Foot Pounds (ft. lbs.)
7/16"	45-56	34-42
5/8"	142-170	105-125

ANCHOR PIN LOCK BOLT (Fig. 9)

	TORQUE	
Bolt Size	Newton-meters (N.m)	Foot Pounds (ft. lbs.)
3/8"	26-37	19-27

ANCHOR PIN

	TORQUE	
Bolt Size	Newton-meters (N.m)	Foot Pounds (ft. lbs.)
3/4" UNF (Wagner)	129-176	95-130
3/4" UNF (Rockwell)	251-475	185-350

CAMSHAFT BRACKET MOUNTING

	TORQUE	
Bolt Size	Newton-meters (N.m)	Foot Pounds (ft. lbs.)
1/2"	88-115	65-85

BRAKES AIR

Replace old Section with this revised Section In your CTS-4001 Manual.

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.

CONTENTS

TORQUE CHART

HUB TO DRUM

Nominal Size	TORQUE N-m	Ft-Lbe
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 WHEEL MOUNTINGS

Refer to Wheels, Rims and Tires section of the service manual.

WARNING
ASBESTOS DUST DURING BRAKE SERVICING

1. Because studies have indicated that exposure to excessive amounts of asbestos dust may be a potential health hazard, the Occupational Safety and Health Administration (OSHA) has set maximum limits of levels of airborne asbestos dust to which workers may be exposed. Since most automotive friction materials normally contain a sizeable amount of asbestos, it Is important that people who handle brake linings be aware of the problem and know the precautions to be taken.

2. Areas where brake work Is done should be set aside, if possible, and should be posted with an asbestos exposure sign as follows:

ASBESTOS DUST HAZARD
AVOID BREATHING DUST
WEAR ASSIGNED PROTECTIVE EQUIPMENT
DO NOT REMAIN IN AREA UNLESS YOUR WORK REQUIRES IT
BREATHING ASBESTOS DUST MAY BE HAZARDOUS TO YOUR HEALTH

3. OSHA standards should be consulted with respect to mandatory requirements as well as for suggested procedures to minimize exposure. (Reference. Title 29, Code of Federal Regulations, Section 1910.1001.)

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, Figure 1, in brake drum may produce pedal pulsation and roughness or brake surge. If these effects are present, drum should be replaced.

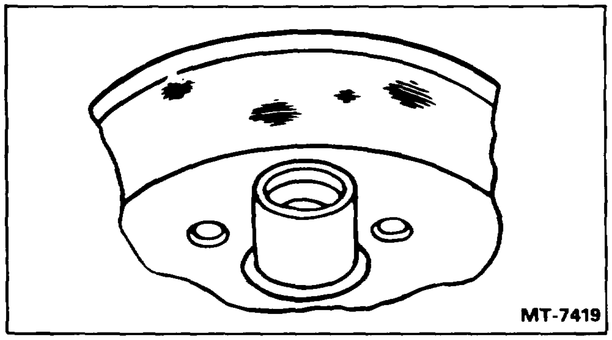


Figure 1 - Hard or Chill Spotted Drum

A barrel shaped drum (Figure 2) results from overheating. If this barrel shaped condition is not corrected, the braking surface is reduced and uneven lining wear results.

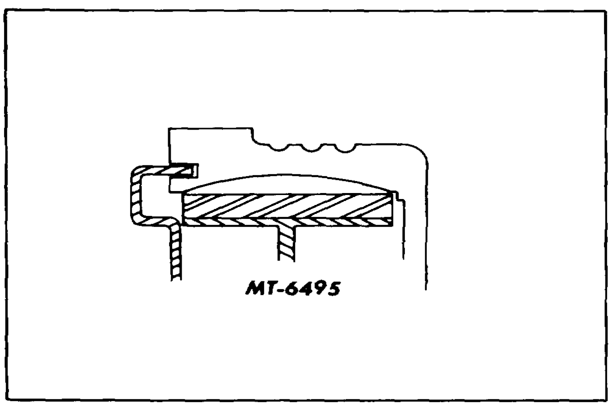


Figure 2 - Barrel Shaped Drum

Extreme pressure which over a period of time will create a bellmouthed drum as shown in Figure 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.

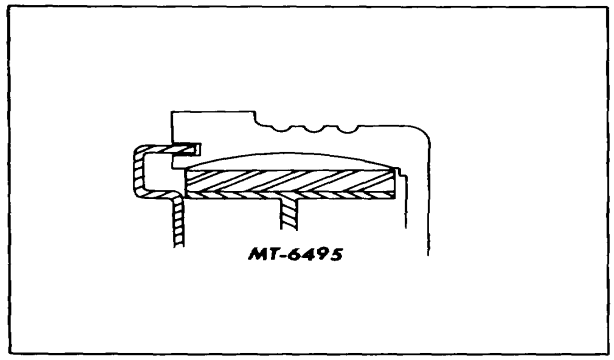


Figure 3 - Bellmouthed Drum

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 (Figure 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.

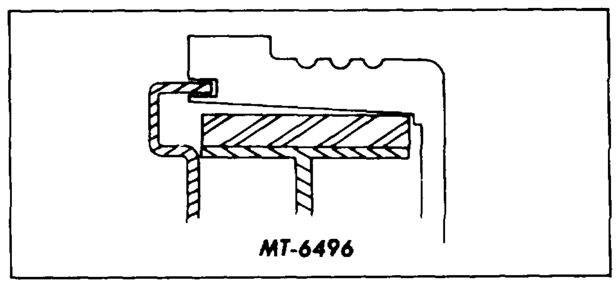


Figure 4 - Scored Drum

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.

Check inner side of drum surface for tool marks to determine if drum has been previously reconditioned, Figure 5. If so, an oversize lining may be required.

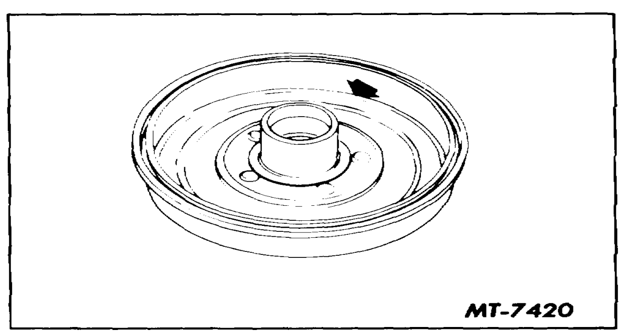


Figure 5 - Check Brake Drum for Tool Marks

Brake lining in an eccentric or out-of-round drum cannot make full contact with the drum This will result in rapid or uneven lining wear and could even cause brakes to seize or chatter. Maximum allowable out-of-round or eccentricity should be 0.25 mm (0.010 inch).

If the 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 brake drum lathe making certain drum is centered. Mount Dial Indicator SE-1848 on lathe and check runout about 12.7 mm (0.5 inch) in from edge of drum (on braking surface) as shown in Figure 6. Runout must not exceed 0.25 mm (0.010 inch).

Before assembling drum, hub and wheel, all parts must be clean and free of foreign matter.

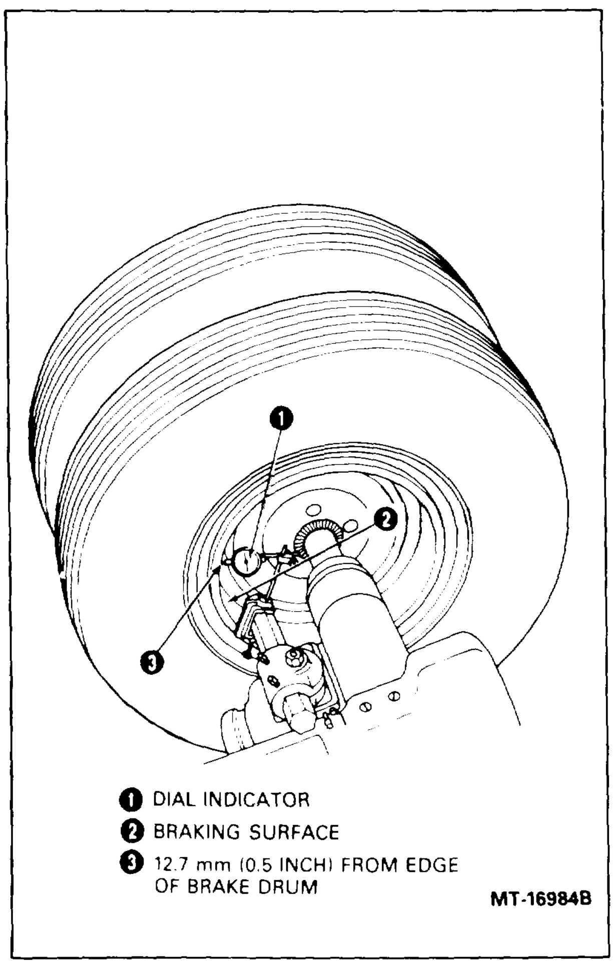


Figure 6 - Checking Drum Runout on Brake Drum Lathe

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 the 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 the 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 0.13 mm (0.005 inch), measured with micrometer across part of all of brake surface, drum should be refinished. Reboring limits (see drum) must not be exceeded and no heat checks, cracks or bluing should be evident. Use a micrometer also to check for an out-ofround drum. Make check by measuring drum brake surface diameter at various points 450apart around circumference. Eccentricity (out-of-round) should not exceed 0.25 mm (6.010 Inch) 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 (Figure 7) to form on inner surface of drums These conditions will become progressively worse until drums fail.

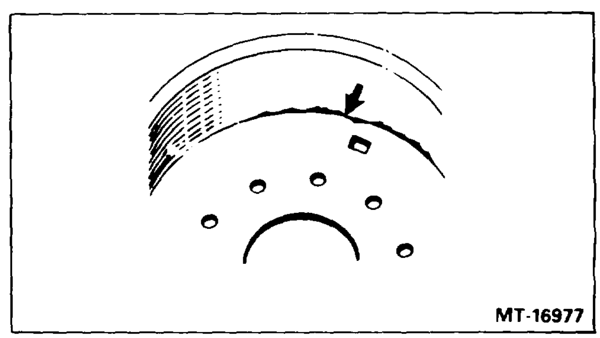


Figure 7 - Cracked Drum

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 inches) may not be increased more than 2 03 mm (0.080 inches) diameter (total cut) and discard at 3 05 mm (O 120 inches) over normal diameter

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 (Figure 8), the drum must be remounted 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.

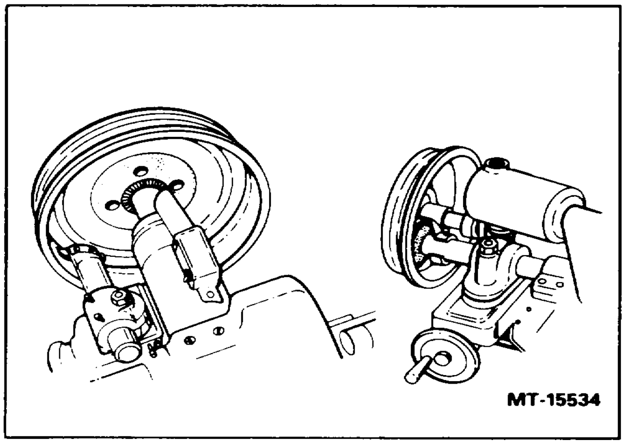


Figure 8 - Reconditioning Drum on Brake Drum Lathe

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. Examine very carefully to see that no metal chips remain in drum.

INSPECTION OF SHOES

When brake linings or blocks are worn to within 6.35 mm (0.25 inch) 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 Figure 9.

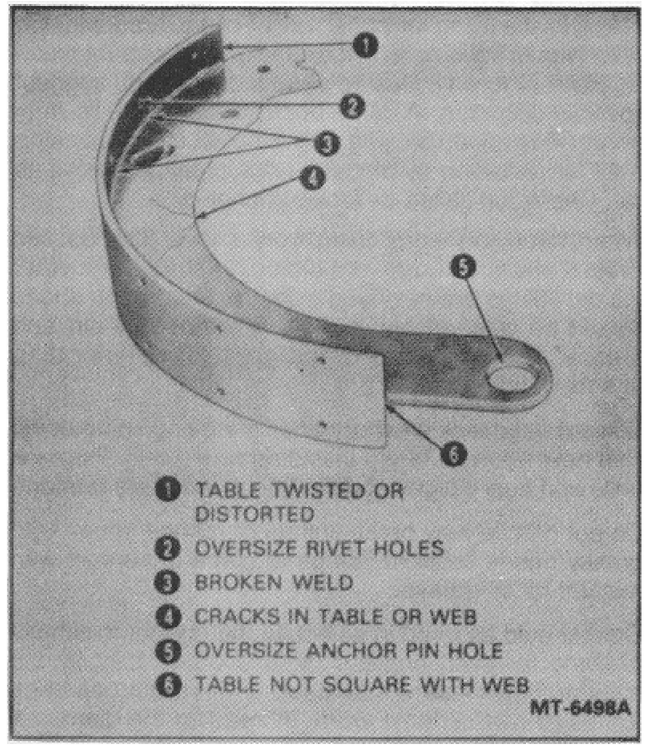


Figure 9 Defects to be Looked for on Brake Shoe

REPLACING LINING ON SHOES

Inspect brake shoe alignment by observing old lining wear pattern, Figure 10.

Figure 10 - Brake Shoe Alignment with Unusual Lining Wear

Check brake lining for possible out-of-square condition which would indicate a distorted shoe and/or bent backing plate, Figure 11. Rusted shoe support pads suggest possible distortion. A loose or bent backing plate may cause unbalanced braking and/or noise. Check backing plate for distortion by placing a straightedge across its flat. Check for galled or loose anchor pins.

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 has become worn, increasing the diameter, oversize lining may be required.

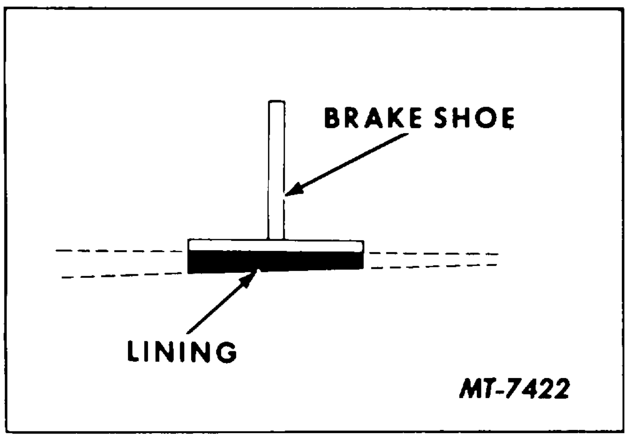


Figure 11 - Checking for Out-of-Square Lining

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), an oversize lining is required (Figure 12). If lining selected is too thick, only the ends of the lining will contact the drum. Refer to Figure 13.

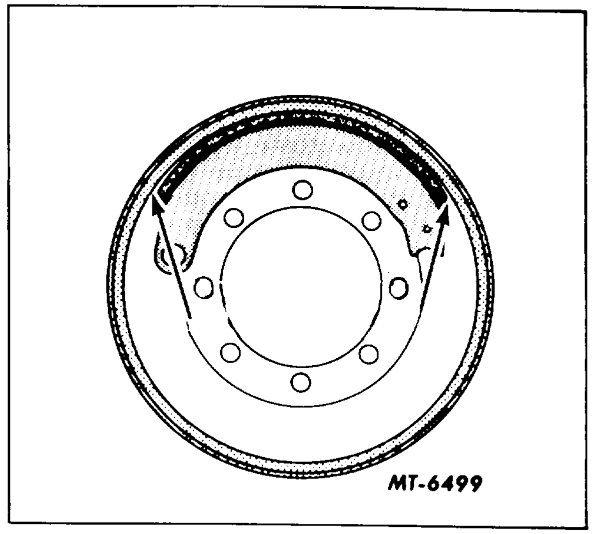


Figure 12 - Space at End of Shoe Lining Selected Too Thin

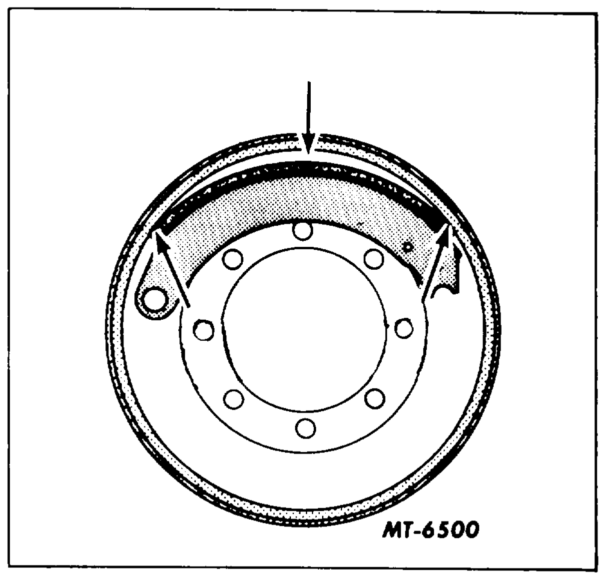


Figure 13 - Space at Center of Shoe And Lining Contacting Ends, Lining Selected Too Thick

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.

When securing brake lining to shoes, start with the center rivet or bolt and work toward the ends as shown in Figure 14. When securing brake block lining to shoe, use the sequence as shown in Figure 15. Always use new lock washers when installing bolt on lining and tighten nuts to 89-111 N-m (20-25 ft lbs.) torque.

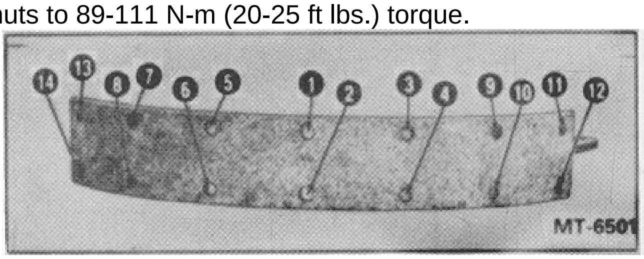


Figure 14 - Sequence In Securing Brake Lining to Shoe

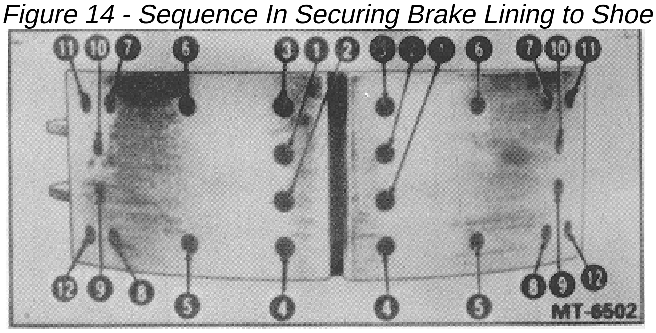


Figure 15 - Sequence in Securing Brake Block Lining to Shoe

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, (Figure 16) with a 0.203 mm (0.008 inch) feeler gauge at any point along the arc of 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 is provided on brake reliner 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 (0.070 inch) less than the inside diameter of brake drum Be sure that **the brake is fully released before grinding.**

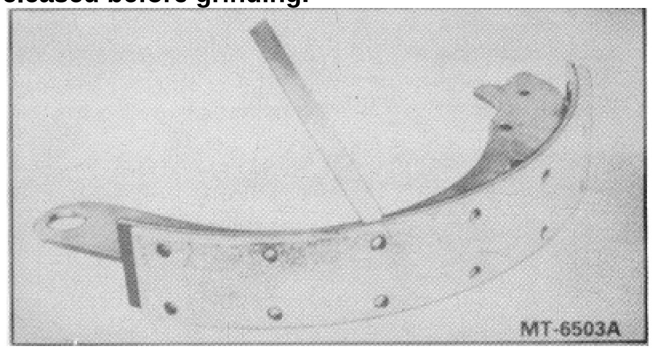


Figure 16 - Checking Tightness of Lining Using A Feeler Gauge

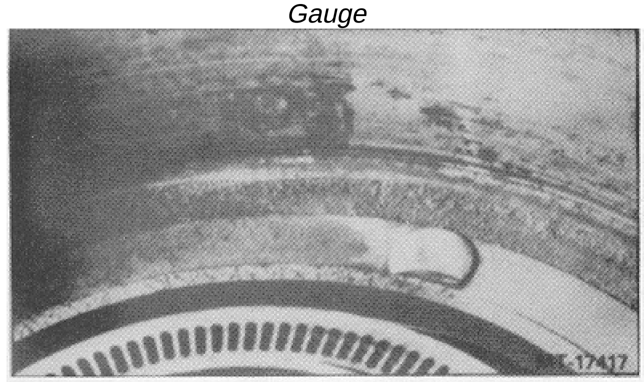


Figure 17 - Drum Bolt Alignment

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 straightedge 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 **all** protective grease, oil or other residue. DO **NOT use gasoline, mineral spirits or** oil.

When assembling hub and drum together, pay special attention to the bolt heads so that they are aligned properly in the drum (Figure 17).

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.

Replace old section with this Ievised section in your CTS-4001 Manual

BRAKES—PARKING

DOUBLE DIAPHRAGM MGM STOPGARD

CONTENTS

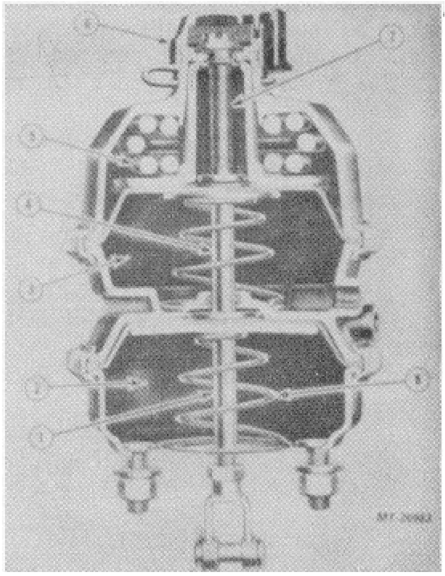


Fig. 1 - Double Diaphragm Spring rake Chamber

1 Push Rod
2 Service Brake Chamber
3 Spring Brake Chamber
4 Spring Brake Push Rod Assembly
5 Parking Brake Spring
6 Breather Cap
7 Release Bolt
8 Push Rod spring

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.

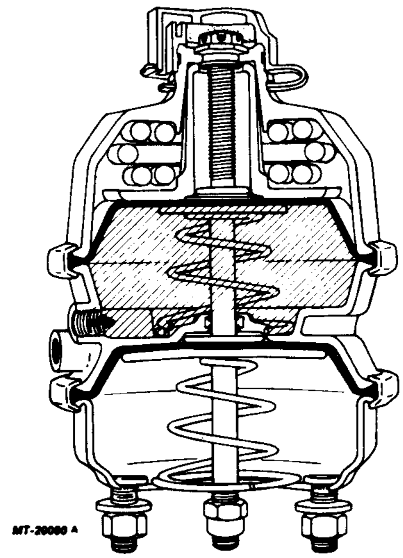


Fig. 2 - Normal Driving Position

SERVICE BRAKE APPLICATION

When the service brakes are applied, air is forced into the service brake chamber (Fig. 3) forcing the pushrod and piston assembly outward, extending the pushrod assembly.

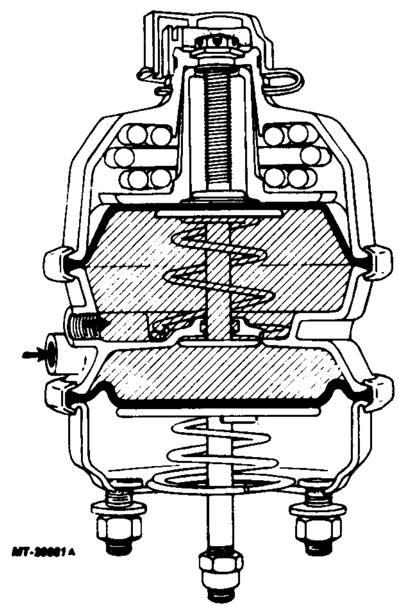


Fig. 3 - Service Brake Application

When the brake (foot) valve is released, air in the service brake system is exhausted and the service brake chamber pushrod assembly and diaphragm are permitted to return to the normal released position. The pushrod sprirg assists in this function by forcing the pushrod 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 pushrod and service brake pushrod assemblies which are in turn connected to brake slack adjusters or brake wedge assemblies.

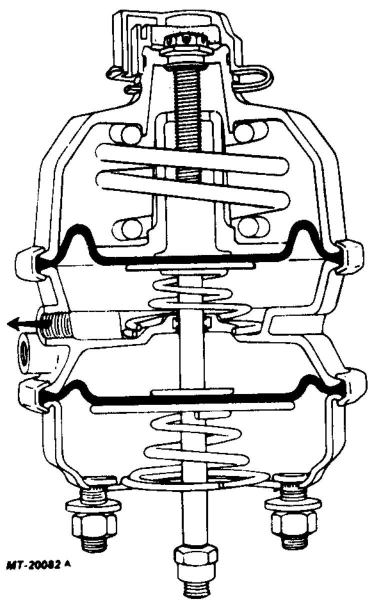


Fig. 4 - Parking Brake Application

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 pushrod 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) section that applies to your vehicle 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).

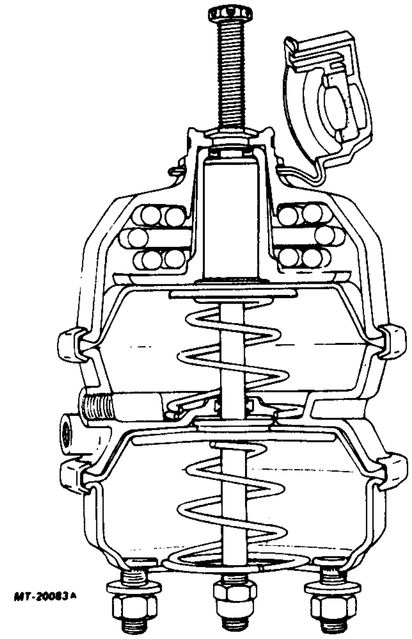


Fig. 5 - Spring Brake In Manual RIoas4ed Position

To manually release the spring brake chamber you are actually compressing the spring to relieve any tension on the pushrod assembly.

WARNING

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 with air in parking brake system if the breather cap is removed and the release bolt backed off counterclockwise as follows:

Type 24 and 30 chambers 57 to 64 rwm (2-1/4 to 2-1/2")

Type 36 chambers 70 to 76 mm (2-3/4 to 3").

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.

Do not apply more than 68 N.m (50 ft lbs) torque to release bolt.

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 head insert. Torque nut to 61-68 N.m (45-50 ft lbs) and reinstall breather caps with arrow pointing toward ground.

MAINTENANCE

The breather cap must be in place and the arrow on the breather cap must point down. The breather cap should be checked periodically. If dirty or clogged, a new breather cap should be installed. When the breather cap is removed, check the release bolt nut to assure it is tightened (clockwise) to 68 N.m (50 ft lbs) torque.

The spring brake and service brake chamber clamp rings should be checked periodically to insure the clamp is evenly sealed and clamp bolt nuts are tightened to 27-34 N.m (20-25 ft lbs) torque.

WARNING

To avoid personal injury never remove the spring brake clamp ring unless manual release mechanism has been applied as instructed in MANUAL RELEASE of SPRING BRAKE and assembly is placed in a caging fixture.

Visually inspect exterior surfaces of assembly for damage.

Be sure to check mounting stud nuts are tightened to 136-156 N.m (100-115 ft lbs).

Air line fitting should be checked to be sure they are torqued to 34 N.m (25 ft lbs).

Check service brake chamber pushrod to insure it has free motion and is in straight alignment from service chamber to slack adjuster. Worn yoke pins are to be replaced and are locked in place with a cotter pin. Make sure the jam nut is tight.

CAUTION,

Some parts, such as air brake chamber diaphragm, should be inspected once a year or every 80,000 km (50,000 miles) and replaced if considered unserviceable for further use.

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 multipurpose lithium grease applied to release bolt, pushrod, seals and white plastic guides, outside of diameter edge of spring piston and guide surface of head.

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.

REMOVE

1. Block the wheels of the vehicle to prevent it from moving.
2. Manually release the spring brakes (refer to MANUAL RELEASE OF SPRING BRAKE). After releasing brakes release the air pressure in she parking brake system by placing the parking brake control in 'apply" position. Be sure that the service brakes are released also.
3. Remove air hoses fron parking brake and service brake chambers. Tag hoses for proper identification at reassembly.
4. Loosen jam nut at service brake pushrod yoke.
5. Disconnect service brake pushrod yoke from slack adjuster.

6. 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

Prior to installing a new brake chamber assembly, be sure that the pushrod and yoke are the correct length and ports are correctly aligned with mounting bolts. New brake assemblies are furnished with a 203.2 mm (8") rod. Cut rod the same length as replaced unit with spring brake fully released (release bolt completely screwed in).

1. Assemble parking and service brake assembly on vehicle mounting bracket. Torque nuts to 136-156 N.m (100-115 ft lbs). Be sure washers are on outside of bracket and not against brake unit.
2. Connect service brake pushrod 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. Torque fittings to 34 N.m (25 ft lbs).
4. Adjust service brakes as outlined elsewhere in this manual.
5. 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.
6. With air still applied to the parking brake, turn the release bolt clockwise until the bolt is fully engaged into the unit and the slotted nut bottoms out on the head insert. Tighten nut to 61-68 N.m (45-50 ft lbs). Do not use an impact wrench.
7. Install the breather cap by snapping it in place over seal with <u>arrow</u> on breather <u>pointing toward ground.</u>
8. Remove vehicle blocks.

REPLACE SPRING BRAKE DIAPHRAGMS

1. Remove complete brake chamber assembly as a unit (refer to REEMOVE).

WARNING

To avoid hazardous shop environmenttal conditions, the warnings listed in this manual must be adhered to while disassembling the spring brake chamber assembly. Sudden accidental release of the power spring will cause spring brake components to be hurled with dangerous force which could strike persons in the area causing serious personal injury or death. Under no circumstances should a spring brake chamber assembly be disassembled without first performing the safeguards as described.

2. Prior to the disassembly of the spring brake chamber assembly, check for broken parking brake spring as follows:
   A. Inspect the spring brake chamber clamp band to be sure it is evenly seated around the spring brake chamber.
   B. Screw the release bolt clockwise all the way into the unit, releasing the spring.
   C. Shake the spring brake chamber assembly vigorously. A rattling from within the head end normally confirms a broken spring. Further evidence of a broken spring would be light resistance when screwing the release bolt down.
   D. If the parking brake spring is broken or suspected of being broken proceed with text concerning SERVICING SPRING BRAKE WITH SUSPECTED DEFECTIVE POWER SPRING or DEFECTIVE RELEASE MECHANISM.
3. If the power spring is not broken, manually release the power spring as instructed in MANUAL SET OF SPRING BRAKE.
4. Using a hydraulic press, adjust it so that there is 203 mm (8") of travel available for releasing the spring after the ram has taken up some pressure on the head of the unit.

WARNING
To prevent personal injury, a heavy iron or steel barred shield, or the equivalent should be positioned between the operator and the spring brake when being disassembled (Fig. 6).

5. Apply about 11,120 N (2,500 lbs) force on the unit. Remove clamp band bolt and nuts and clamp ring (Fig. 6).
6. Slowly release the shop press until the spring brake chamber can be separated and the spring brake diaphragm can be removed (Fig. 7).

WARNING
If pressure remains between the ram and the actuator, either the spring brake 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 (Fig. 8).

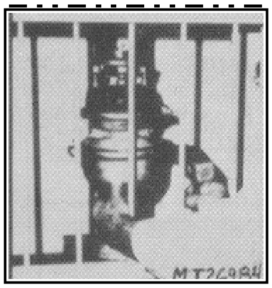


Fig. 6

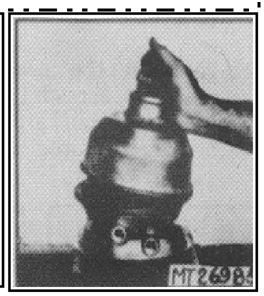


Fig 7

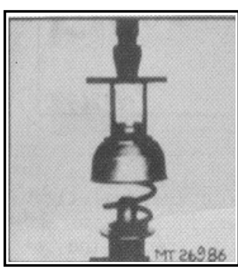


Fig. 8

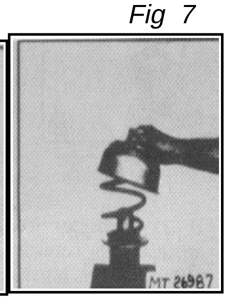


Fig. 9

7. Lift off the head-spring piston subassembly with care since the power spring is caged between the piston and head (Fig. 9).
8. Remove the diaphragm. When the diaphram is removed, inspect the inside of the flange case, return spring, pushrod plate, screw and plastic guide rings. If the condition of these parts are questionable refer to the text covering REPLACE SPRING BRAKE SUSPECED DEFErIVE PUSHROD SEAL.
9. Position new spring brake diaphragm in the spring brake head and install both on top of the flange case. Position the complete assembly in the press with a slit-tube type adapter between the press ram and the head of the spring brake unit.
10. Be sure the parts are lined up and apply 2.668-3.559 kN (600-800 lbs) force to compress the return spring between the diaphragm and the two housings.
11. While the assembly is compressed the spring brake chamber clamp band can now be assembled. Tap the clap band all the way around while tightening the clamp band nut to insure proper seating. Tighten nuts to 27-34 N.m (20-25 ft lbs).
12. Reinstall the brake chamber assembly and manually reset the spring brake unit as instructed in the REINSTALL instructions.

REPLACE SPRING BRAKE UNIT OR SERIVICE BRAKE DIAPHRAGM

1. Block wheels to prevent vehicle from moving.
2. Manually release the spring brakes (refer to MIAL RELEASE OF *SPRING* BRAKE). After releasing brakes release the air pressure in the parking brake system *by* placingthe parking brake control in 'apply position.
3. To ease the installation, the service brake pushrod should be extended. Extending the pushrod can be accomplished by manually pushing back the slack adjuster or by application of the service brakes. While the pushrod is extended, a locking type pliers should be used to retain the Pushrod in the extended position (Fig. 10). Then release the service brakes or slack adjuster.
4. Remove air hoses from parking brake and service brake chambers. Tag hoses for proper identification at reassembly.

5. Remove service brake chamber clamp band assembly (clamp closest to mounting bolts).
6. New spring brake unit should have release bolt fully extended outward, like a manual released unit.

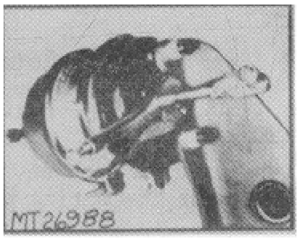


Fig. 10

7. Inspect diaphragm, return spring and inside of non pressure (service brake) chamber. Replace any worn or damaged parts.
8. If service brake diaphragm is being replaced, position diaphragm on brake chamber.
9. Position spring brake unit (new if replaced or old if only service brake chamber diaphragm being replaced) on service brake chamber half. Align air hose ports.
10. Install clamp band. Tap the clamp band all the way around while tightening the clamp band nuts to insure proper seating. Tighten nuts to 27-34 N.m (20-25 ft lbs).
11. Apply sealing compound to hose fittings and install fittings and air hoses. Torque fittings to 34 N.m (25 ft lbs). Do not use impact wrench on air fittings.
12. Apply air to service brakes. Remove locking pliers and check for air leaks.
13. Adjust service brakes as outlined in the Service Manual Section which applies.
14. Apply air to spring brake by pushing control at instrument panel to release mode. Turn release bolt clockwise to manually set spring brake. Turn bolt until it is fully engaged into the unit and the slotted nut bottoms on the unit. Tighten nut to 61-68 N.m (45-50 ft lbs). Do not use an impact wrench.
15. Snap breather cap in place over seal, with arrow on breather cap pointing to the ground.

REPLACE SPRING BRAKE SUSPECTED DEFECTIVE PUSH ROD SEAL

WARNING

Do not attempt to disassemble the rower spring section while unit is on vehicle since it is spring loaded. Sudden accidental release of the power spring will cause spring brake components to be . hurled with dangerous force which could strike persons In the area causing serious personal injury or death.

1. Refer to text REPLACE SPRING BRAKE DIAPHRAGM. Give special attention to the WARNING references. Perform steps 1 thru and including 7 to remove the spring brake chamber. Then perform steps 3, 4 and 5 in the instructions for REPLACE SPRING BRAKE UNIT OR SERVICE BRAKE DIAPHRAGM.
2. Remove the pushrod screw, plate and rod. The screws are secured with Loctite material. To remove the screws and pushrod assembly:
   a. Position a phillips screwdriver handle in a vise so that the blade extends outward.
   b. Heat one of the screws to ease their removal.
   c. Position the case assembly over the phillips screwdriver in the vise; with a second phillips screwdriver loosen and remove the opposite screw (Fig. 11).

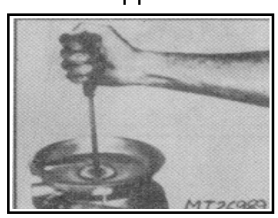


Fig. 11

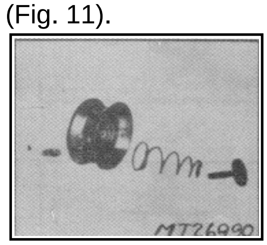


Fig. 12

   It is important to hold the case tight against the screwdriver in the vise and slowly remove pressure to prevent the return spring from releasing suddenly. Remove all parts from the case (Fig. 12).
3. Wash all parts in cleaning solvent.
4. Remove guide rings and pushrod seal (Fig. 13). The seal can be removed by inserting a small screwdriver behind the seal and carefully pry the seal out of the groove as shown in Fig. 14

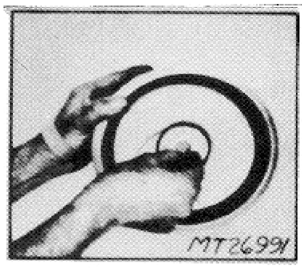


Fig. 13

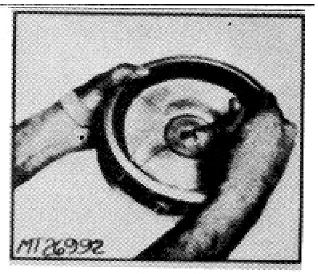


Fig. 14

5. Clean seal groove. Lubricate the groove and the new seal with an IH 251H EP grease or equivalent to NLCI #2 multi purpose lithium grease. Install the new seal. Be sure the seal is seated, by running your finger around the seal inside diameter and press seal in place.
6. Position a new guide ring on each side of the seal (Fig. 13). The wider flange side will be away from the seal. Align the skive cuts approximately 1800 apart.

7. Install smaller pushrod plate on pushrod if it was removed. Be sure to thoroughly clean screw threads and threaded holes in the pushrod. Apply Loctite General Purpose Lock N' Seal to the screw threads. Install screw to secure small plate in place. Tighten screw to 20 N.m (15 ft lbs).

8. Apply a small amount of lubricant to tip of pushrod and insert the pushrod through the seal from the service brake chamber side of case.

9. Position return spring in case and compress spring with large pushrod plate so that the screw can be threaded in the pushrod. Use General Purpose Lock N' Seal on the screw. Tighten this screw to 20 N.m (15 ft lbs). The large pushrod plate must be toward the spring brake side of unit. The screws can be tightened using one screwdriver in a vise to hold one screw and tighten the opposite screw (refer to step 2).

10. Check the alignment of return spring in case and to large pushrod plate. Straight alignment is important for positive rod sealing.

11. Inspect the diaphragms; replace them if damaged or more than a year old.

12. To complete the reassembly of the unit refer to REPLACE SPRING BRAKE UNIT OR SERVICE BRAKE DIAPHRA(G and complete steps 9, 10 and 11. Then complete steps 10, 11, 12 and 13 of REPLACE SPRING BRAKE DIAPHRAGM.

SERVICE SPRING BRAKE UNIT WITH SUSPECTED DEFECTIVE POWER SPRING OR DEFECTIVE RELEASE MECHANISM

WARNING

Do not attempt to disassemble power spring unit while it is on the vehicle; even though a broken power spring is confirmed, it is important to manually release the spring brake unit before any disassembly is performed. Accidental release of the power spring will cause spring brake components to be hurled with force which could strike persons in area causing serious personal injury or death. Refer to MANUAL RELEASE OF SPRING BRAKE.

1. Refer to text REPLACE SPRING BRAKE DIAPHRACM. Pay special attention to the CAURION references. Perform steps 1 thru and including 7 to remove spring brake head assembly.

2. Use a 3.175 mmn (1/8") diameter punch. Support the release bolt and knock out lock pin in release bolt as illustrated in Fig. 15. Then remove the slotted release nut.

3. Use a screwdriver to pop off the piston plug in the center of the piston (Fig. 16).

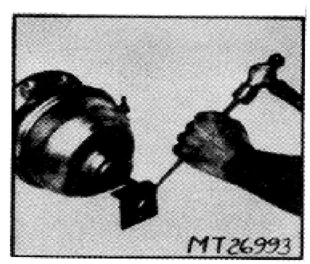


Fig. 15

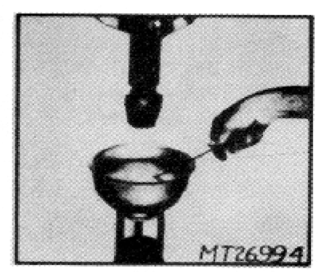


Fig. 16

4. Insert head-spring piston subassembly in press (Fig. 17). It is important to position one 356-381 mn (4-5"') diameter slit-tube under the assembly supporting the piston and another one over the assembly between the head and the flat plate under the press ram. Without these tubes, the final safe disassembly cannot be accomplished. After the ram touches the plate, the ram must be able to travel a minimum of 203 mm (8") away from the assembly. Without the length of travel available the spring will not completely relax.

STEERING

CONTENTS

STEERING

POWER STEERING PUMP

EATON

HEAVY DUTY ROLL VANE-TYPE

PUMP WITH INTEGRAL RESERVOIR

CONTENTS

CONTENTS (Cont'd.)

DESCRIPTION

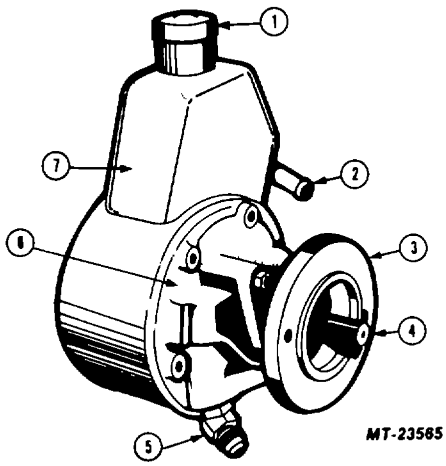


Fig. 1 Eaton Heavy Duty Roll Vane Pump

1 Reservoir Cap
2 Oil Return Inlet
3 Pump Mounting Flange
4 Pump Shaft
5 High Pressure Line Fitting
6 Pump Housing
7 Reservoir

The housing and internal pump parts are located inside the reservoir so that the pump parts operate submerged in oil. The reservoir is sealed against the pump housing, leaving the housing face and shaft hub exposed. A shaft seal and non-replaceable bushing are pressed into the housing from the front. The drive shaft is inserted through this seal and bushing. A large cavity in the rear of the housing contains the rotating pump parts. A smaller cavity contains the flow control valve and spring.

The Eaton heavy duty roll vane pump can be gear or belt driven. Both configurations are used on International trucks.

MAINTENANCE

FLUID LEVEL

1. Run engine until power steering fluid reaches normal operating temperature, approximately 800C (1700F), then shut engine off. Remove reservoir filler cap and check oil level on dipstick.
2. If oil level is low, add power steering fluid to proper level and replace filler cap. For lubrication intervals, refer to Operator’s Manual. For types of lubricant recommended refer to Lubrication Section CTS- 4033.
3. When checking fluid level after the steering system has been serviced, air must be bled from the system. Proceed as follows:

   a. With wheels turned all the way to the left add power steering fluid to level indicated on dipstick.

   b. Start engine, and running at idle, recheck fluid level. Add fluid if necessary.

   c. Bleed system by turning wheels from side to side without hitting stops. Maintain fluid level so it is just visible in the reservoir. Fluid with air in it will have a light tan or milky appearance. This air must be eliminated from fluid before normal steering action can be obtained.

   d. Return wheels to center position and continue to run engine for two or three minutes, then shut engine off.

   e. Road-test vehicle to make sure steering functions normally and is free from noise.

   f. Recheck fluid level as described in Steps 1 and 2.

BELT TENSION

A belt that has been previously tensioned is considered to be a used belt and should be tightened to from 245 to 311 Newtons (55 to 70 lbs.). A belt that has never been tensioned is considered to be a new belt and should be tightened to 445 Newtons (100 lbs.).

Place Belt Tension Gage SE-2312, or equivalent, midway between the pulleys on drive belt being checked.

BELT ADJUSTMENT

When adjusting a power steering pump belt, never pry against the pump reservoir or pull against the filler neck. To increase belt tension move the pump outward by prying against the bracket pry lugs or against the pump housing casting extension directly behind the pump drive pulley.

1. When power steering pump is driven by a single belt:
   a. Loosen the pump attaching bolts and adjust the belt to correct tension by moving the pump outward, away from the engine.
   b. Snug all pump mounting bolts and remove pry bar.

c. Tighten all pump mounting bolts to specified torque.

d. Check belt tension.

2. When the power steering pump is driven by two belts in a matched set:

a. Follow same checking and adjusting procedure as 1 above, but if it is necessary to replace one belt, both must be replaced by a new matched set to equalize belt tension in both belts. Check tension in both belts.

3. When the power steering pump pulley is driven by one primary belt and is used as an idler for a second belt driving some other accessory:

a. Follow same checking and adjusting procedure for the primary power steering pump drive belt as for above.

b. Recheck and adjust as necessary the pump belt tension after adjusting tension on belt driving the other accessory.

DIAGNOSTIC INFORMATION

GENERAL INFORMATION

Complaints of faulty steering are frequently the result of problems other than the pump. Those areas of the steering system which can be easily checked and quickly corrected without disassembly and overhaul of any major components should be attempted first.

Conditions such as hard or loose steering, road shock or vibrations are not always due to the steering gear or pump, but are often related instead to such factors as low tire pressure and front end alignment. These factors should be checked and corrected before any adjustment or disassembly of the power steering pump is attempted.

Many factors affect proper operation of the steering system, of which the most common are:

1. Fluid level and condition.
2. Drive belt tension.
3. Loose component mountings.
4. Loose pump pulley nut.

These factors must be checked and corrected before making any further diagnosis of the steering system. The need for proper diagnosis cannot be overemphasized.

After the source of the problem has been found, determine the cause. For example, if the oil level in the reservoir is found to be low, refill and check the entire hydraulic system for oil leaks. Refilling the reservoir will not necessarily correct the problem.

When reference is made to power steering gear components in the following charts, it will be necessary to determine which gear the vehicle is equipped with, and then refer to the appropriate manual in your CTS-4001 Truck Service Manual for gear adjustment and repair procedures.

DIAGNOSTIC CHARTS

CONDITION	POSSIBLE CAUSE	CORRECTION
Chirp noise in steering pump	1 Loose belt	1 Adjust belt tension to specification.
Belt squeal (particularly noticeable during steering at full wheel travel and standstill parking)	1 Loose belt	1 Adjust belt tension to specification.
Growl noise in steering pump	1 Excessive back-pressure in hoses or steering gear caused by restriction	1 Locate restriction and correct. Replace part if necessary.
Growl noise in steering pump (particularly noticeable at standstill parking)	1 Scored pressure plates or carrier 2 Extreme wear of cam ring and rolls	1 Replace parts and flush system. 2 Replace parts.

CONDITION	POSSIBLE CAUSE	CORRECTION
Groan noise in steering pump and check for leaks.	1 Low oil level 2 Air in the oil Poor pressure hose connection	1 Fill reservoir to proper level 2 Tighten connector to specified torque Bleed system by operating steering from right to left - full turn.
Rattle or knock noise in steering pump	1 Loose pump pulley nut	1 Tighten nut to specified torque. If pulley is still loose, both the pulley and pump shaft must be replaced.
Momentary increase in effort when turning wheel fast to right or left	1 Low oil level 2 Loose belt 3 High internal leakage	1 Fill reservoir to proper level and check for leaks. 2 Adjust belt tension to specification 3 Check pump flow and pressure. (See Power Steering System Test Procedure)
Steering wheel surges or jerks when turning with engine running especially during parking tion	1 Low oil level 2 Loose belt 3 Insufficient pump pressure 4 Sticky flow control valve	1 Fill reservoir to proper level and check for leaks. 2 Adjust belt tension to specifica- 3 Check pump pressure (See Power Steering System Test Procedure) Replace relief valve if defective Replace pumping elements if excessively worn. 4 Inspect for varnish and small nicks or damage on valve Replace if necessary.
Foaming milky power steering fluid	1 Low oil level 2 Air in the fluid 3 Hard shaft seal	1 Fill reservoir to proper level and check for leaks. 2 Bleed air from system. 3 If oil level is correct and pump still foams, check shaft seal for excessive hardening or wear. Extremely cold temperatures will cause system aeration with these conditions Replace shaft if excessively worn at seal area.
Low pressure to steering gear	1 Flow-control valve stuck or inoperative 2 Pressure plate not flat against cam ring 3 Extreme wear of cam ring and rolls 4 Scored pressure plate or carrier 5 Cracked or broken thrust or pressure plate	1 Remove burrs or dirt; replace. 2 Correct. 3 Replace parts Flush system. 4 Replace parts Flush system. 5 Replace part.

CONDITION	POSSIBLE CAUSE	CORRECTION
Low pressure to steering gear (Cont'd.)	6 Low oil level 7 Loose belt	6 Fill reservoir to proper level and check for leaks. 7 Adjust belt tension to specification
Hard steering or lack of assist especially in parking	1 Loose belt 2 Low oil level 3 Steering gear to column misalignment 4 Lower coupling flange rubbing against steering gear 5 Tires not properly inflated 6 Cracked or broken pressure plate or cam ring 7 Missing housing ball plug or cracked housing	1 Adjust belt tension to specification 2 Fill reservoir to proper level and check for leaks. 3 Align steering column 4 Loosen pinch bolt and assemble properly 5 Inflate to recommended pressure 6 Replace parts. 7 Replace part.
Note: If checks 1 through 7 do not reveal cause of hard steering, refer to Power Steering System Test Procedure	Further possible causes could be: 8 Sticky flow control valve 9 Insufficient pump pressure output 10 Excessive internal pump leakage 11 Excessive internal system leakage	In order to diagnose conditions such as listed in 8, 9, 10 and 11, a test of the entire power steering system is required.

POWER STEERING SYSTEM TEST PROCEDURE

This -section presents a systematic method of diagnosing and trouble shooting the power steering hydraulic system. Start with Step 1 and move consecutively through the remaining steps completing every procedure and if necessary, the correction described before moving on.

1. Disconnect pressure hose at pump or gear and connect power steering analyzer SE-2780 (Fig. 2) in series with the pressure hose.

2. Open valve on analyzer and start engine. Allow power steering system oil to reach normal operating temperature and check analyzer connections for leaks. Correct if necessary.

3. Check fluid level in system and add fluid as required.

4. With engine at idle, record flow and pressure. If pressure is in excess of 517 kilopascals (75 PSI), check hoses for restrictions and correct as required.

5. With engine at idle, partially close valve on analyzer to build 4826 kilopascals (700 PSI) and record flow. Subtract this flow from the flow recorded in Step 4. Flow should not drop more than 3.8 1/MIN (1 GPM). If flow drops more than 3.8 1/MIN (1 GPM), check rotating group (cam ring, rolls and carrier) in pump and correct as required.

6. Close and partially open analyzer valve three times. Record the highest pressure each time the valve is closed.

> IMPORTANT
> Do not leave valve fully closed for more than five seconds as the pump could be damaged.

All three readings must be within the listed specifications and must not vary more than 345 kilopascals (50 PSI). If readings do not meet this criteria, check for loose belt. If no problem exists with belt, replace pump flow control valve.

7 Increase engine speed to 1500 RPM and record flow. Subtract this flow from the flow recorded in Step 2. Flow should not vary more than 3.8 1/MIN (1 GPM). If flow does vary more than 3.8 1/MIN (1 GPM), remove flow control valve and clean. Check oil condition. If oil is dirty, disassemble pump and gear, clean and reassemble.

8. With engine idling, turn wheel slightly in both directions and observe pressure readings. Release wheel quickly; if pressure does not snap back, disassemble and clean gear hydraulic control valve. If oil is dirty, disassemble and clean gear and pump.

9 With engine idling, turn and hold wheel against wheel stops in both directions. A noticeable drop in pressure should occur as the wheel hits the stops. If no drop, or a rise in pressure occurs, adjust steering gear relief plungers (if so equipped) or replace steering gear relief valve (if so equipped) to correct.

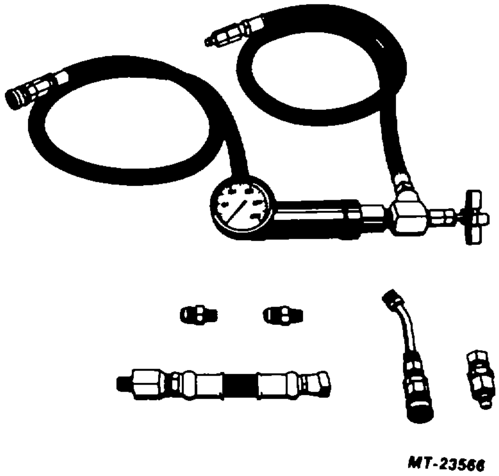


Fig. 2 SE-2780 Power Steering Analyzer

EXTERNAL LEAKAGE DIAGNOSIS

The adjacent diagram has been prepared to show the potential areas of leakage. If leakage occurs in the areas shown, perform the operation described.

When diagnosing external leakage, always check for the possibility of system overheating. An indication of overheating is when the majority of the pump gaskets become hard and brittle within 48,000 kilometers (30,000 miles) of vehicle operation. Some gaskets normally harden during routine operation, therefore it is important to determine if the majority of the gaskets are hard and brittle. Another indication of overheating is when the power steering fluid has decomposed and significantly darkened interior pump surfaces. Occasionally a "burnt" oil odor will be noticeable with overheated systems. Overheating is normally caused by restricted lines causing excessive back pressure or by severe operating conditions. A complete gasket overhaul and/or addition of a cooler may be required.

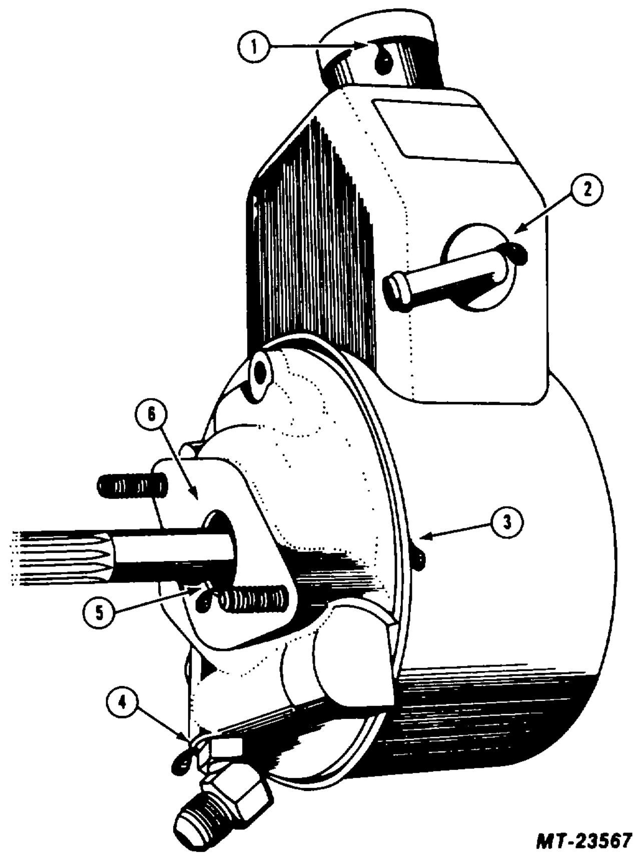


Fig. 3 Suspected Leakage Areas

1. Check oil level. An overfilled pump reservoir can be a cause for leakage. The oil in the steering system expands as heated during normal usage. If overfilled the excess is forced through the reservoir cap vent. Operate the engine and steering system until nor-mal operating temperature is obtained. Remove the reservoir cap and check level. Adjust the oil level as required. If leakage persists with the oil level correct and the cap tight, replace the cap.

Air in the system can also cause fluid level to rise, especially after system repair. Bleed the system as described in the MAINTENANCE section of this chapter.

2. Replace reservoir.

3. Replace reservoir gasket seal.

4. Tighten fitting to specified torque. If leakage persists, replace O-ring seal.

   If either the return hose or the pressure hose leaks, other than at the nut connections, replace the hose.

5. Replace drive shaft seal after inspecting and thoroughly cleaning the sealing surface. Replace drive shaft if severe wear is found at sealing locations. If the corrosion in the lip seal contact zone is slight, clean the surface of the shaft with crocus cloth. Always replace the seal if the shaft is replaced.

   On certain Cummins direct drive applications, leaks in this area will cause migration of engine oil into the pump. If the seal does not appear excessively hardened, correct excessive pressure condition in the engine pump mounting area cavity. Modification to the engine is required.

6. Clean all gasket surfaces removing old gasket material and replace with new O-ring seal.

INSTALLATION AND REMOVAL
INSTALLATION
Belt Driven Pump

1. If removed, reinstall pump mounting bracket. Tighten mounting bolts to specified torque.
2. Position pump assembly on engine with holes lined up and install bolts loosely.
3. Install pulley. Insure that key remains in groove to avoid seal damage. Install pulley retaining bolt finger tight.
4. Connect and tighten hose fittings to specified torque.
5. Fill reservoir. Bleed pump by turning pulley backward (counter-clockwise as viewed from front) until air bubbles cease to appear.
6. Install pump belt over pulley.
7. Adjust belt tension and tighten pump mounting bolts to specified torque. See BELT TENSION and BELT ADJUSTMENT.
8. Tighten pulley retaining bolt to specified torque.
9. Bleed system per FLUID LEVEL section of this manual.

Gear Driven Pump

1. Remove any existing gasket material from the pump mounting flange and corresponding engine mounting surface. Mount pump and reservoir assembly and accessory drive coupling on engine using a new gasket. Tighten mounting bolts to specified torque,
2. Connect and tighten hose fittings to specified torque.

3. Fill reservoir and bleed system per FLUID LEVEL section of this manual.

REMOVAL

Belt Driven Pump
1. Disconnect both hoses at pump, taking care not to bend hoses any more than absolutely necessary. (With time and temperature exposure, hoses may take a "set" and will not have the flexibility of a new hose). When both hoses are disconnected, secure ends in raised position to prevent drainage of oil. Protect hose ends to avoid contamination of system.
2. Install caps at both pump fittings to prevent drainage of oil from pump.
3. Loosen pulley retaining bolt. Then loosen bracket mounting bolts to relieve belt tension.
4. Remove belt and pulley.
5. If pump is to be disassembled, remove pump and mounting bracket as an assembly. If pump is not to be disassembled, the mounting bracket may remain attached to the engine.

Gear Driven Pump
1. Disconnect both hoses at pump, taking care not to bend hoses any more than absolutely necessary. (With time and temperature exposure, hoses may take a "set" and will not have the flexibility of a new hose). When both hoses are disconnected, secure ends in raised position to prevent drainage of oil. Protect hose ends to avoid contamination of system.
2. Install caps at both pump fittings to prevent drainage of oil from pump.

3. Remove mounting flange to engine bolts and remove pump assembly with flange from vehicle.

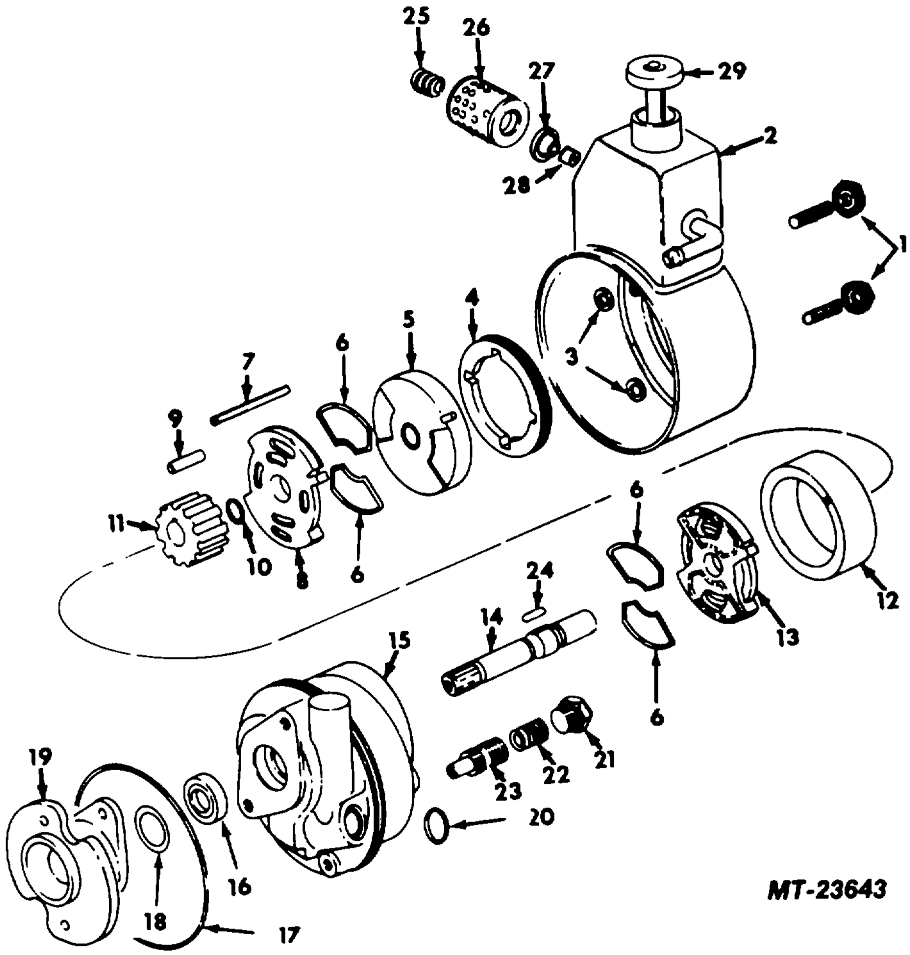


Fig. 4. Pump Components

SERVICE

Refer to Figure 4 to aid service procedures.

OIL FILTER REPLACEMENT

1. Remove pump from vehicle. See INSTALLATION AND REMOVAL section of this manual. Drain oil from reservoir.

2. Place pump in a bench vise using the mounting flange (gear driven pump) or mounting bracket (belt driven pump) to hold pump.

IMPORTANT
Do not clamp vise on pump housing or reservoir,

3. Mark position of reservoir on pump housing to provide proper location during reassembly.

4. Remove reservoir retaining nuts, Figure 5.

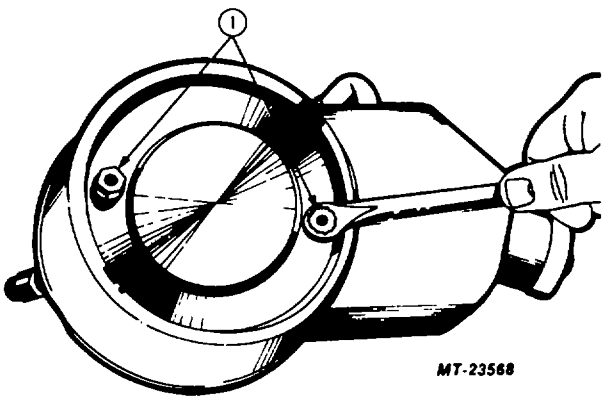


Fig. 5 Remove Retaining Nuts
1 Reservoir Retaining Nuts

5. Remove reservoir by rapping the side of the reservoir with the hand until the reservoir rotates slightly on the pump housing.

IMPORTANT
Do not pry on reservoir flange to remove reservoir

6. To remove filter element, insert a screwdriver behind the spring and pry the spring out, The filter element can then be removed. There is also a loose filter element guide that fits over the end of the return tube on the inside of the reservoir, Figures 6 and 7. Clean interior of reservoir and components with clean solvent and air dry.

7. To install filter element, slide the guide over the end of the return tube with the long end of guide toward reservoir wall. Some units are equipped with a spacer which should be placed over the return tube prior to installing the guide.

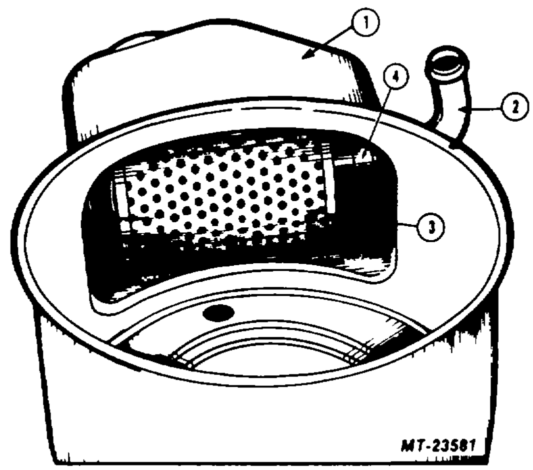


Fig. 6 Filter Location
1 Reservoir
2 Oil Return Inlet Tube
3 Filter Element
4 Filter Guide

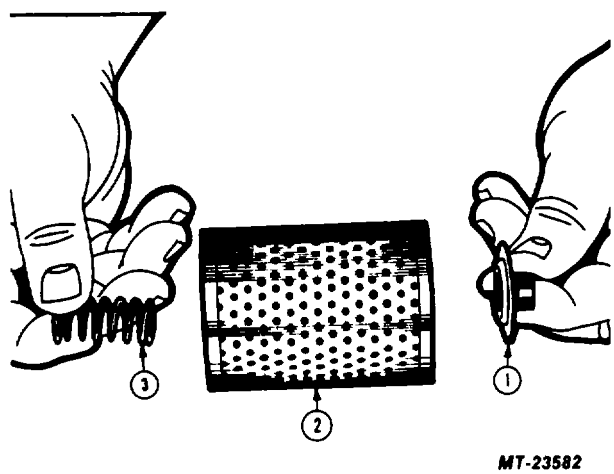


Fig. 7 Filter Components
1 Filter Guide
2 Filter
3 Spring

Insert the spring into the cupped or closed end of the filter element. Position the open end of the filter element over the guide and force the spring into place in the recessed area of the reservoir neck.

8. Replace reservoir gasket and sealing washers on inside of reservoir (Figure 8) and install reservoir. Seat reservoir by placing a wood block against rear of reservoir and rapping block with a hammer.

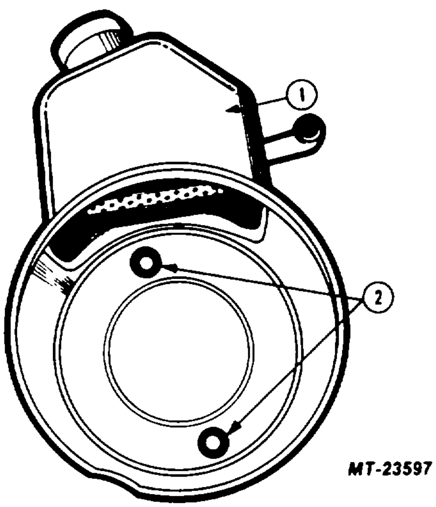


Fig. 8 Sealing Washer Location
1 Reservoir
2 Sealing Washers

9. Install reservoir retaining nuts and tighten to specified torque.

10. Reinstall pump assembly on vehicle. See INSTALLATION AND REMOVAL section of this manual.

PUMP SHAFT OIL SEAL REPLACEMENT (PUMP ASSEMBLED)

1. Remove pump assembly from vehicle. See INSTALLATION AND REMOVAL section of this manual. Remove mounting flange (gear driven pump only) and coupling (if equipped).
2. Place Seal Remover SE-2839 over pump shaft. Apply downward pressure on top of tool and screw tool into seal material until firmly seated, Figure 9.
3. Thread tool bolt into tool and against top of

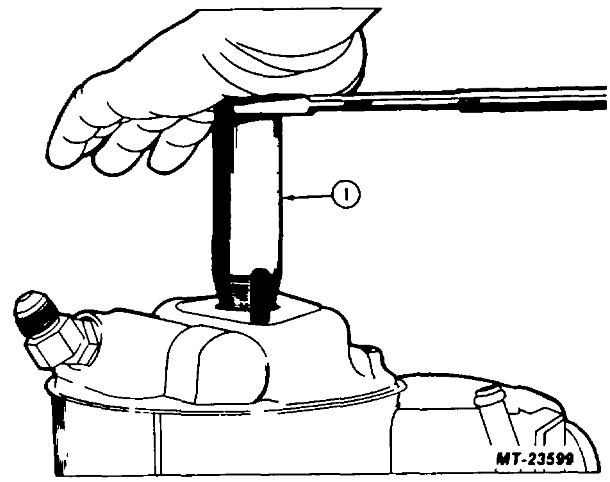


Fig.9 Seating Seal Remover Tool
1 Seal Remover SE-2839

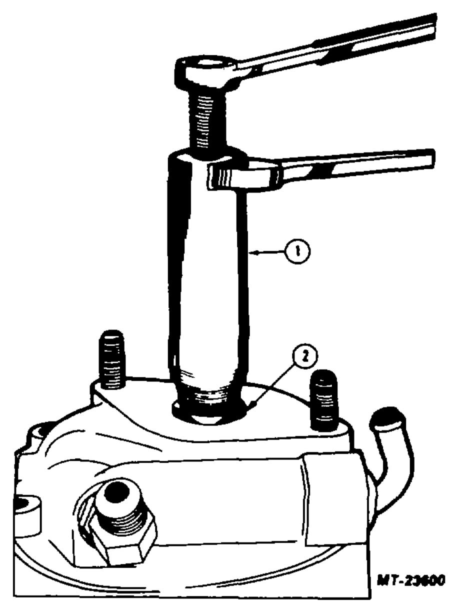


Fig. 10 Removing Shaft Seal
1 Seal Remover SE-2839
2 Pump Shaft Oil Seal

4. Lubricate new shaft seal with same type of pump shaft until tool and seal are drawn out fluid as used in pump, then slide seal over shaft with metal side of seal upward.

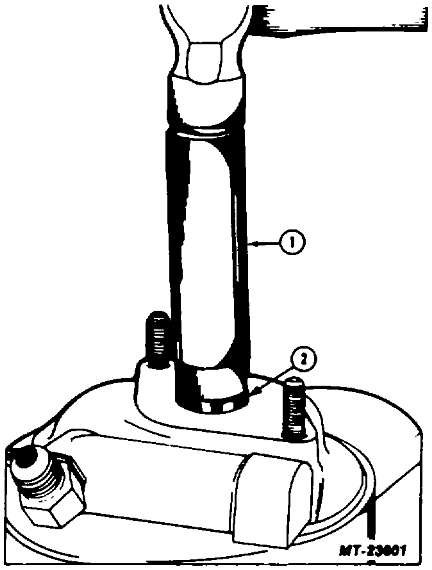


Fig. 11 Installing Shaft Seal

1 Seal Installer SE-2840
2 Pump Shaft Oil Seal

5. Install new seal using Seal Installer SE-2840, Figure 11. Seal should be bottomed in seal bore but be careful not to crush seal cage.

6. After cleaning flange to pump mating surfaces, reinstall pump mounting flange (gear driven pumps only) using a new O-ring. Tighten mounting bolts to specified torque.

   Reinstall drive coupling and nut (some units also have a washer) if so equipped and tighten to specified torque.

7. Reinstall pump on vehicle. See INSTALLATION AND REMOVAL section of this manual.

DISASSEMBLY

Before disassembly of pump, remove reservoir filler cap and drain oil from reservoir by inverting the pump so oil may drain out the filler neck.

After oil is drained from reservoir, cap should be replaced and the entire pump assembly washed in a non-toxic solvent to remove all dirt and prevent any foreign matter from contaminating pump components.

IMPORTANT

Examine exposed part of drive shaft. If it is corroded, use crocus cloth to remove corrosion before disassembling pump. This will prevent damage to the shaft bushing which might require replacement of the entire housing.

1. Place pump in a bench vise using the mount- ing flange (gear driven pump) or mounting bracket (belt driven pump) to hold pump.

IMPORTANT

Do not clamp vise on pump housing or reservoir.

2. Mark location of reservoir on pump housing to provide proper location during reassembly
3. Remove reservoir retaining nuts, Figure 12.

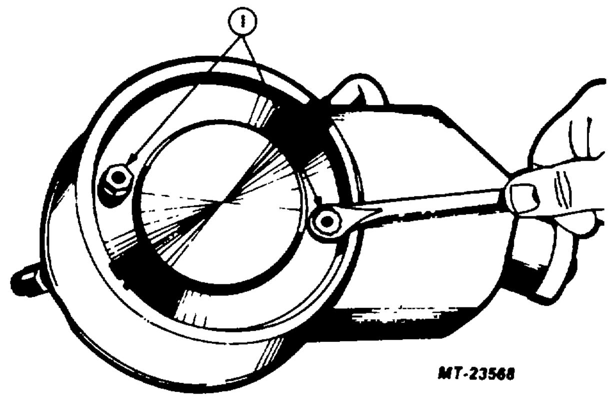


Fig. 12 Remove Rationing Nuts

1 Reservoir Retaining Nuts

4. Remove reservoir by rapping the side of the reservoir with the hand until the reservoir rotates slightly on the pump housing.

IMPORTANT

Do not pry on reservoir flange to remove reservoir.

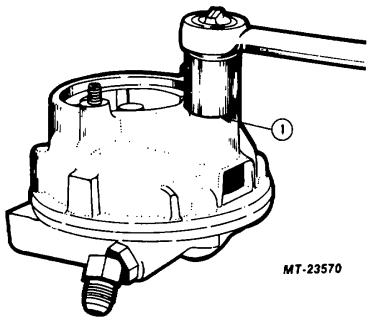


Fig. 13 Remove Valve Cap

1 Flow Control Valve Cap

5. Loosen but do not remove flow control valve cap, Figure 13.

6. Mark position of discharge fitting in housing to provide proper positioning during reassembly, Figure 14. Loosen but do not remove discharge fitting.

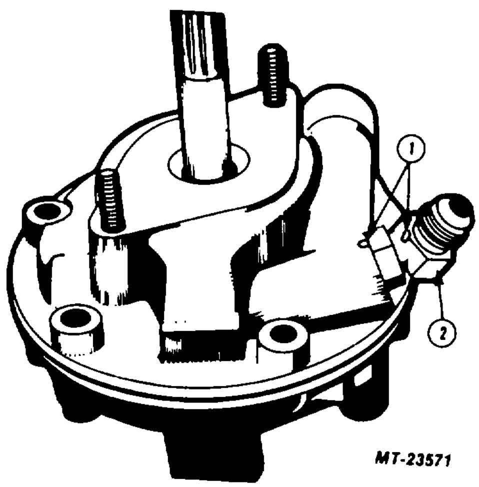


Fig. 14 Mark Fitting Location

1 Alignment Marks
2 Discharge Fitting

7. Loosen but do not remove the large threaded retaining ring in the center of the pump body Figure 15.

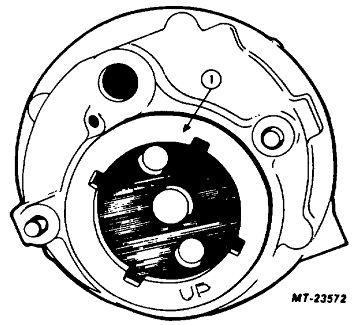


Fig. 15 Ring Location

1 Threaded Retaining Ring

8. Use tool SE-2838 to loosen retainer ring,

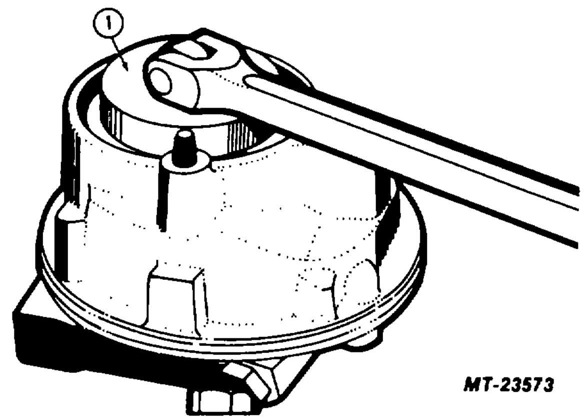


Fig. 16 Removing Retainer Ring

1 SE-2838

9. At this point, the pump may be removed from the vise for the remaining disassembly procedures.

10. Remove mounting flange (gear driven pumps) and coupling (if equipped) or mounting bracket (belt driven pumps).

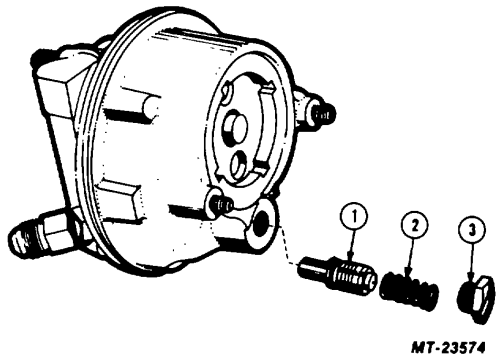


Fig. 17 Valve Components

1 Flow Control Valve
2 Spring
3 Valve Cap

11. Remove flow control valve cap and flow control valve components, Figure 17.

12. Remove discharge fitting and discard O-ring, Figure 18.

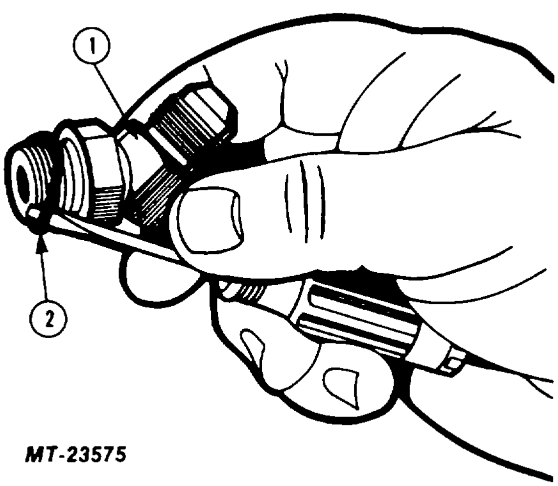


Fig. 18 Remove O-Ring

1 Discharge Fitting
2 O-Ring

13. Remove threaded retainer ring.

14. Remove pump cover. Tap end of drive shaft lightly to aid removal if necessary.

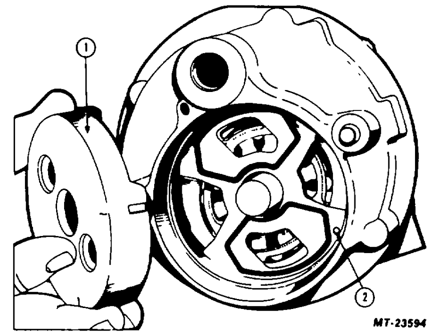


Fig. 19 Pin Location

1 Pump Cover
2 Locating Pin

IMPORTANT
Some pump housing will be drilled with two locating pin holes. Note position of pin for proper location during reassembly, Figure 19.

15. Remove rear end plate and discard O-rings.

16. Remove the shaft and carrier assembly, roll vanes and then the cam ring, Figure 20.

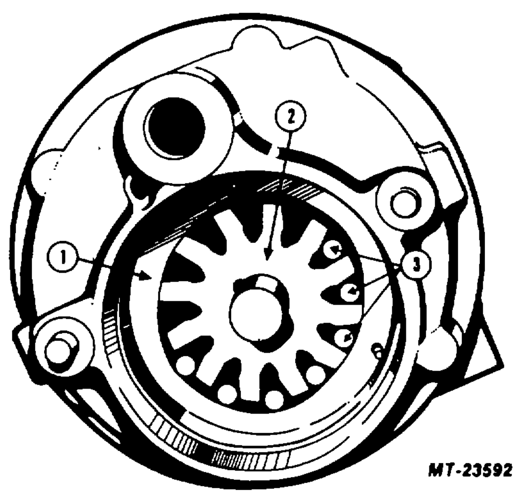


Fig. 20 Remove Components

1 Cam Ring
2 Shaft and Carrier Assembly
3 Rol) Vanes

The cam ring can develop sharp edges from wear. Use a clean shop cloth to remove cam ring to avoid cuts. Remove ring by lifting straight up.

17. Remove front end plate and discard gaskets. Remove locating pin.

18. Remove housing-to-reservoir sealing gasket. Figure 21.

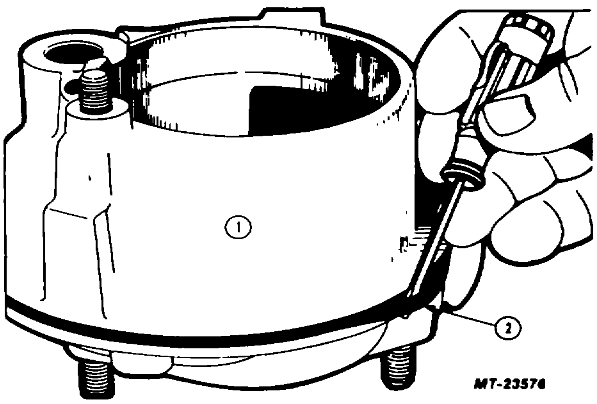


Fig. 21 Remove Gasket

1 Housing
2 Gasket

19. Remove shaft oil seal with a screwdriver being careful not to scratch seal bore or housing bushing, Figure 22.

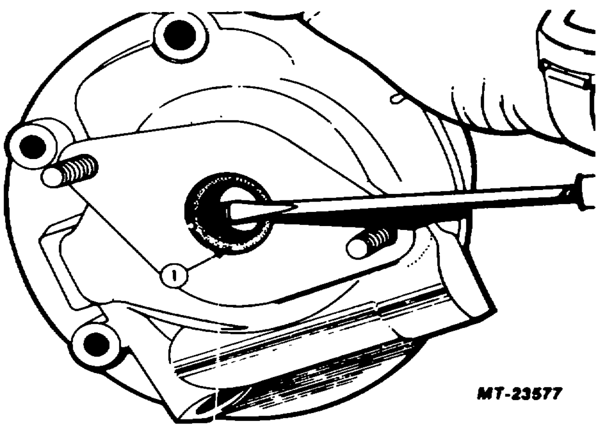


Fig. 22 Remove Seal

1 Shaft Seal

CLEANING, INSPECTION AND REPAIR

Wash all components in a non-toxic solvent, air dry and inspect individually as outlined below.

Component Inspection

Housing - Inspect drive shaft bushing in housing for burning, scoring or oversize condition. The bushing is not serviceable. If bushing is damaged, the housing must be replaced.

Inspect ball plug located near the valve cap. If plug has blown out, it can be driven back in to a depth approximately 6.35 mm (1/4 inch) below the cast surface.

Pump Cover - Inspect drive shaft bushing in cover for burning, scoring or oversize condition. The bushing is not serviceable. If bushing is damaged, replace cover.

Cam Ring - Inspect internal surface of cam ring for wear or scoring. Polish in some areas is normal, but any wear severe enough to raise a noticeable burr on the edge of the cam ring I.D. indicates replacement is necessary.

Shaft and Carrier Assembly - Inspect carrier on the ends of drive tooth faces for excessive wear or scoring. If ends are worn or scored or wear pattern on any of the roll drive faces is greater than 2.3 mm (.09 in.) in width, the carrier must be replaced. Carriers are not serviced alone, but can be replaced as part of a pumping element kit.

Inspect the shaft for any excessive wear, burning, or scoring in the areas of the two bushings and the oil seal. If any of these conditions exist, replacement is required.

Rolls - Inspect each of the twelve rolls for burning, scoring, or wear on the O.D. surface. End Plates - Inspect both end plates for wear, cracks or scoring on the surface opposite the sealing O-rings. Any scoring indicates replacement is required.

Flow Control Valve Assembly - It is difficult to visually determine if a valve is defective. If the pump problem was diagnosed as low pressure, and the pumping element shows no sign of excessive wear, it is probable that the valve needs replaced. The valve must fit and move smoothly in the valve bore.

Pump Shaft Seal Installation

1. Lubricate new shaft seal with same type of fluid as used in pump. Place seal on top of seal bore with metal side of seal upward.

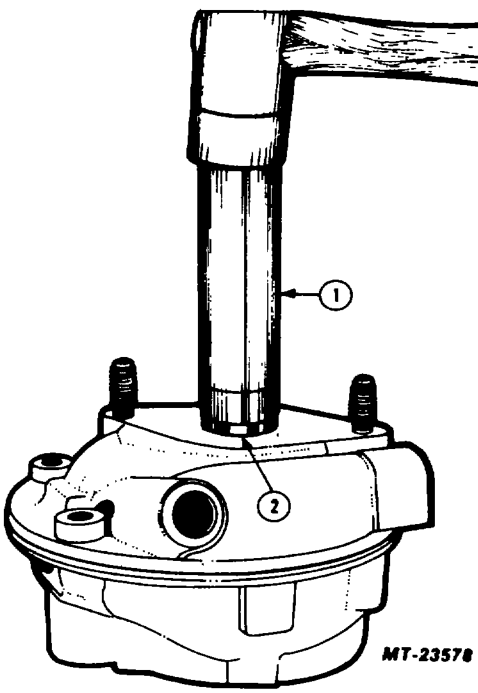


Fig. 23 Installing Shaft Seal

1 Seal Installer SE-2840
2 Shaft Seal

2. Install seal using Seal Installer SE-2840, Figure 23. Seal should be bottomed in seal bore but be careful not to crush seal cage.

ASSEMBLY

IMPORTANT

The figures in this manual section illustrate assembly of a clockwise rotation pump. Certain pumping elements are installed differently for counter clockwise rotation pumps. Where those differences occur, they will be noted in the text but not illustrated.

Internal pump components will be assembled in pump housing as shown in Figure 24.

1. Install new pre-formed gaskets into front end plate, Figure 25. Use a small amount of multi-purpose grease to hold gaskets in place during assembly.

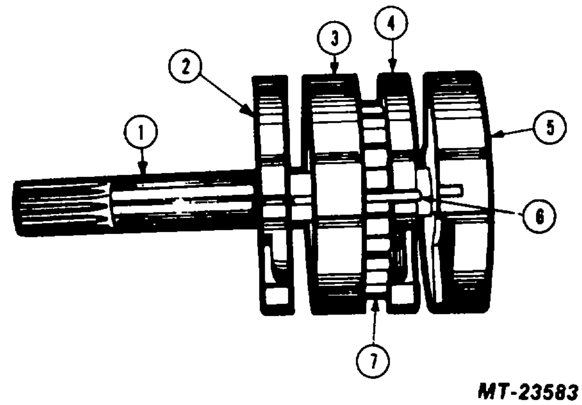


Fig. 24 Internal Pump Components

1 Pump Shaft
2 Front End Plate
3 Cam Ring
4 Rear End Plate
5 Pump Cover
6 Locating Pin
7 Carrier with Rolls

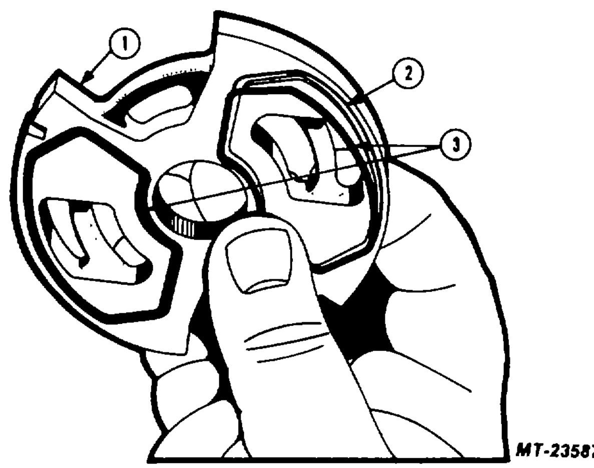


Fig. 25 Installing Pre-formed Gaskets

1 Front End Plate
2 Gasket Grooves
3 Pre-formed Gaskets

IMPORTANT
The front and rear end plates are different and must be assembled in their proper locations for the pump to function correctly. As shown in Figure 26, the front end plate for clockwise rotation pumps contains the oil grooves. For counter clockwise pumps, the end plate without the oil grooves is the front end plate. A correct assembly will align the end plate O.D. large open slots with the large shallow pump housing pocket ports. The end plate gasket side will be away from the pumping elements.

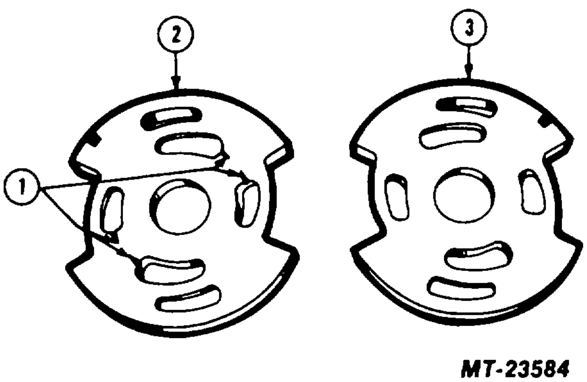


Fig. 26 End Plate Identification

1 Oil Grooves
2 Grooved End Plate
3 No Groove End Plate

IMPORTANT
Two different types of end plates and gaskets are used in this pump assembly. They may be identified by the shape of the gasket grooves in the end plate surface. As illustrated in Figure 27, one type of end plate uses a circular gasket which must be formed into the end plate grooves. The other type uses a pre-formed gasket moulded in the shape of the end plate grooves. Determine which type of end plate is used in the pump being serviced. <u>The different types of gaskets are not interchangeable.</u>

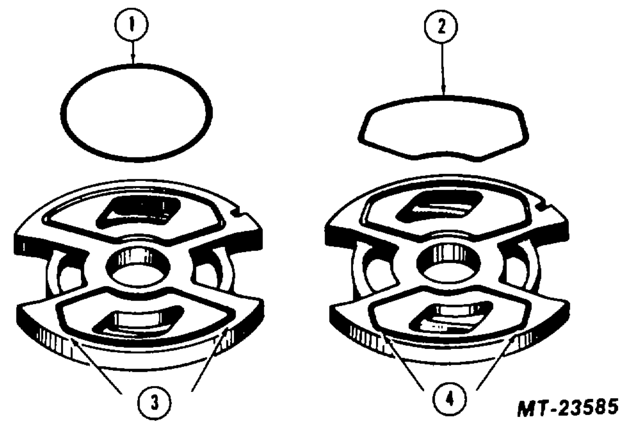


Fig. 27 End Plato and Gasket Identification

1 Circular Gasket
2 Pre-formed Gasket
3 Different on Each Side
4 Same on Both Sides

2. Install locating pin in pump housing, Figure 28. If housing is drilled to accept two pins, install pin in original location as marked during disassembly.

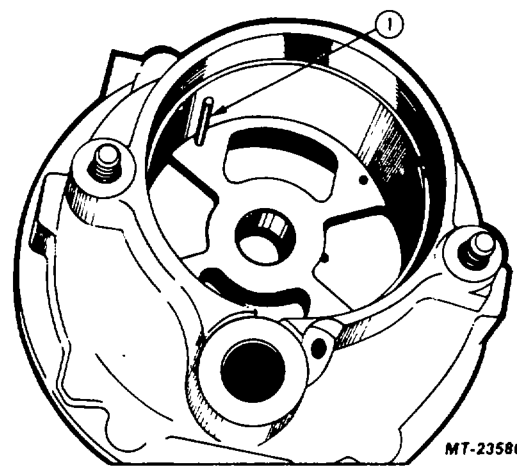


Fig. 28 Locating Pin in Housing

1 Locating Pin

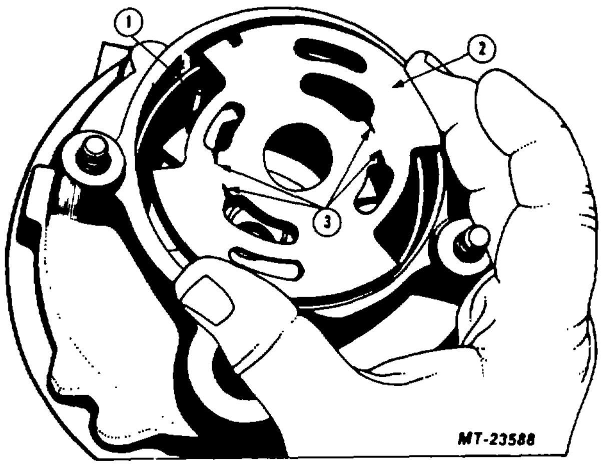


Fig. 29 Installing Front End Plate

1 Locating Pin
2 Front End Plate
3 Oil Grooves

3. Install front end plate in housing with O-ring side down, Figure 29 (CW pump assembly illustrated).

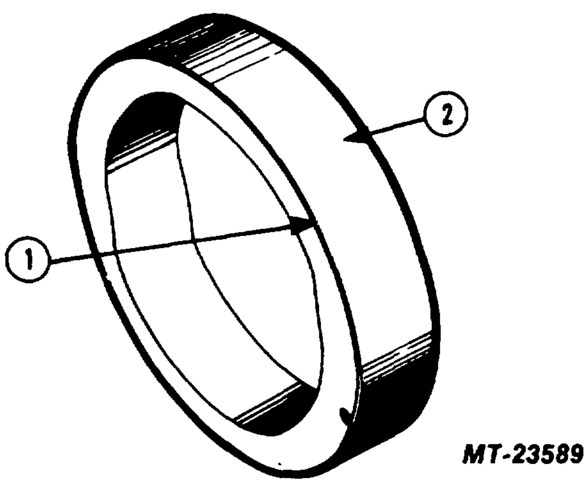


Fig. 30 Chamfered Edge of Cam Ring

1 Chamfered Edge
2Cam Ring

4. Install cam ring into the pump housing positioning it over the locating pin, Figure 31. If pump assembly being serviced is equipped with two locating pins, install second pin at this time.

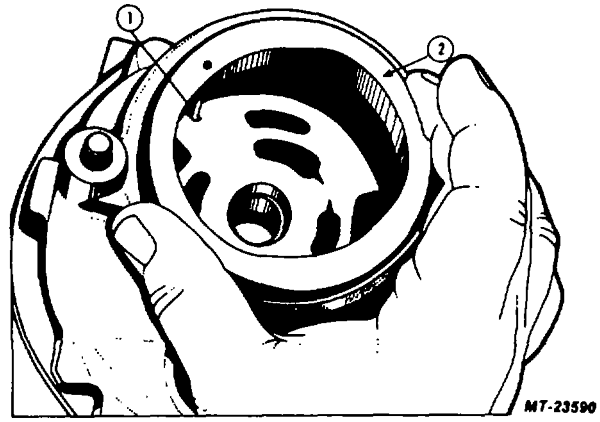


Fig. 31 Installing Cam Ring

1 Locating Pin
2 Cam Ring

> IMPORTANT
> The cam ring has a chamfer on one edge of the ring O.., Figure 30. Install cam ring with chamfered edge down for clockwise pumps and chamfered edge up for counter clockwise pumps.

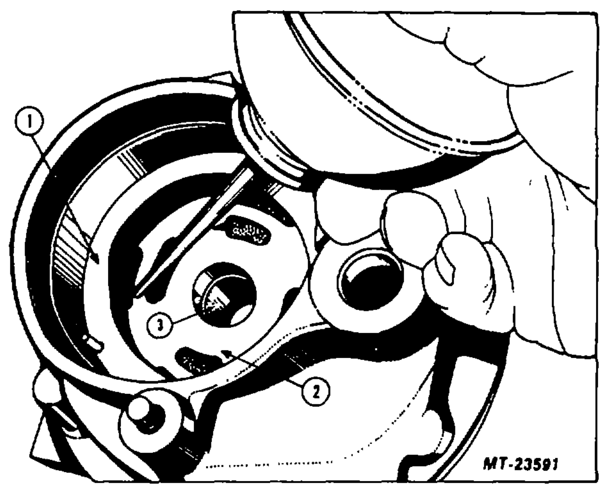


Fig. 32 Lubricate Pump Components

1 Cam Ring
2 Front End Plate
3 Housing Bushing

5. Lubricate the face of the front end plate, shaft bushing and I.D. wall of the cam ring with the same type of fluid as used in the pump, Fig. 32.

6. If shaft and carrier assembly or any of the individual components of the shaft and carrier assembly are being replaced, check orientation of the carrier on the shaft. Looking at the rear of the shaft (opposite driven end), the carrier teeth should be angled to the left as shown in Figure 33 for clockwise pumps and to the right for counter clockwise pumps. Two snap rings are used to hold the carrier to the shaft. Snap rings must be assembled in the grooves closest to each carrier end.

7. Lubricate shaft seal I.D. with a generous amount of multi-purpose grease and install shaft and carrier assembly into pump housing.

8. Insert rolls into carrier and lubricate carrier face and shaft with same type of lubricant as used in pump, Figure 34.

9. Install new pre-formed gaskets into rear end plate. See IMPORTANT notes in Step 1 of assembly procedure.

10. Install rear end plate over locating pin in pump housing with gasket side up, Figure 35.

11. Install cover over the shaft and onto the locating pin, Figure 36. If properly assembled, open slots of body, end plates and cover should align.

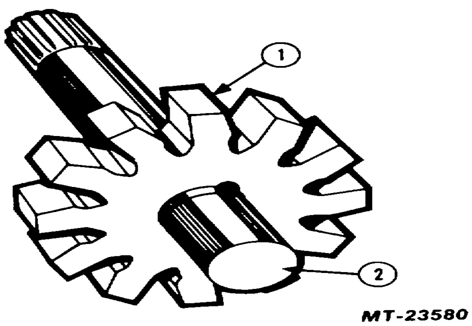


Fig. 33 Proper Carrier Orientation

1 Carrier Teeth
2 Rear of Shaft

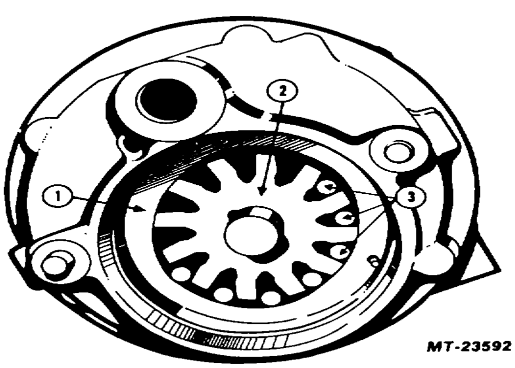


Fig. 34 Inserting Rolls

1 Cam Ring
2 Carrier
3 Rolls

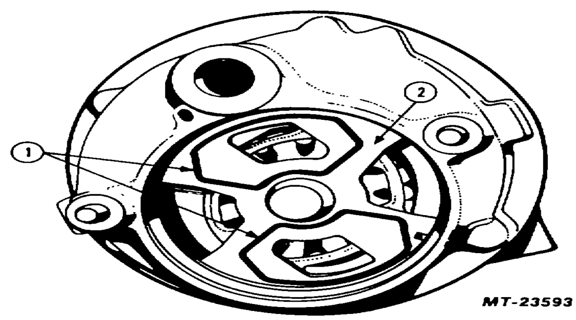


Fig. 35 Installing Rear End Plate

1 Pre-formed Gaskets
2Rear End Plate

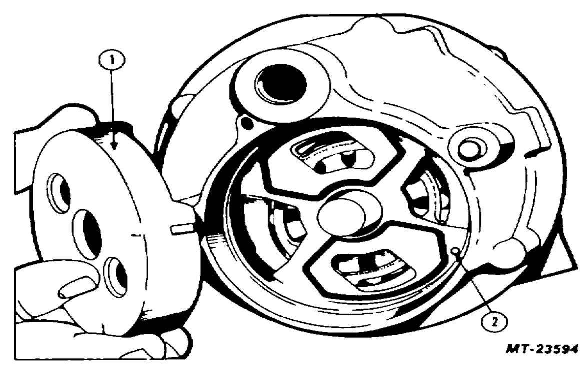


Fig. 36 Installing Cover

1 Pump Cover
2 Locating Pin

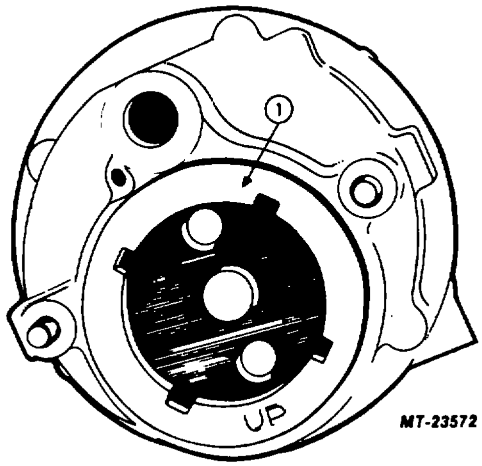


Fig. 37 Retainer Ring In Housing
1 Retainer Ring

12. Thread the retainer ring into pump body finger tight. Install the "UP" side of the ring up, Figure 37.
13. Lubricate the flow control valve bore with the same type of lubricant as used in pump. Insert the valve assembly into the bore with the long small diameter end in first, Figure 38. The valve must slide smoothly in the bore. Place the flow control valve spring in the valve bore and install the valve cap finger tight.
14. Install new O-ring on discharge fitting (Figure 39) and install fitting in housing finger tight.
15. Clean mating surfaces and install the pump mounting flange using a new O-ring (gear driven pump) or mounting bracket (pulley driven pump) and tighten mounting nuts to specified torque.
16. Place pump in a bench vise using the mounting flange (gear driven pump) or mounting bracket (pulley driven pump) to hold pump.

IMPORTANT
Do not clamp vise on pump housing.

17. Tighten valve cap to specified torque.

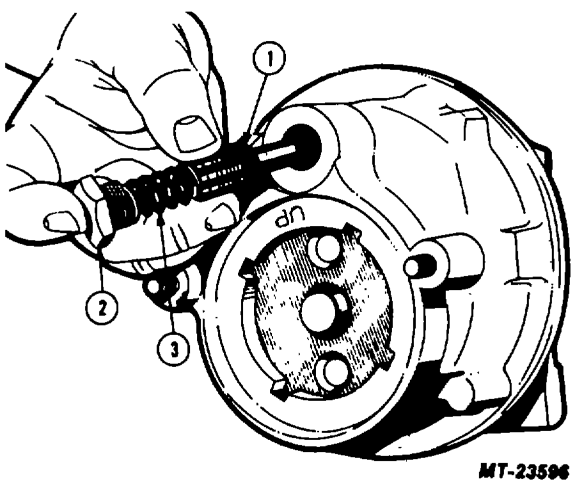


Fig. 38 Installing Flow Control Valve

1 Flow Control Valve
2 Valve Cap
3 Valve Spring

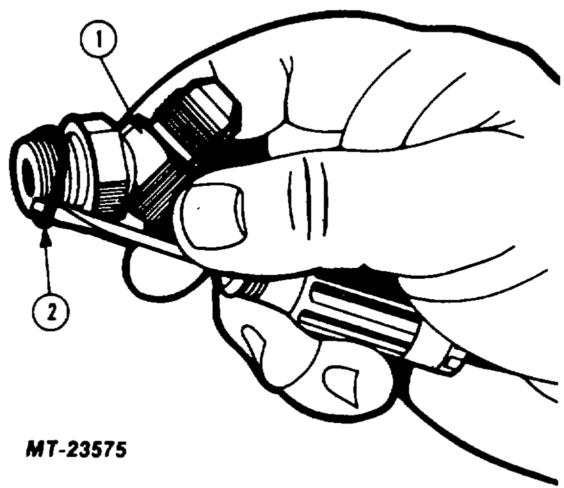


Fig. 39 Discharge Fitting 4-Ring

1 Discharge Fitting
2 O-Ring

18. Locate discharge fitting in its original position as marked during disassembly (Figure 40), and tighten jam nut to specified torque.

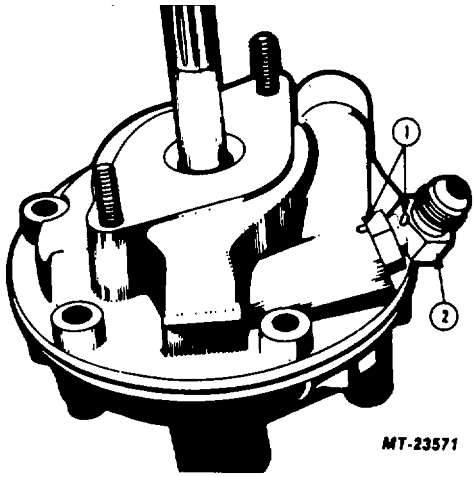


Fig. 40 Positioning Discharge Fitting

1 Alignment Marks
2 Discharge Fitting

19. Using tool SE-2838, tighten retainer ring to the specified torque, Figure 41.

20. The base pump is now assembled. Check the shaft to insure that it rotates freely and smoothly.

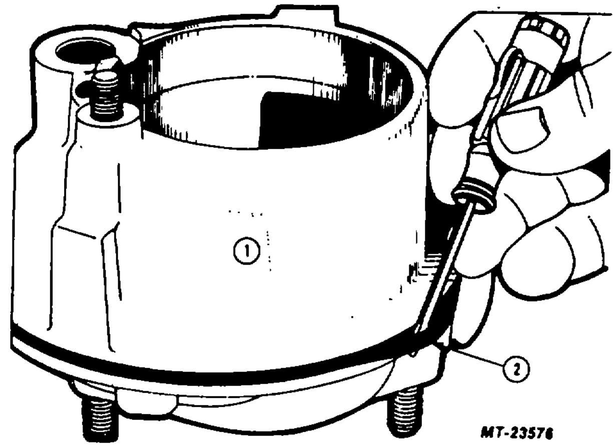


Fig. 42 Housing-to-Reservoir Gasket

1 Housing
2 Gasket

21. Install a new pump housing-to-reservoir 0- ring in the pump housing groove, Figure 42. Gasket should be installed with color side out.
22. Prior to assembling reservoir on pump, install a new filter element. The filter element is located in the expansion neck of the reservoir, Figure 43.

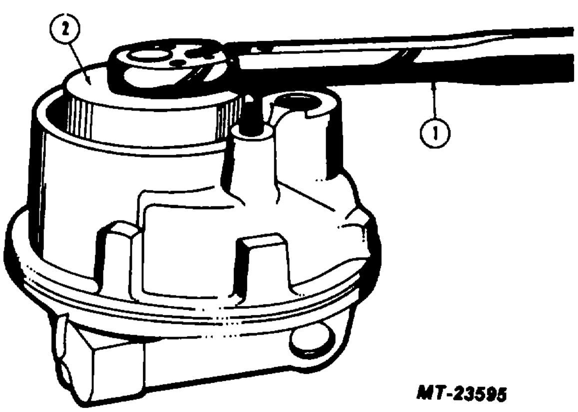


Fig. 41 Tightening Retainer Ring

1 Torque Wrench
2 SE-2838

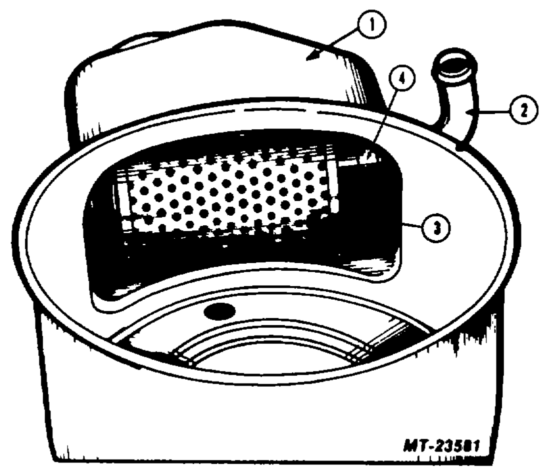


Fig. 43 Filter Element Location

1 Reservoir Expansion Neck
2 Oil Return Inlet Tube
3 Filter Element
4 Filter Guide

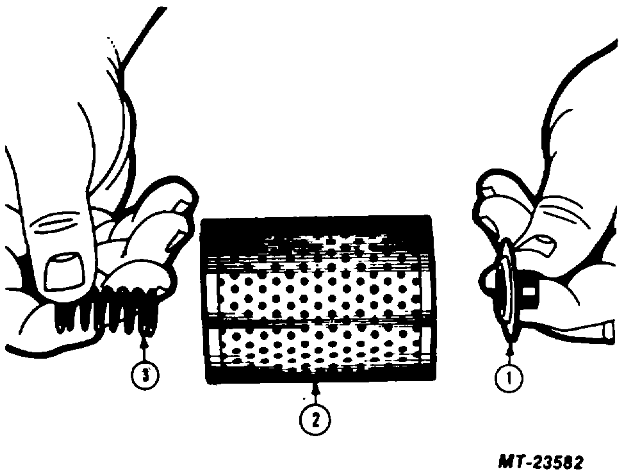


Fig. 44 Filter Element Components

1 Filter Guide
2 Filter
3 Spring

23. To remove filter element, insert a screwdriver behind the spring and pry the spring out. The filter element can then be removed. There is also a loose filter element guide that fits over the end of the return tube on the inside of the reservoir, Figure 44.

24. To install filter element, slide the guide over the end of the return tube with long end of guide toward reservoir wall. Some units are equipped with a spacer which should be placed over the return tube prior to installing the guide.

    Insert the spring into the cupped or closed end of the filter element. Position the open end of the filter element over the guide and force the spring into place in the recessed area of the reservoir neck.

25. If removed, install reservoir mounting studs in pump housing and place sealing washers over studs.
26. Install reservoir on pump housing in original position by indexing alignment marks made during disassembly.
27. Seat reservoir by placing a wood block against rear of reservoir and rapping block with a hammer. Install reservoir retaining nuts and tighten to specified torque.
28. Reinstall pump assembly on vehicle. See INSTALLATION AND REMOVAL section of this manual.

TORQUE CHART

FASTENER LOCATION	NEWTON METERS	FT. LBS.
Flow Control Valve Cap	54-75	40-55
Discharge Fitting Jam Nut	41-61	30-45
Threaded Retainer Ring	122-149	90-110
Reservoir Retaining Nuts	34-41	25-30
Pulley Retaining Bolt	20-27	15-20
Drive Coupling Nut	34-47	25-35
Mounting Flange Studs	1.4-14	1-10
Mounting Flange-to-Pump Nut	46-52	34- 38
Mounting Flange-to-Engine Bolt (All except Detroit	46-52	34-38
Diesel)		
Mounting Flange-to-Engine Bolt (Detroit Diesel Only)	61-68	45-50
Mounting Bracket Hardware 3/8 Inch	41-52	30-38
Mounting Bracket Hardware 7/16 Inch	68-81	50-60
Mounting Bracket Hardware 1/2 Inch	95-115	70-85

SPECIAL TOOLS

SE-2050 Torque Indicator Wrench (0-150 ft. lbs.)
SE-2780 Power Steering System Analyzer
SE-2838 Power Steering Pump Retainer Ring Spanner Wrench
SE-2839 Power Steering Pump Shaft Oil Seal Remover
SE-2840 Power Steering Pump Shaft Oil Seal Installer

STEERING

Replace old Section with this revised Section in your CTS-4001 Manual.

STEERING COLUMN ASSEMBLY
S-SERIES
CONVENTIONAL CAB, FLAT BACK COWL (FBC) AND BUS

CONTENTS

DESCRIPTION
The steering column assemblies used on S-Series Regular Cab and Flat Back Cowl (FBC) and Bus chassis are constructed with a few minor differences; however, the overall design and function are similar.

The steering wheel, containing the horn switch mechanism, is connected to the upper steering column shaft. On conventional cab models, the upper steering column shaft passes through the steering column housing assembly and connects with the lower steering column shaft at a double-yoke assembly with the aid of a spider type universal joint. The steering column housing is fastened to the dash panel via two support bracket assemblies, of which the bracket closest to the steering column incorporates the tilt-column mechanism on models equipped with an adjustable steering column.

On all S-Series chassis, the lower steering column shaft is joined to the steering gear by either another double yoke U-joint and end yoke pinch bolt assembly or a shell coupling assembly.

MAINTENANCE
STEERING COLUMN SHAFT BOLTS
The steering column end yoke pinch bolt assembly, or the column shaft mounting and shell coupling clamp nuts should be checked for tightness annually or every 80 000 kilometers (50,000 miles), whichever comes first. All bolts and nuts should be tightened to torque recommended in SPECIFICATIONS. **Do not overtighten.**

Bolts affected are:
Item 22, Figures 2

REMOVAL AND INSTALLATION
STEERING WHEEL
Procedures for steering wheel removal and installation are common to all S-Series models.
Removal
1. Position front wheels in a straight ahead position.
2. Remove negative battery terminal.
3. Pry up horn button cap evenly, disconnect horn wire, and remove the horn button.
4. Remove the retainer ring.
5. Remove the slip ring retainer screws.
6. Remove the steering wheel mounting nut.
7. Remove steering wheel using steering wheel puller SE-1821 (Figure 1).

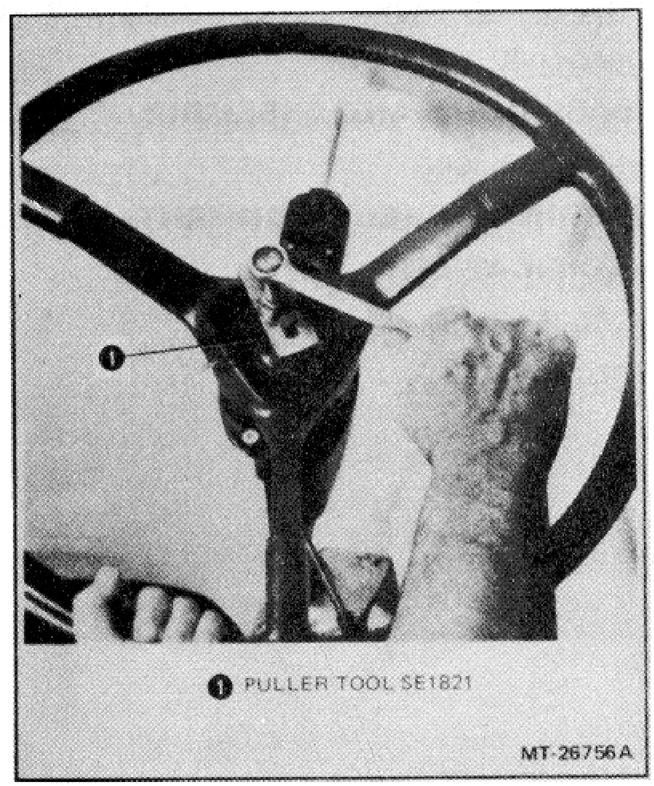
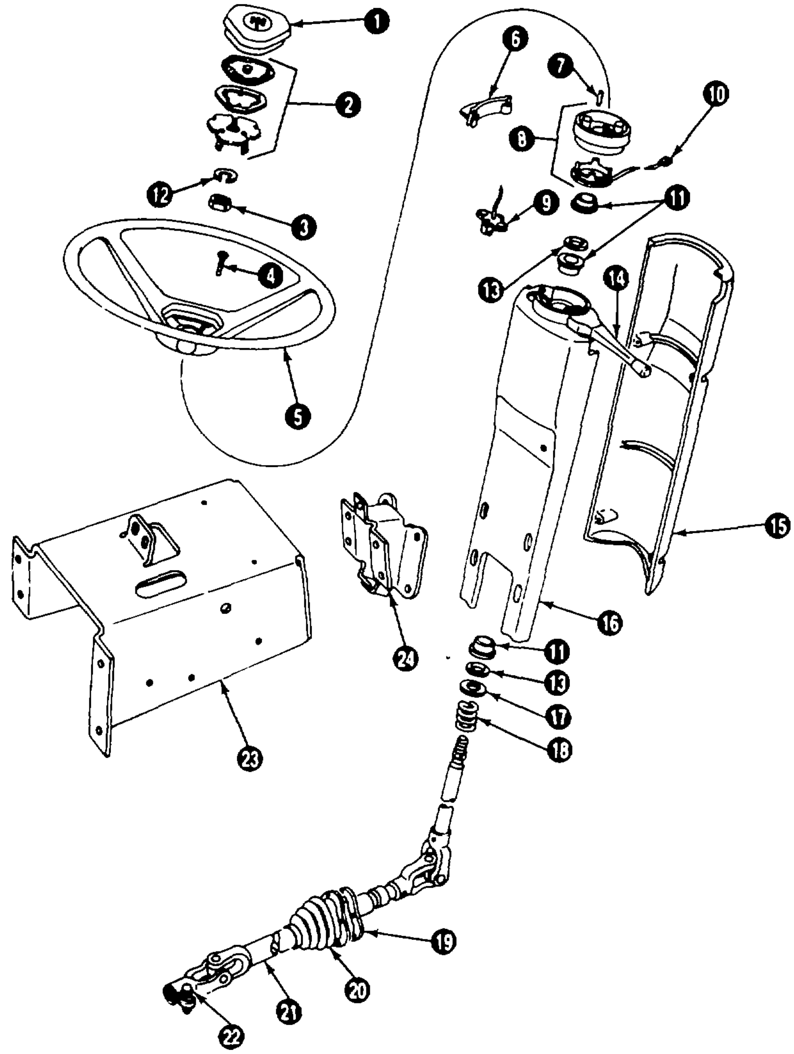


Figure 1 - Removing Steering Wheel



1. HORN BUTTON
2. HORN BASE PLATE ASSEMBLY
3. STEERING WHEEL MOUNTING NUT*
4. SCREW, PAN-CR-REC-HD
5. STEERING WHEEL ASSEMBLY WITH PIN
6. STEERING COLUMN HOUSING COVER
7. CANCELLING PIN
8. RETAINER WITH SLIP RING
9. HORN CONTACT BRUSH ASSEMBLY
   SCREW, PAN-CR-REC-HD
   PLAIN WASHER
10. HORN CABLE
11. STEERING COLUMN BUSHING
12. RETAINER RING
13. STEERING COLUMN WASHER
14. TURN SIGNAL AND HAZARD SWITCH
15. STEERING COLUMN HOUSING
16. STEERING COLUMN HOUSING
17. HARDENED FLAT WASHER 7/8
18. STEERING COLUMN SHAFT SPRING
19. STEERING COLUMN SEAL RETAINER
20. STEERING COLUMN SEAL
21. STEERING COLUMN SHAFT ASSEMBLY
22. END YOKE PINCH BOLT ASSEMBLY
    BOLT, HEX-HD 3/8NC X 1-3/4
    LOCK NUT 3/8NC*
    BOLT, HEX-HD 7/16NC
    LOCK NUT 7/16NC*
23. STEERING COLUMN SUPPORT BRACKET ASSEMBLY
24. STEERING COLUMN SUPPORT BRACKET ASSEMBLY

*REFER TO TORQUE CHART IN THIS SECTION

MT-28153A

Figure 2 - Stationary Steering Column -Conventional Cab

Installation

1. With front wheels in a straight ahead position, install the steering wheel with the narrow spoke (with the word "top") at the 12 o'clock position. Install the steering wheel mounting nut and tighten to recommended torque (see SPECIFICATIONS).
2. Install the slip ring retainer screws.
3. Install the retainer ring.
4. Connect the horn wire to the horn button and install the horn button.
5. Connect the negative battery terminal.

STEERING COLUMN - CONVENTIONAL CAB
Removal

(Refer to Figure 2,

1. Disconnect the negative battery terminal cable.
2. On vehicles with the universal joint steering shaft assembly, remove the pinch bolt from the yoke at the steering gear (Figures 2
3. Remove the steering wheel as previously outlined and install the steering wheel mounting nut to prevent the steering column from sliding out of the steering column housing.
4. Remove the steering column trim cover.
5. Remove the electrical connectors and wiring from the steering column housing.
6. Remove the screws attaching the steering column rubber seal to the dash panel.
7. Remove the bolts attaching the steering column housing to the steering column support bracket. Tilt the steering column assembly to the side and remove it from the vehicle.
8. Remove the steering wheel mounting nut, and remove the steering shaft assembly, bushing, washer, flatwashers and spring.

Installation

1. Assemble the steering shaft assembly, spring, flatwashers, washer and bushing and install in the steering column housing. Install the steering wheel mounting nut temporarily.
2. Guide the lower portion of the steering column assembly through the opening in the dash panel. On vehicles with universal joint steering shaft assemblies, position the shaft assembly on the steering gear. On vehicles with the shell coupling steering shaft assembly, position the shaft assembly on the lower steering column shaft.
3. Install the bolts attaching the steering column housing to the steering column support bracket and tighten to recommended torque (see SPECIFICATIONS).
4. Install the screws attaching the steering column rubber seal to the dash panel.
5. Install the electrical connectors and wiring in the steering column housing.
6. Install the steering column trim cover.
7. Install the steering wheel as previously outlined.
8. On vehicles with the universal joint steering shaft assemblies, install the nut and bolt in the yoke assembly and tighten to recommended torque. On vehicles with the shell coupling steering shaft, install the U-bolt and clamp and tighten the attaching nuts to recommended torque. Refer to Lower Column Shell Coupling Adjustment and SPECIFICATIONS in this Section.
9. Install the battery negative terminal and close the hood.

PITMAN ARM - ROSS STEERING GEAR

Replace the Pitman arm if it is bent, if the ball stud hole is excessively worn, or the serration are damaged or excessively worn.

Removal

1.Remove the cotter pin and nut from the drag link ball stud at the Pitman arm (Figure 8).

2.Remove the drag link ball stud from the Pitman arm.

3.Remove the nut and lockwashers from the pinch bolt secures the Pitman arm to the steering gear sector shaft.

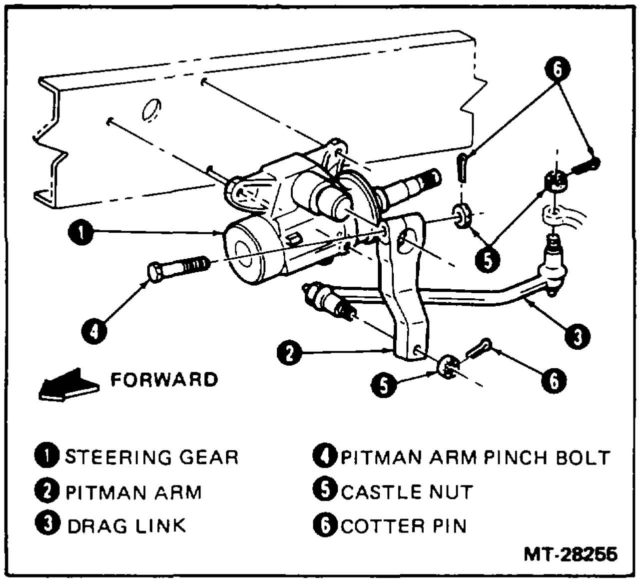


Figure 8 - Pitman Arm and Drag Link Installation

4. Drive wedge into slot in Pitman arm (Figure 9). Remove Pitman arm.

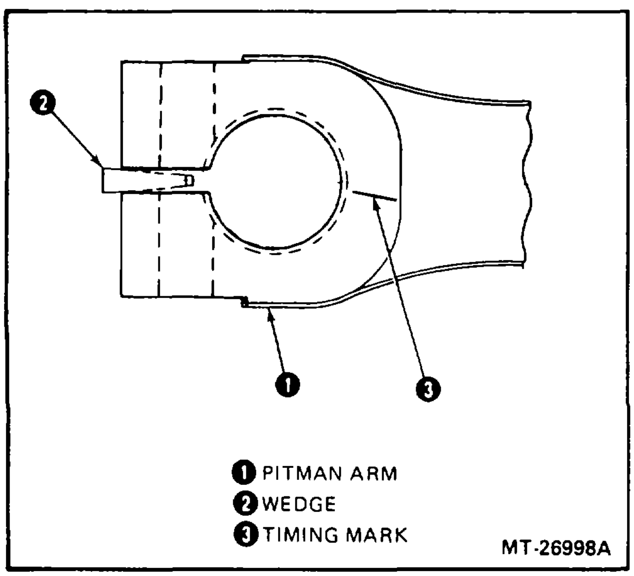


Figure 9 - Pitman Arm Removal

Installation

1. Position the Pitman arm on the sector shaft, aligning the timing mark on the sector shaft to the timing mark on the Pitman arm. Use the pinch bolt to align the groove on the sector shaft and the bolt hole in the Pitman arm.

2. Remove the wedge, making certain that the Pitman arm stays aligned to the sector shaft.
3. Install the nut and lockwashers and tighten to recommended torque (see SPECIFICATIONS).
4. Install the drag link ball stud in the Pitman arm and tighten the nut to recommended torque. **If the cotter pin cannot be installed after obtaining minimum torque, do not back off nut. Tighten to next castellation. Refer to SPECIFICATIONS.**

DRAG LINK

Removal

Refer to Figure 8.

1. Remove cotter pins from the attaching nuts.
2. Remove the nuts.
3. Remove the ball studs from the Pitman arm and steering linkage.

Installation

1. Install ball studs in the Pitman arm and steering linkage holes.
2. Install nuts and tighten to recommended torque (see SPECIFICATIONS).
3. Install cotter pins. **If cotter pin cannot be installed after obtaining minimum torque, do not back off nut. Tighten to next castellation.**

DISASSEMBLY AND ASSEMBLY

UNIVERSAL JOINT

The double-jointed columns used in certain S-Series models utilize Dana 500 series universal joints, which are non-serviceable, and should not require servicing. **Do not attempt to disassemble these universal joints.** Columns equipped with the lower steering shaft shell coupling utilize a standard spider-type universal joint for connecting the upper and lower steering column shafts. To service the universal joint on these models, it is first necessary to remove the steering column from the vehicle.

CAUTION - USE EXTREME CARE NOT TO DAMAGE BEARING SURFACES.

Disassembly

1. Place the universal joint in a vise as shown in Figure 10. Remove the snap rings retaining the bearings in the yoke.

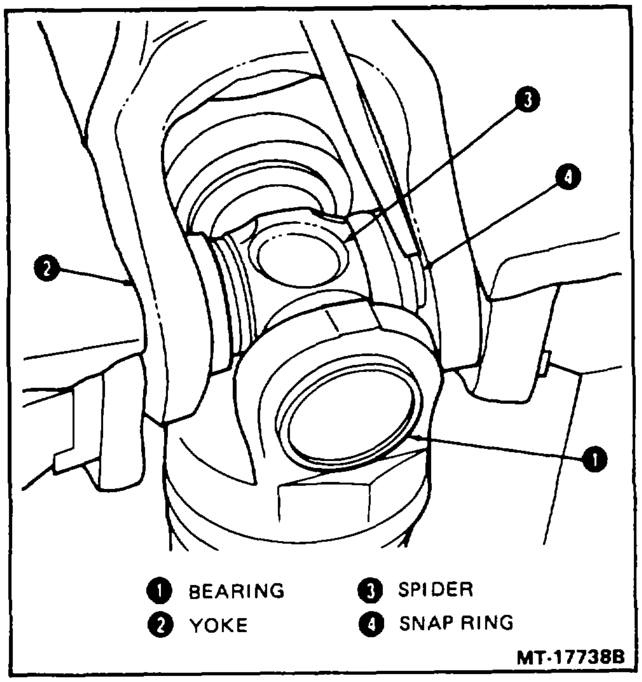


Figure 10 - Snap Ring Removal

2. Place the shaft assembly in a vise as shown in Figure 11. Tap the yoke with a soft hammer beside the bearing that is being removed. The bearing should come out. If the bearing does not come out, place the bearing in a vise. Use copper Jaw covers on vise. Tap the yoke away from the bearing as shown in Figure 12.

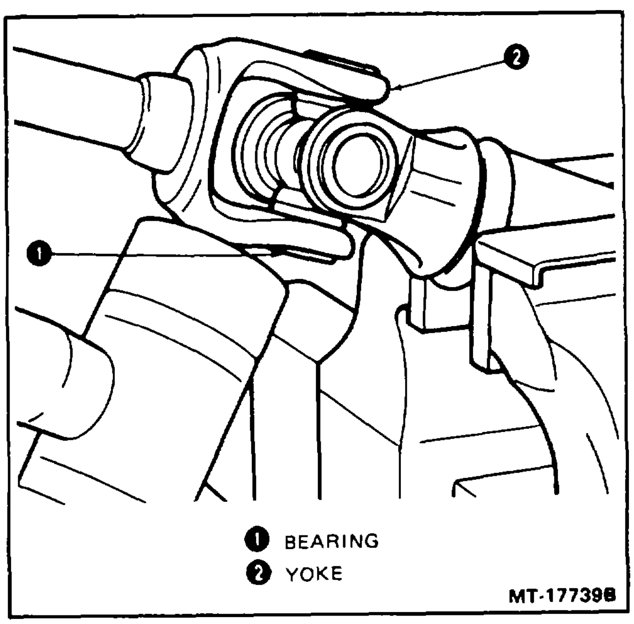


Figure 11 - Bearing Removal

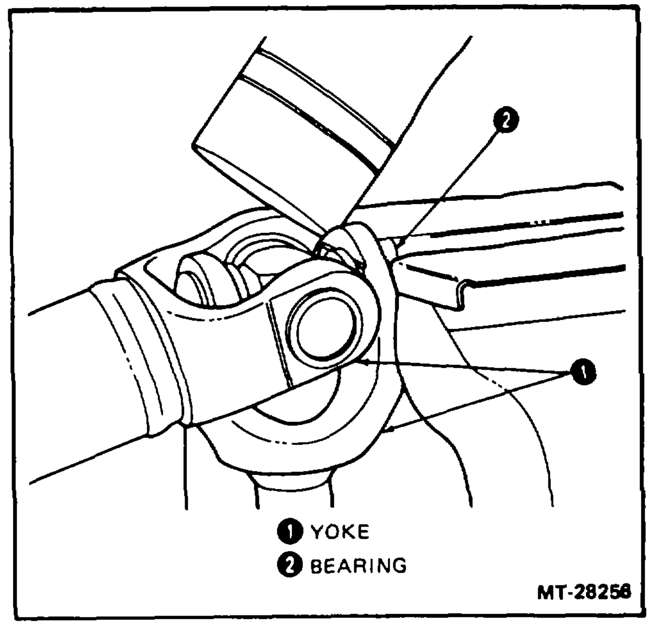


Figure 12 - Bearing Removal

3. Remove the spider after the bearings have been removed.

Assembly

1. Make certain parts are clean before assembly.
2. Rest yoke on hard surface. Tap one bearing part way into yoke with a soft hammer (Figure 13). Be certain bearings are straight in yoke.

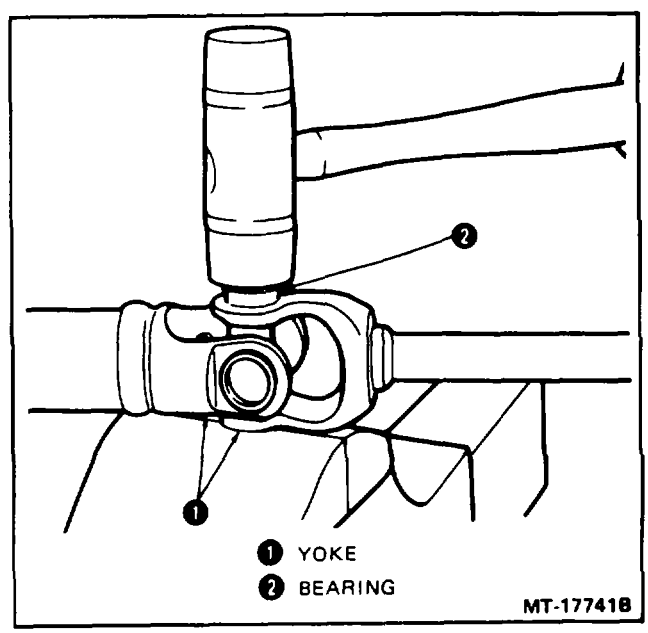


Figure 13 -- Install Bearing Part Way Into Yoke

3. Insert spider through the opposite hole, without bearing, and swing it into place and down into the partially installed bearing.
4. Turn assembly over and tap the opposite bearing part way into the yoke. Be certain to start bearing straight in yoke.
5. Place yoke in vise with bearings against jaws of vise. Tighten vise slowly and the bearings will be pressed into the yoke as shown in Figure 14.

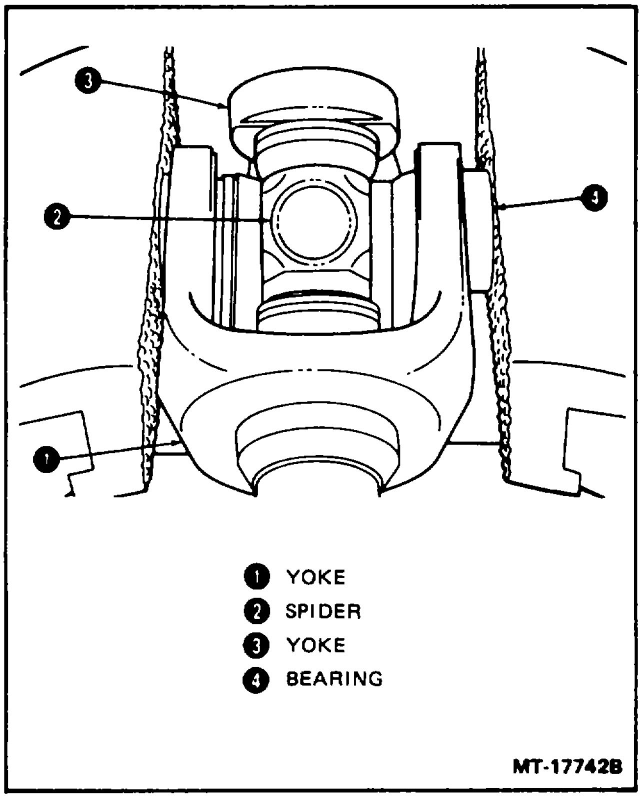


Figure 14 - Press Bearings Into Yoke

6. After pressing bearing into yoke, the spider may be off center in yoke. This is desirable because it permits installation of snap ring on the side with the most clearance. Refer to Figure 15 and install snap ring.

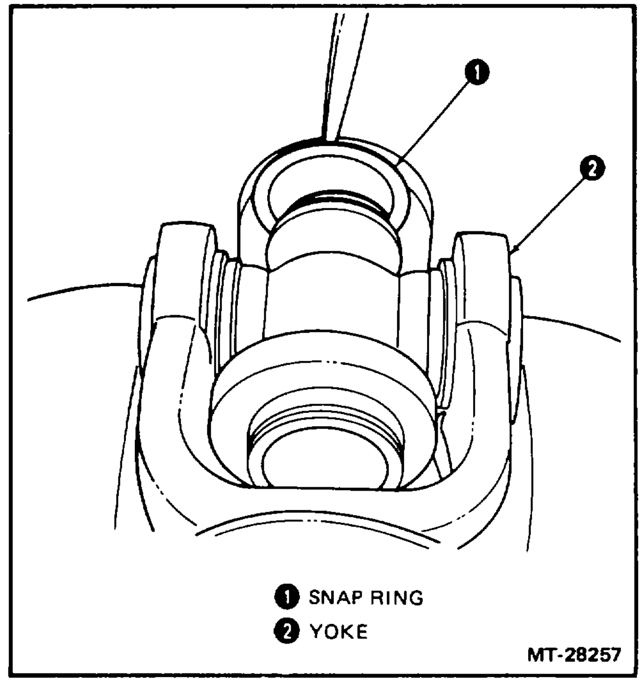


Figure 15 - Snap Ring Installation

7. After the first snap ring is in place, turn assembly over. The bearing with snap ring installed should be on the bottom. Rest yoke on vise and strike bearing which is on top. This will seat both bearings. Snap rings should rest against inside milled surface of yoke. Install remaining snap ring.

8. Bearings must move freely. If tight, tap yoke until free.

STEERING WHEEL ALIGNMENT

1. Position front wheels in a straight ahead position. The narrow spoke of the steering wheel (marked stop") should be pointed to the front of the vehicle.
2. If the narrow spoke of the steering wheel is off center, remove the steering wheel and install it with the narrow spoke centered. Refer to Steering Wheel in this section for removal and installation procedures.

SPECIFICATIONS

TORQUE CHART

LOCATION	RECOMMENDED TORQUE
Steering Wheel Mounting Nut	102-108 N-m (75-80 lb-ft)
Steering Column End Yoke Pinch Bolt	
3/8 Bolt 7/16 Bolt	47-54 N-m (35-40 Ib-ft) 81-89 N-m (60-66 Ib-ft)
Shell Coupling Clamp Bolt	41-47 Nom (30-35 Ib-ft)
Column Shaft Mounting U-Bolt (Shell Coupling)	 14-16 N-m (10-12 Ib-ft)
Drag Link Locking Clamp	68-81 Nom (50-60 Ib-ft)
Drag Link to Pitman Arm Nut	149-169 N-m (110-125 Ib-ft)*
Steering Column to Support Bracket	31-36 N-m (23-27 Ib-ft)
Pitman Arm Pinch Bolt 1/2" Bolt (Sector Shaft Diameter 1-3/8") 5/8" Bolt (Sector Shaft Diameter 1-1/2" to 1-3/4") 3/4" Bolt (Sector Shaft Diameter 1-15/16")	 149-163 N-m (110-120 Ib-ft) 298-325 N-m (220-240 Ib-ft) 447-502 N-m (330-370 Ib-ft)
*If a castle nut and cotter pin are used, and the cotter pin cannot be inserted after attaining minimum torque, tighten to next castellation and insert cotter pin. Do not back nut off to insert cotter pin.	

*'Castle nut only with drag link studs

SPECIAL TOOLS

SE-1821 Puller
SE-2221 Torque Indicator Wrench (0-150 Ib-ft)
SE-2189 Torque Indicator Wrench (100-600 Ib-ft)

PROPELLER SHAFT

CONTENTS

PROPELLER SHAFT

CONTENTS

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FORWARD

This manual is presented as a guide in solving problems associated with drive shafts. No attempt has been made to discuss technical consideration of design or theory of vibrating systems.

In discussing installation of drive shafts, no hard and fast rule or fine dividing line has been drawn between satisfactory and unsatisfactory operation.

The limits set forth in this manual correspond with our own standards. Our long experience in the installation of drive shafts has proven these standards to be accurate.

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FUNCTION

In examining the drive line, it would be well to start with a review of drive shaft operation. A critical examination of why it is there and what it must do may be helpful in analyzing its effect on the entire drive line system. A driveshaft's functions can be briefly described as follows:

1. It must transmit torque from the transmission to the axle. This requirement makes it necessary that the driveshaft be capable of transmitting the maximum low gear torque developed by the engine and transmission ratio and any shock loads which may develop. It must also be capable of rotating at the maximum speed required for vehicle operation. This speed is often engine speed increased by an overdrive ratio in the transmission.
2. The driveshaft must operate through constantly changing relative angles between transmission driveshaft and axle.
3. The length of the driveshaft must be capable of changing while transmitting torque. Length changes are caused by necessary axle movement due to torque reaction, road deflections, braking loads, etc.

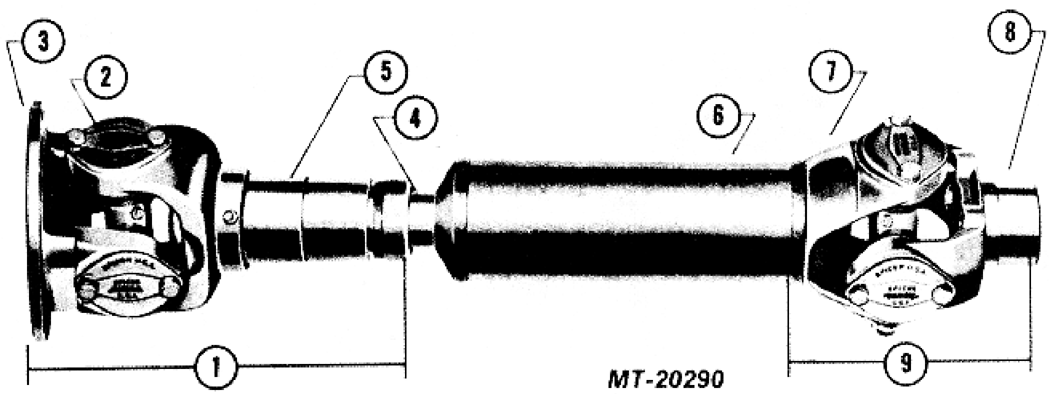


Fig. 1 Typical Parts Identification

1 Slip Joint
2 Journal and Bearing Kit
3 Flange Yoke
4 Slip Stub Shaft
5 Sleeve Yoke Assembly
6 Tubing
7 Stub Yoke
8 End Yoke
9 Permanent Joint

CONSTRUCTION

The basic functions having been designated, let's look at conventional universal joint and driveshaft construction.

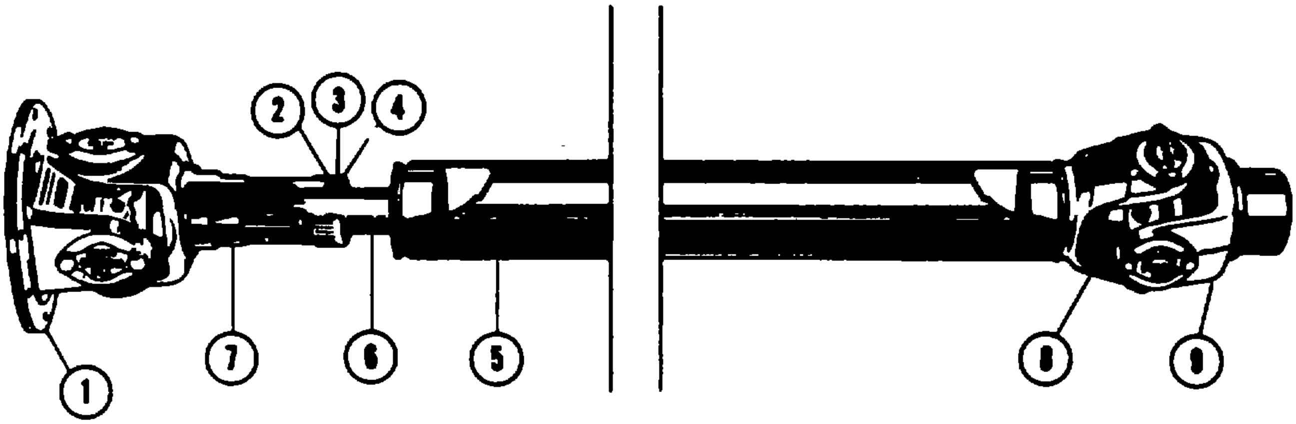
To transmit required loads, the driveshaft must possess high strength. Forged steel, or high strength cast yokes are generally used to provide necessary strength and the rigidity required to maintain bearing alignment under torque loads and during high speed operation. Special high-strength tubing is used to provide maximum torque carrying capacity at minimum practical weight. This tubing must be securely welded to its end members, to provide the necessary torque capacity.

High quality anti-friction bearings are used to withstand required loads while oscillating at high speeds. These bearings on the journal cross carry very high loads for their size. The full complement, roller-type (needle) bearings are generally used because of their high capacity in a limited space. Bearings are individually sealed to provide retention of required lubricants as well as to prevent the entry of foreign material. If lubricants become contaminated with water or abrasive material, needle bearing life is seriously affected.

Abrasive material is a major problem where a vehicle operates under conditions of extreme moisture and dirt. Off-highway installations are especially critical in this respect. Military trucks represent the extreme in this direction and were the first to show the shortcomings in the conventional cork seals used in universal joint bearings. It was found that an improved seal was required for this type of operation. Synthetic rubber-type seals were developed for these installations. These seals have been in use for many years on military vehicles and are now used in most commercial installations. The improved sealing shows increased life and a less critical re-lubrication cycle.

The sliding splines between slip joint and permanent joint must support the driveshaft and be capable of sliding under full torque loads. To provide adequate strength and wear resistance, hardened and ground splines are used. These splines are phosphate or nylon coated to resist galling and to reduce sliding friction.

COMPONENTS



MT-20291

Fig. 2 Slip Joint

Permanent Joint

1 Flange Yoke
2 Cork Washer
3 Steel Washer
4 Dust Cap
5 Tubing
6 Slip Stub Shaft, Center Bearing
7 Sleeve Yoke Assembly
8 Stub Yoke
9 End Yoke

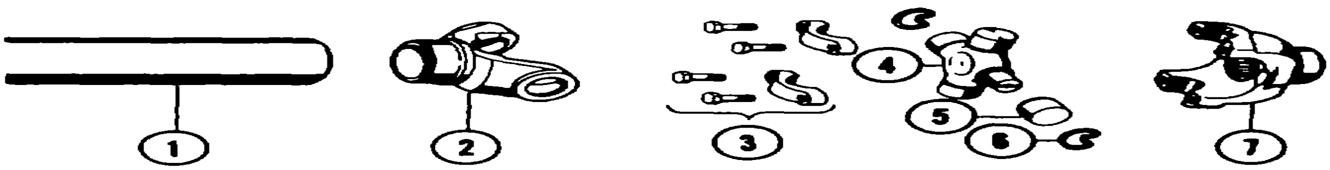


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Fig. 3 Permanent Joint

1 Tubing
2 Stub Yoke
3 Cap and Bolt
4 Journal Assembly
5 Bearing Assembly
6 Snap Ring
7 End Yoke

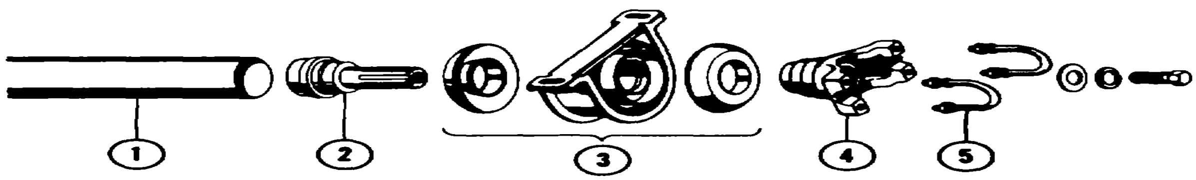

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Fig. 4 Center Baring Assembly

1 Tubing
2 Midship Stub Shaft
3 Center Bearing
4 End Yoke
5 U-Bolt

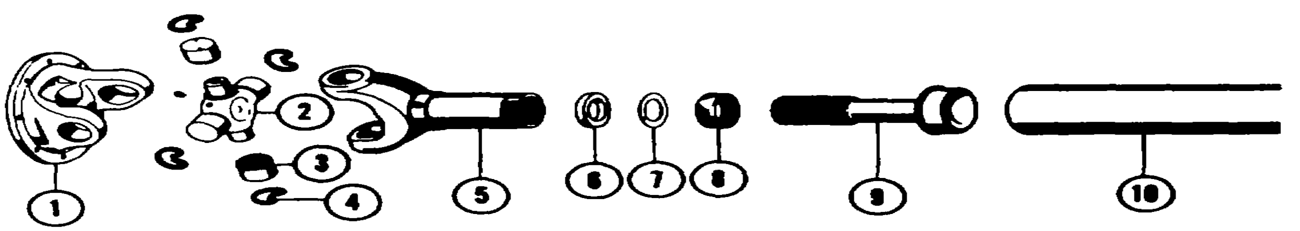

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Fig. 5 Slip Joint

1 Flange Yoke
2 Journal Assembly
3 Bearing Assembly
4 Snap Ring
5 Sleeve Yoke
6 Cork Washer
7 Steel Washeror one piece
8 Dust Capneoprene seal
9 Slip Stub Shaft
10 Tubing

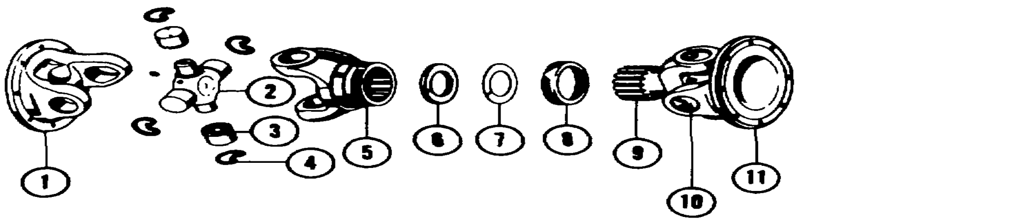


Fig. 6 Short Couple Joint

1	Flange Yoke	6	Cork Washer	
2	Journal Assembly	7	Steel Washer	or one piece
3	Bearing Assembly	8	Dust Cap	neoprene seal
4	Snap Ring	9	Yoke Shaft	
5	Sleeve Yoke	10	Journal and Bearing	
		11	Flange Yoke	

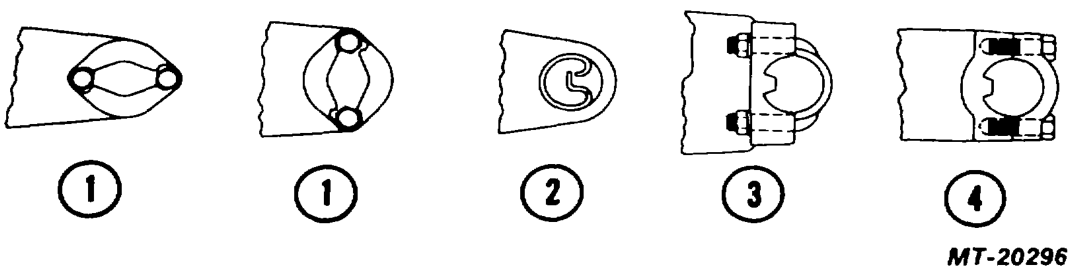


Fig. 7 Alternate Yoke Constructions

1	Bearing Cap	3	U-Bolt
2	Snap Ring	4	Cap and Bolt

Fig. 8 Alternate Companion Flange - Flange Yoke

1	Circular Type	2	Rectangular Type

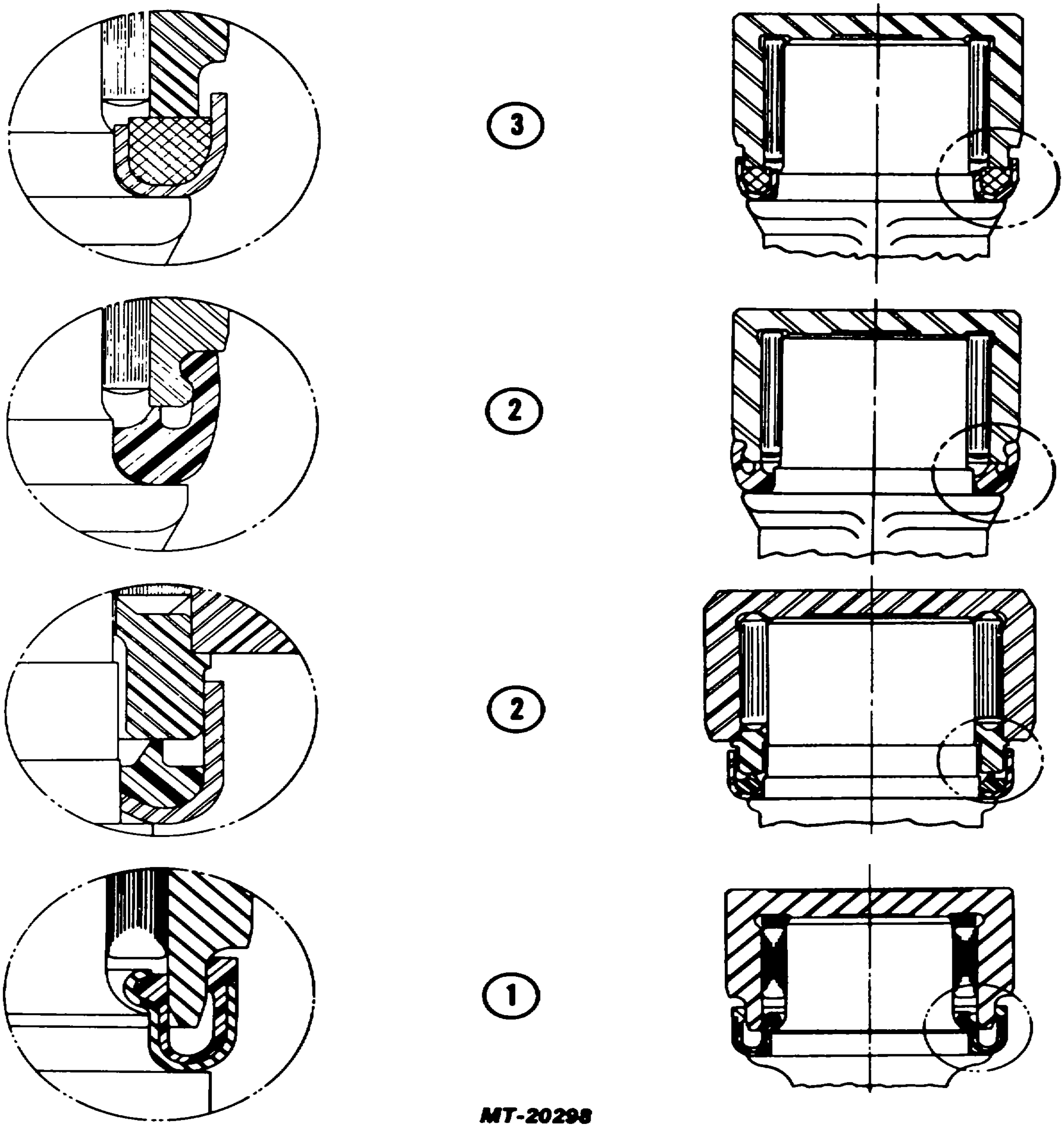


Fig. 9 Universal Joint Seals

1 Extended Life Seal
2 Rubber Seal
3 Cork Seal

LUBRICATION

DON'T NEGLECT DRIVE SHAFT LUBRICATION!

Lack of adequate or proper lubrication is among the most common causes of U-Joint and drive shaft failure!

Proper servicing of the drive shaft is an essential part of vehicle maintenance and should not be overlooked in routine shop procedure.

UNIVERSAL JOINTS IN THE VEHICLE OR APPLICATION

To insure proper lubrication of all four bearing assemblies on universal joints, it is essential that mechanics add lubricant until it appears at all journal cross bearing seals (Fig. 10). This assures removal of dirt particles and other contaminants that may find their way into the bearings and indicates to the mechanic that the bearings are fully lubricated.

Do not assume that bearing cavities have been filled with new lubricant unless flow is noticed around all four bearing seals!

Journal cross seals are designed to relieve. However, if all the seals do not "pop" when being lubed, move the driveshaft laterally in all four directions and pull or push on the drive shaft in the direction opposite to the journal cross seal not relieving while lube gun pressure is being applied to the alemite fitting. An increase in line pressure may also be necessary.

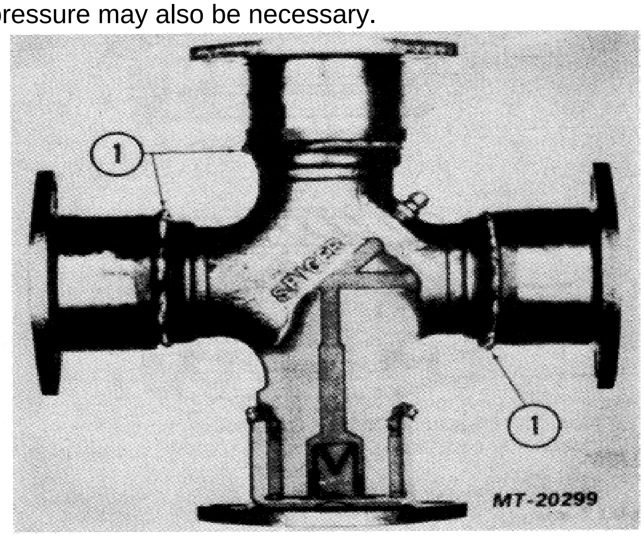


Fig. 10

1 Lube

DRIVE SHAFT ASSEMBLY

Factory assembled drive shafts are lubricated at the plant prior to shipment. However, ship-ping, handling and installation of the drive shaft assembly into the vehicle usually results in some loss of lube. Therefore, it is recommended that all universal joints be relubricated after installation of the drive shaft prior to putting vehicle in service.

JOURNAL AND BEARING KITS

Replacement universal joint kits contain only enough grease to provide needle bearing protection during storage. It is therefore necessary to completely lubricate each replacement kit prior to assembly into the drive shaft yokes. Each journal cross lube reservoir should be fully packed with a recommended grease and each bearing assembly should also be wiped with the same grease; filling all the cavities between the rollers and applying a liberal grease coating on the bottom of each race. After the kits are installed into the driveshaft yokes and prior to placing into service, they should be relubed, through the zerks, using the same grease.

RECOMMENDED LUBRICANTS

For center bearings, slip joints and universal joints use IH 251 HEP grease or equivalent NLGI #2 multi-purpose grease.

RELUBE CYCLES

Relubrication cycles for driveshaft universal joints and slip splines will vary with service requirements and operating conditions. Refer to Operator's Manual.

SLIP JOINT LUBRICATION

Relube spline at intervals prescribed in Operator's Manual. Apply grease gun pressure to lubrication zerk until lubricant appears at pressure relief hole in welch plug at sleeve yoke end of spline (Fig. 11). At this point, cover pressure relief hole with finger and continue to apply pressure until grease appears at sleeve yoke seal (Fig. 12). This will insure complete lubrication of spline.

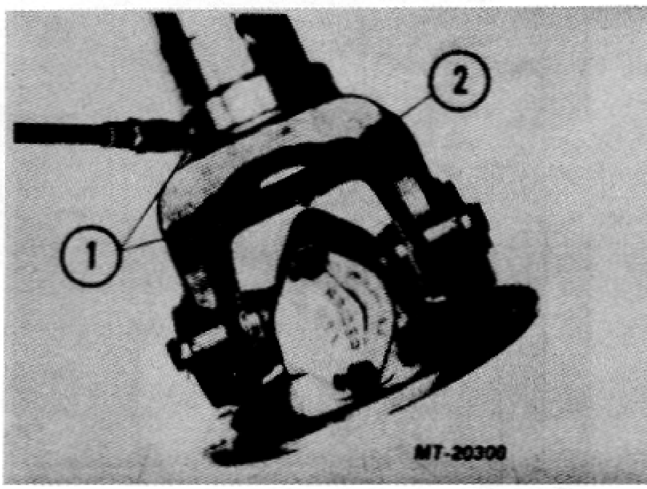


Fig. 11

1 Lube
2 Pressure Relief Hole

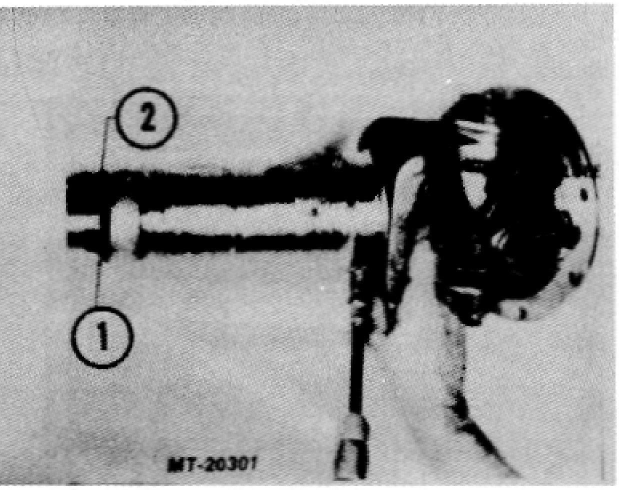


Fig. 12

1 Lube
2 Sleeve Yoke Seal

SERVICE INSTRUCTIONS

Needle bearing joints are simple in construction, easily removed from the vehicle and readily disassembled and reassembled without the use of any special tools or any special mechanical knowledge.

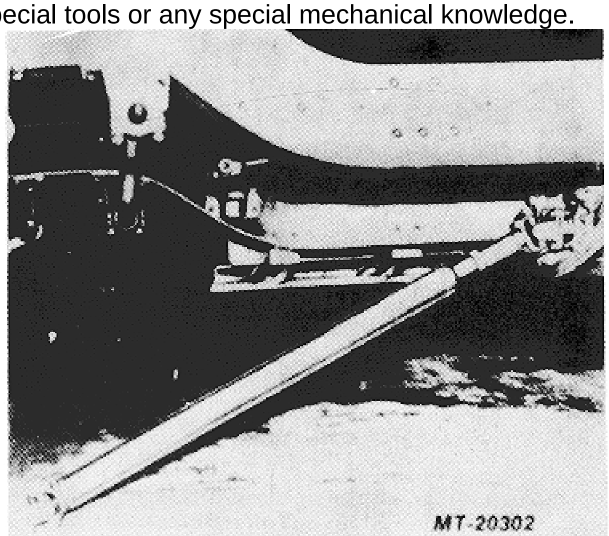
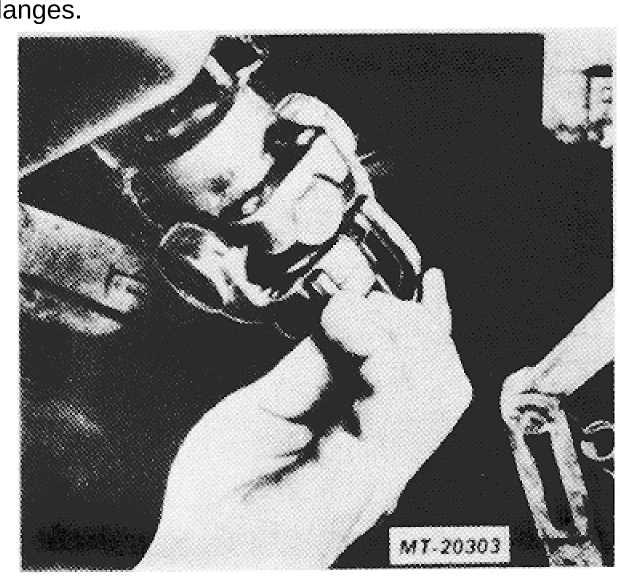


Fig. 13

REMOVAL FROM THE VEHICLE

1. Double Flange, Yoke Types (Bearing Cap and Snap Ring Construction)(Fig. 13)

All Double Flange Yoke Type Joints are re-moved as a complete assembly by removal of the Companion Flange Bolts, Nuts and Lockwashers, which allows the assembly to slip out from between the Companion Flanges.



2. Double End, Yoke Type (U-Bolt Construction) (Fig. 14)

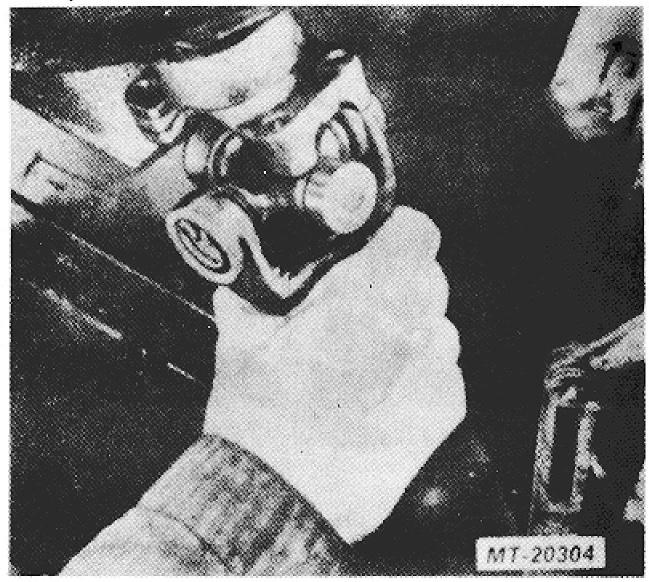


Fig. 15

Remove the U-Bolts, Nuts, and Lockwashers from the End Yokes. Slide the Sleeve Yoke toward the shaft to free the Bearings from their seats between the shoulders in the End Yokes (Fig. 15). Care should be taken not to drop the two Bearings from the trunnion ends of the Journal Cross at both ends of the driveshaft. The End Yokes remain on the vehicle.

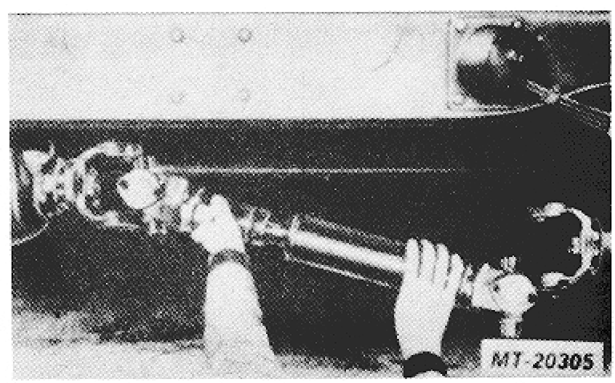


Fig. 16

3. Double End Yoke Type (Bearing Cap Construction)(Fig. 16)

Remove the capscrews, lock plates and bearing and retaining cap sub-assemblies from the transmission and axle end yokes. Remove the driveshaft with the remaining journal crosses and bearings as a unit. The end yokes remain on the vehicle.

REMOVAL OF THE SLIP JOINT

1. Slip Joint (All Types). Unscrew the dust cap from the sleeve yoke and slide the joint off the driveshaft (Fig. 17).

2. ARROW MARKS - Make sure arrow marks are stamped on the shaft and sleeve yoke before removing the slip joint (Fig. 18). If arrow marks are not readily seen, mark both members so that when reassembled they will be in exactly the same relative position, since the sleeve yoke lugs must be in the same plane as the stub ball yokes to prevent excessive vibration.

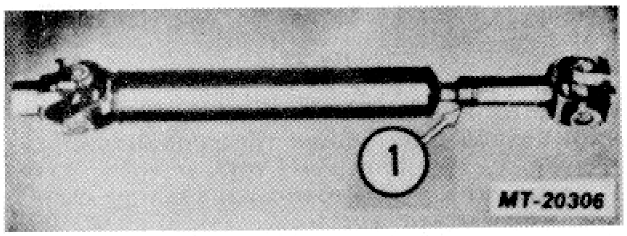


Fig. 17
1 Remove Dust Cap

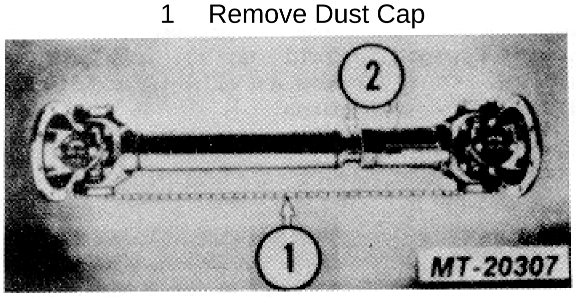


Fig. 18
1 Yoke Lugs in Line
2 Line Up Arrows

DISASSEMBLING UNIVERSAL JOINT MEDIUM AND HEAVY DUTY

1. LOCK STRAP - Bend down the locking lugs with a screwdriver and remove the cap-screws.

2. NEEDLE BEARINGS & RETAINING CAP SUB-ASSEMBLY - Remove by using a large pair of channel lock pliers on retaining cap edges, turn retaining cap and bearing sub-assembly at the same time lifting upward to remove the sub-assembly from the journal trunnion diameter and out of the yoke hole. Turn the joint over and tap the exposed end of the journal cross until the opposite needle bearing is free. Use a soft round drift with flat face about .79 mm (1/32") smaller in diameter than the hole in the yoke, otherwise there is danger of damaging the bearing (Fig. 19).

3. JOURNAL CROSS - Remove by sliding it to one side of the yoke and tilting it over the top of the yoke lug (Fig. 20).

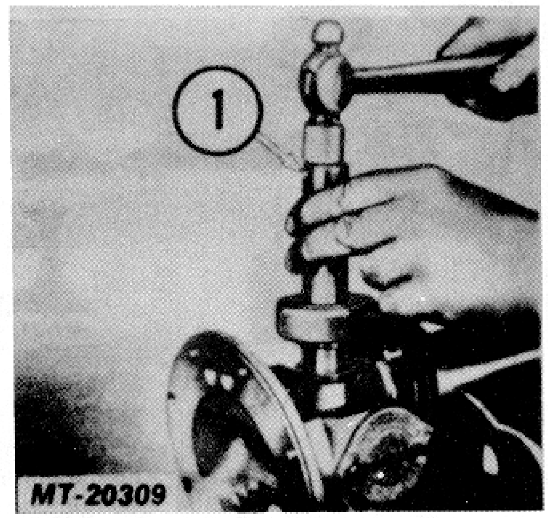


Fig. 19

1 Use Soft Drift 1/32" Smaller in Diameter Than Bearings

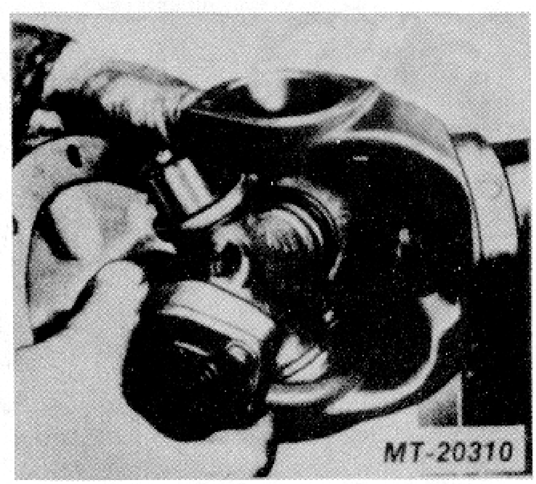


Fig. 20

SERVICE INSTRUCTIONS

ASSEMBLING UNIVERSAL JOINT - MEDIUM AND HEAVY DUTY (Figs. 21, 22 and 23)

1. SEAL - If necessary to install a new kit make sure that four new seals are installed in the journal retainers.

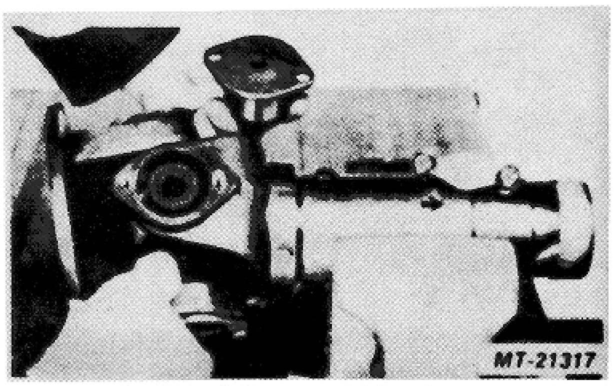


Fig. 21

2. JOURNAL CROSS - With the relief valve facing the flange yoke, insert one trunnion of the journal cross into the bearing hole in the yoke lug from the inside between the lugs and tilt until the trunnion of the journal cross will clear the hole in the opposite yoke lug.

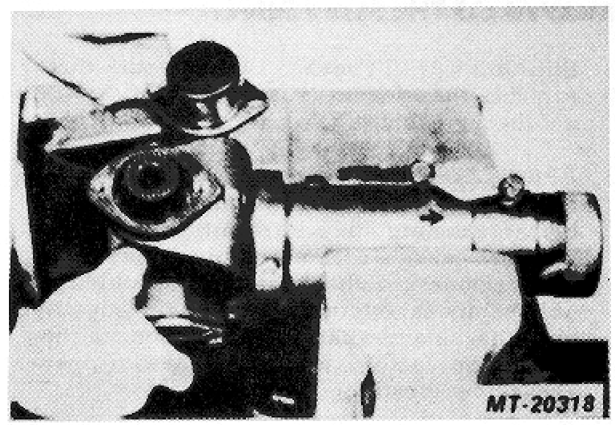


Fig. 22

3. NEEDLE BEARING AND RETAINING CAP SUB-ASSEMBLY - Insert from outside of yoke. Press into place with an arbor press or tap with a soft round drift taking care not to mar any surfaces.

4. LOCK STRAP AND CAPSCREWS - Assemble and bend the lugs of the lock strap up against the flat of the capscrew. If the joint appears to bind, tap the lugs lightly to relieve any pressure of the bearing on the end of the journal.

BEARING CAP CONSTRUCTION MEDIUMA ND HEAVY

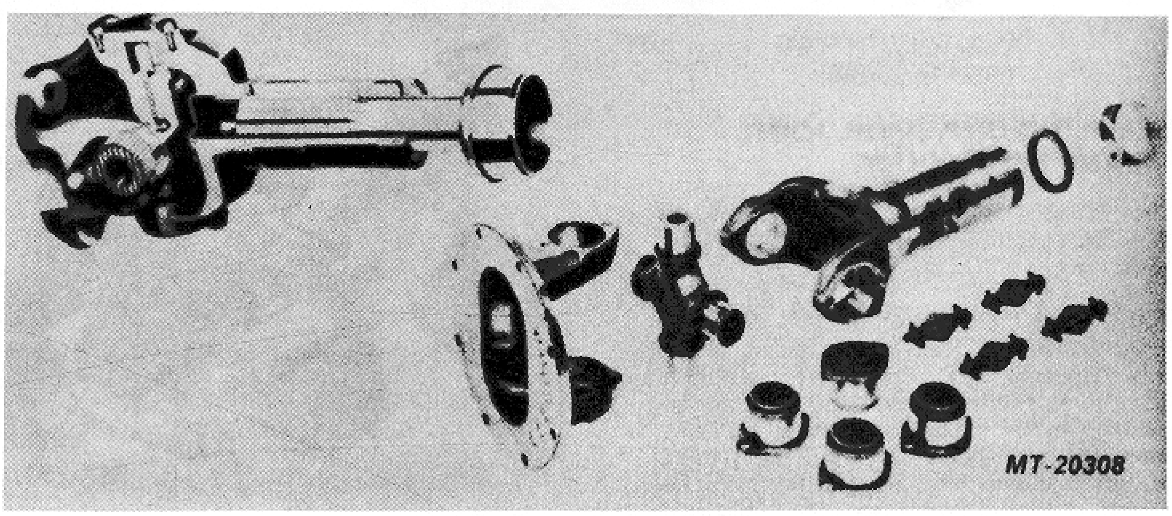


Fig. 23

SERVICE INSTRUCTIONS

DISASSEMBLING UNIVERSAL JOINT

1. SNAP RING - Remove by pinching the ends together with a pair of pliers. If a ring does not readily snap out of the groove in the yoke, tap the end of the bearing cap lightly to relieve the pressure against the ring (Fig. 24).

2. THRUST PLATE CONSTRUCTION (Fig. 25) - Remove capscrews and plate. The balance of the disassembly and assembly instructions are the same as those for snap ring joints.

3. NEEDLE BEARING CAP - Remove by driving on the end of one bearing cap until the opposite bearing cap comes out. Turn the joint over and tap the exposed end of the journal cross until the opposite needle bearing cap is free. Use a soft round drift with flat face about .79 mm (1/32") smaller than the hole diameter in the yoke, otherwise, there is danger of damaging the bearing.

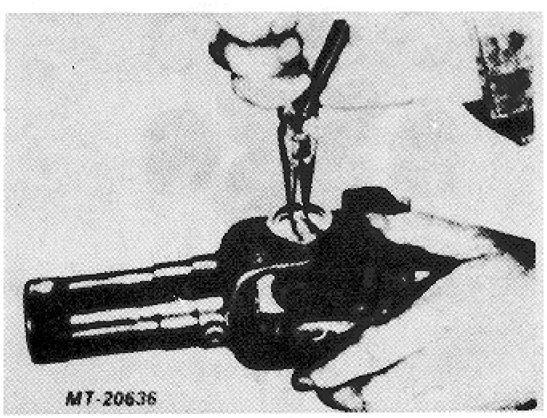


Fig. 24

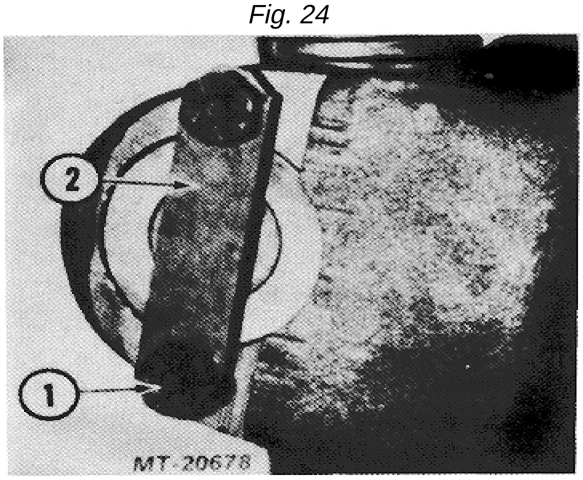


Fig. 25

4. JOURNAL CROSS- Remove by sliding it to the side of the yoke and tilting it over the top of the yoke lug (Fig. 26).

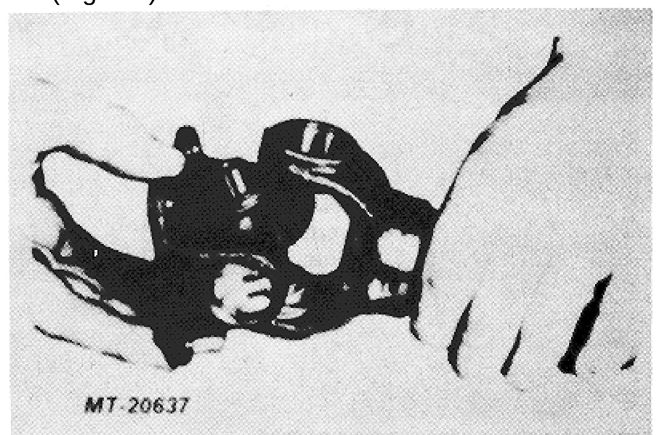


Fig. 26

ASSEMBLING UNIVERSAL JOINT

Reassembly is merely reverse order of the above operations. On joints without a lubrication fitting, repack reservoirs in the journal cross ends with the recommended lubricant. Make sure the reservoir in each trunnion is filled. With the rollers in the race, fill the race about 1/2 full (Fig. 27).

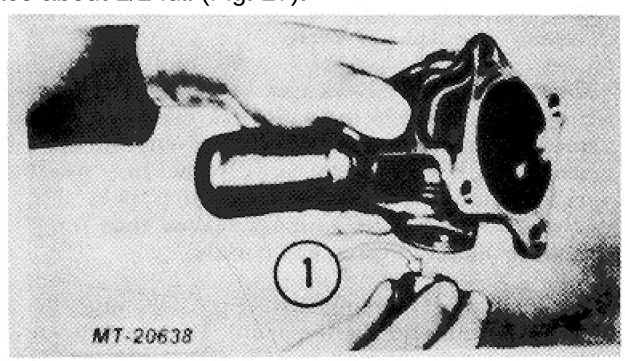


Fig. 27

1 Fill Race 1/2 Full With Lube

U-BOLT CONSTRUCTION

U-Bolt joints are a combination of U-Bolt and snap ring construction (Fig. 28). Except that the U-Bolts are disassembled when the complete propeller shaft is removed from the vehicle, the balance of disassembly and assembly instructions are the same as those for snap ring joints.

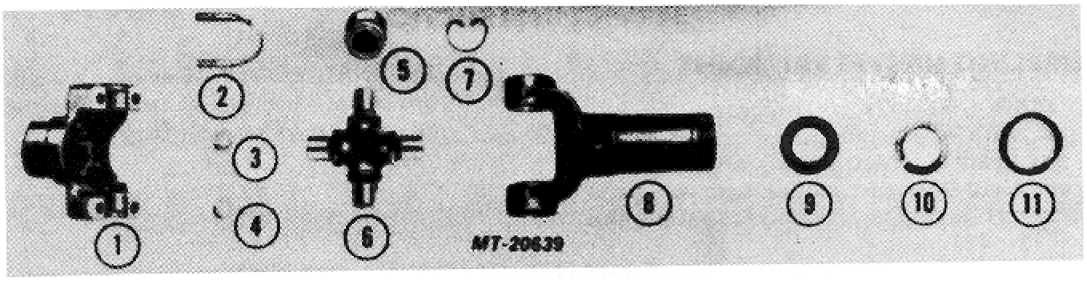


Fig. 28

1 End Yoke
2 U-Bolt
3 Nut
4 Lock Washer
5 Bearing Assembly
6 Journal Assembly
7 Snap Ring
8 Sleeve Yoke
9 Cork Washer
10 Steel Washer
11 Dust Cap

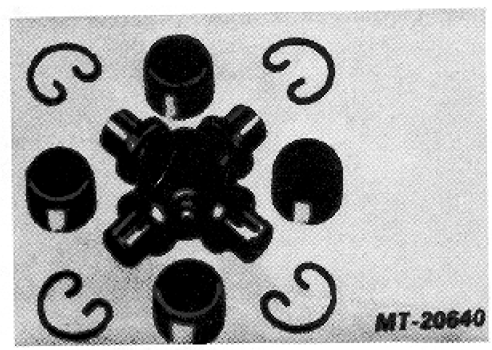
CLEANING AND INSPECTION

1. Clean All Parts - Use a suitable cleaning fluid. Allow the parts to remain in the cleaner for some time to loosen up any particles of grease or foreign matter. Re-move any burrs or rough spots from any machined surfaces.

2. Needle Bearings - Do not disassemble. Clean with short stiff brush and blow out with compressed air. Work a small quantity of lubricant into each bearing cap and turn the needle bearing on the trunnion to check wear. Replace if worn.

3. Journal Cross - Because worn needle bearings used with a new journal cross or new needle bearings used with a worn journal cross will wear more rapidly making another replacement necessary in a short time, always replace the journal cross and four needle bearing caps as a unit.

4. Journal and Bearing Kit (Figs. 29 and 30) - To facilitate the replacement of journals and bearings, a Journal and Bearing Kit is available. The use of the Kit insures having the correct individual parts when required and saves valuable time.



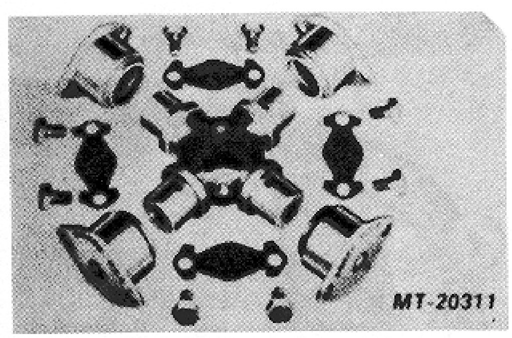


Fig. 30

FAILURE ANALYSIS

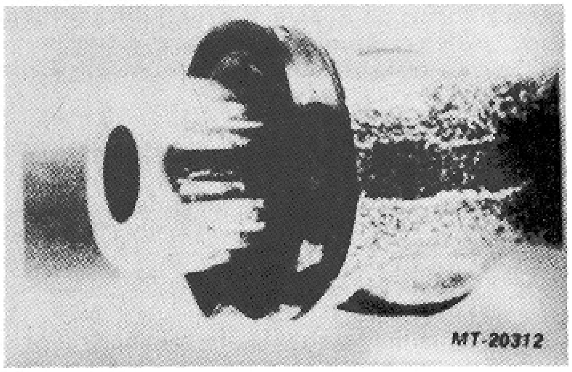


Fig. 31 Lack of Lubrication

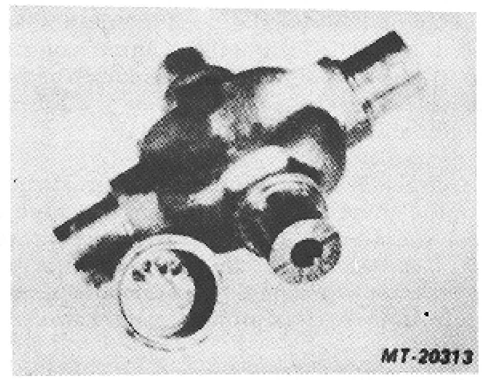


Fig. 32 End Galling

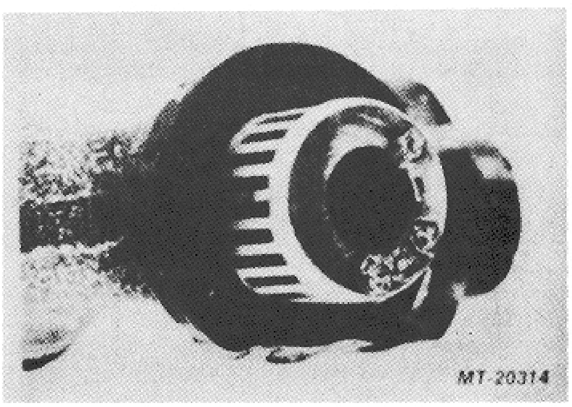


Fig. 33 Brinnelling

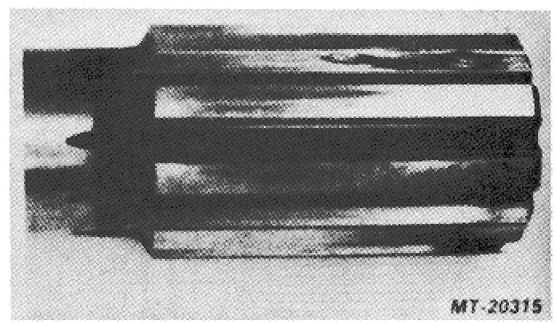


Fig. 34 Slip Spline Galling

REBUILDING DRIVESHAFTS

BALANCING

The rebuilding of a driveshaft assembly usually consists of replacing worn journal cross and bearings with a new kit. These kits replace the part of a driveshaft most subject to wear in operation. The slight off-center condition pre-sent in the journal cross assemblies makes it desirable to balance the assembly after installing new journal and bearing kits.

Generally, unbalance resulting after installation of a journal and bearing kit is equivalent to the unbalance existing after straightening the shaft. If balancing cannot be done, it is advisable to check assembly for smooth operation in vehicle before it is put into operation.

It is sometimes necessary to revise drive-shaft lengths when rebuilding a vehicle. This job requires proper facilities to produce a quality assembly. It is necessary to properly assemble fittings into the tube and straighten, before welding, to be sure parts are centralized. This can be done by mounting shaft assembly on center and straightening at fittings until ends of tube run concentric within about .12 mm (.005"1) TIR. The welding of the tube in the fittings must provide for adequate strength and prevent distortion which could cause excessive runout. It is often desirable to tack weld and recheck for runout before proceeding with final weld. After welding, the entire driveshaft should be straightened to the following limits: (See Fig. 35)

.12 mm (.005") TIR	On shaft neck
.25 mm (.010") TIR	On ends of tubing 38.1 mm (1-1/2") from welds
.38 mm (.015") TIR	In center of tube

These runouts should be taken with entire driveshaft assembly mounted on master attaching flanges or yokes, selected for dynamic balance to eliminate as much unbalance as possible. During balancing, the driveshaft again should be mounted on these selected flanges or yokes.

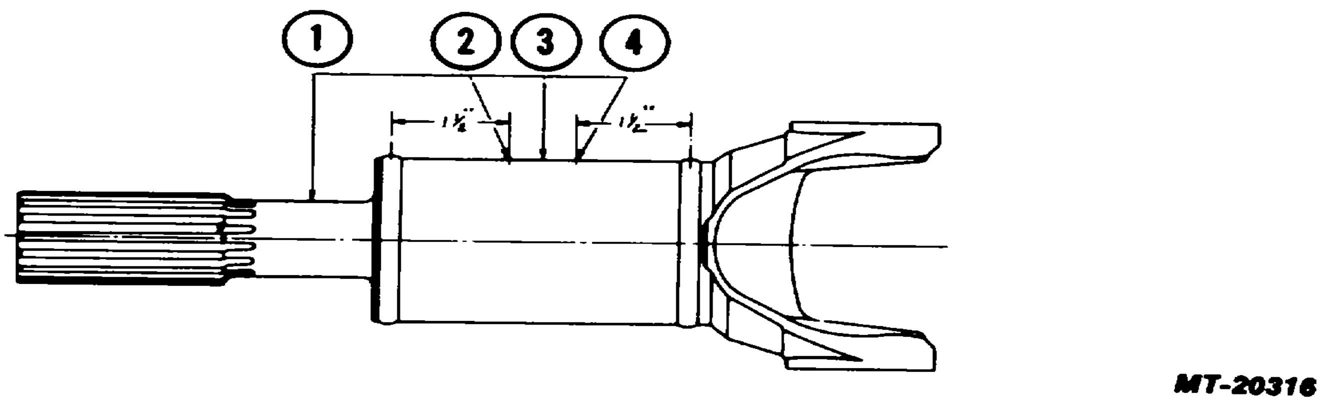
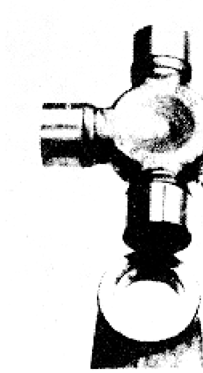


Fig. 35 Chock Straightness of Shaft With Dial Indicator At Points 1- 2 - 3 - 4.

1 - .005"	3 - .015"
2 - .010"	4 - .010"

INSTALLATION



JOURNAL CAPS WITH LOCK FLATS (Fig. 36) - When installing new journal kit caps into yoke ear holes, the lock flat on two of the journal caps must be kept in alignment with the locking flats near the front of the yoke ears. Proper location of locking flats will assure that the journal cap will not rotate.

The installation of a driveshaft into the vehicle does not present any unusual mechanical difficulties. Before actual installation, the drive-shaft should be checked for the following items:

1. No damage or dents on driveshaft tubing which could cause unbalance. If the dents are severe enough they can weaken the tube and a failure might occur under torque load.

2. Splines should slide freely with slight drag from spline seal.

3. Bearings should flex and be free from excessive bind. A slight drag is the most desirable condition on a new universal joint. This drag is from the bearing seals. When rotating, yoke lug deflections cause some additional clearance. Excessive looseness is not desirable due to the resulting unbalance.

4. Mounting flanges and pilots should be free from burrs, paint and foreign substances which would not allow proper seating at assembly.

The driveshaft is mounted using flange bolts, bearing capscrews, or "U" bolts depending upon the size and construction. These bolts must carry high torque loads and should be of quality material and properly torqued. The following reviews requirements on these bolts:

1. Flange Bolts: Flange bolts should be alloy steel equivalent to SAE Grade 8, high-strength bolts. These bolts used with spring lockwashers and nuts provide the capacity. required. The nuts should be torqued to the following specifications:

	N.m	Ft. Lbs.
5/16"-24 Thread	29.8-32. 5	22-24
3/8"-24 Thread	54.2-59.6	40-44
7/16"-20 Thread	85.4-94.9	63-70
1/2"-20 Thread	132.9-146.4	98-108

IMPORTANT

In cap and bolt construction joints (Fig. 7), be sure to torque the cap-screws to 135.6 N.m (100 ft.lbs.). These joints are usually in the inter-axle assemblies.

2. U-Bolt Style Yokes: On smaller size universal joints, a "U" bolt style end yoke is used. This construction permits easier assembly where the smaller size bearings allow its use. The bearing race is seated in a half round hole and under locating ears. Be sure that mounting faces are cleaned of rust, paint and other foreign material. The "U" bolts are assembled over the bearing races to retain them in the end yokes. Spring lockwashers and nuts should be used with these "U" bolts at assembly. The following torque loads are suggested for use with these parts:

	N.m	Ft. Lbs.
5/16"-24 Thread	18.9-23.0	14-17
3/8"-24 Thread	27.1-32.5	20-24
7/16"-20 Thread	43.3-50.1	32-37

These torque loads are somewhat lighter than normally used with these thread sizes, how-ever, the lower torques are required to prevent bearing race distortion.

ASSEMBLING SLIP JOINT ON SHAFT

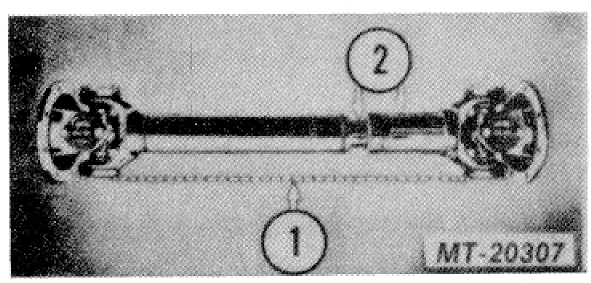


Fig. 37

1 Yoke Lugs in Line
2 Line Up Arrows

INSTALLATION

Lubricate the splines thoroughly (refer to page 10) and assemble on the shaft. BE SURE that the arrows or marks on the shaft and slip joint are in line, since the sleeve yoke lugs must be in the same plane as the stud ball yoke lugs to prevent excessive vibration (Fig. 37).

The cork washer should be replaced if necessary before assembling with the dust cap and steel washer on the sleeve yoke.

INSTALLING PROPELLER SHAFT

1. Propeller Shaft Assembly - Place in a pair of centers and check the shaft for runout if not previously done during assembly. The runout on the tube should not be more than .38 mm (.015") indicator reading, and on the neck of the slip stub shaft the runout should not be more than .12 mm (.005") indicator reading. Mark the high and low points on the shaft with chalk and straighten if necessary. Install with the slip joint nearest the source of power. Tighten the flange bolts evenly after the nuts and NEW lockwashers are in place.

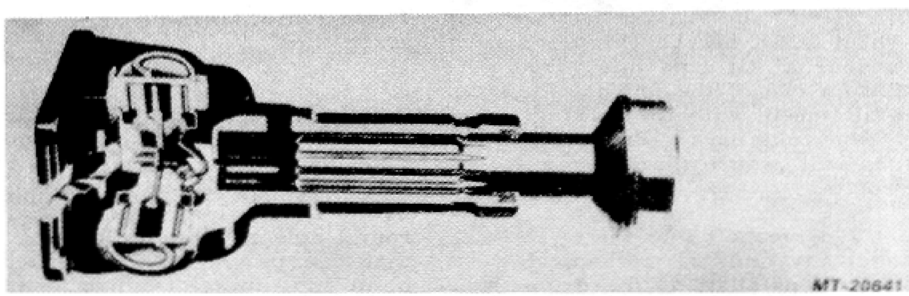


Fig. 38

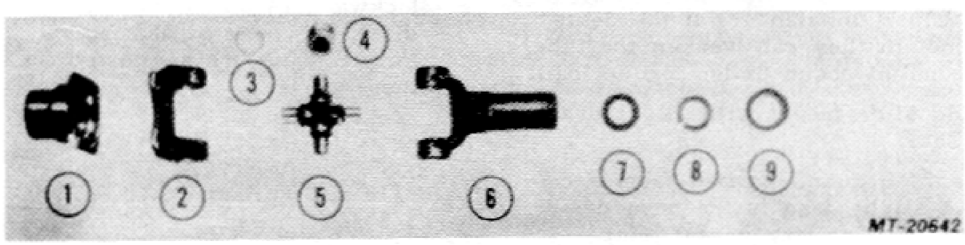


Fig. 39

1 Flange Yoke
2 Flange Yoke
3 Snap Ring
4 Bearing Assembly
5 Journal Assembly
6 Sleeve Yoke
7 Cork Washer
8 Steel Washer
9 Dust Cap

TWO-JOINT PROPELLER SHAFT

It is of primary importance that universal joints of sufficient capacity be used. When assembling the slip joint on the shaft, care must be taken to place the sleeve yoke lugs (12) in the same plane as the shaft yoke lugs (13). Arrows will be found stamped on the sleeve and shaft for this purpose.

Install transmission so that the transmission mainshaft and axle pinion shaft are parallel or nearly so, in order to keep the angles (X) on both joints as nearly equal as possible. See Fig. 40. If this method results in angles (X) of more than 12 degree, use the method shown in Fig. 41, where the axle pinion shaft is tilted upward to enable the centerlines to intersect at a point midway between the joint centers, thus giving equal angles (Y).

INSTALLATION

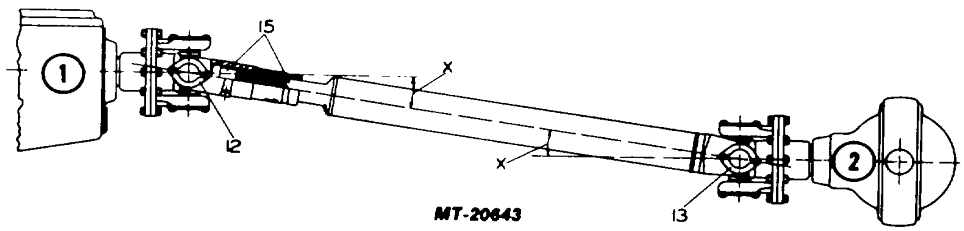


Fig. 40

1 Transmission 2 Axle

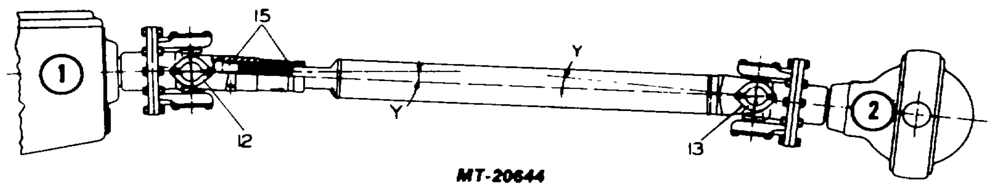


Fig. 41

1 Transmission 2 Axle

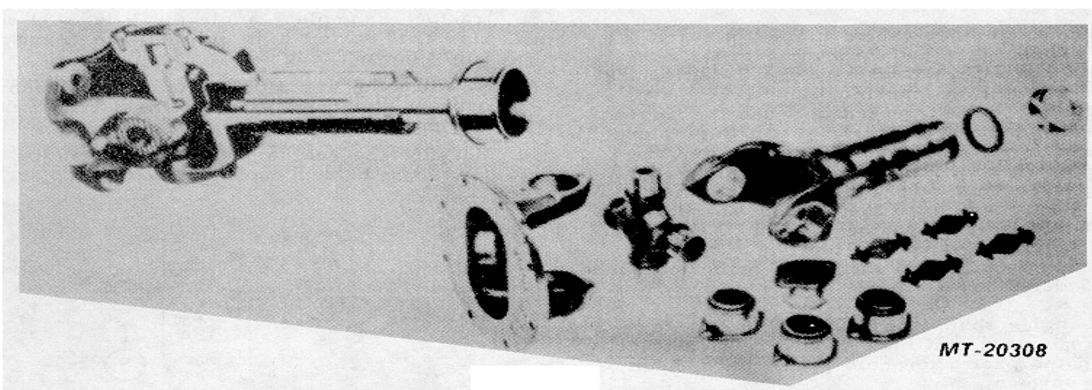


Fig. 42

UNIVERSAL JOINT PHASING (See Fig. 37)

When U-joints or yokes are assembled to their shafts in the same plane, they are in phase. When they are assembled to the shaft in different planes, they are out of phase. To obtain vibration free operation, check the following.

1. Yokes or flanges between the main and auxiliary transmission must be "In Phase".
2. In the case of a two-piece driveshaft assembly, between the transmission (Main or Auxiliary) and the forward rear axle, the joints on this shaft should be assembled "In Phase", unless otherwise specified by the manufacturer of the vehicle.
3. The inter-axle driveshaft yokes must be "In Phase".
4. If a vehicle has driveshafts that do not have intersecting angles but parallel angles throughout the drive line system, the yokes or flanges must be held parallel to within 1 deg. of each other.

INSTALLING DRIVESHAFT

Drive Shaft Assembly - Place in a pair of centers and check the shaft for runout if not previously done during assembly. The runout on the tube should not be more than .38 mm (.015") indicator reading, and on the neck of the slip stub shaft the runout should not be more than .12 mm (.005") indicator reading. Mark the high and low points on the shaft with chalk and straighten if necessary. Install with the slip joint nearest the source of power. Tighten the flange bolts evenly after the nuts and NEW lockwashers are in place.

CHECKING DRIVESHAFT ANGLES

The procedure to check driveshaft angles for proper universal joint operating angles follows:

1. Remember to check driveshaft angles both with the tractor fifth wheel unloaded, and loaded with a trailer.

2. To determine driveshaft angles, a spirit level protractor is required (Fig. 43). When angles are read from the 0 deg. Mark (for example, measuring inter-axle shaft angle - 5 deg.), record and use the angle shown on the protractor. When angles are read from either of the 90 deg. Marks (vertically) for example, measuring yoke angles, do not record the angle shown on the protractor since the 90 deg. marks must be understood to be the same as 0 deg. On the horizontal plane. Thus, if a vertical reading is 85 deg., the angle being measured is 5 deg.

3. All angles should be read within 1/4 deg. (15 minutes) and they should be measured with the protractor held plumb on a clean, flat surface.

4. Inflate all tires to the pressure at which they are normally operated. Park the tractor on a surface which is as nearly level as possible both from front-to-rear and from side-to-side.

5. The tractor must be in its normal operating position. Do not attempt to level the truck by jacking up the front or rear axles to obtain a level condition.

6. Check and record the angle on the engine and main transmission. This reading can be taken at the rear of the main transmission on the output yoke or flange. Record this reading on a sketch similar to Fig. 44 (Example on Fig. 45, -1 deg. down).

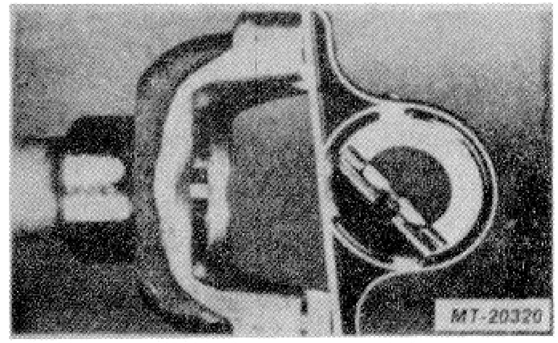


Fig. 43

7. Move protractor to the 0 deg. reading and check driveshaft angle between transmission and forward axle (Example 4 deg. 30 sec. down).

8. Check front axle input yoke angle with protractor (Example - angle up 2 deg. 30 sec.), also check front axle output yoke (Example angle down 2 deg. 20 sec.).

9. Measure the angle of the tandem driveshaft between the front axle and first rear axle (Example 5 deg. down).

10. Measure the rear axle input yoke angle (Example 12 deg. up).

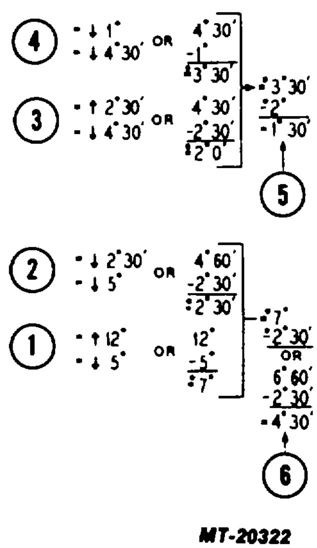


Fig. 44

See Page 23 for legend.

INSTALLATION

Legend for Fig. 44

1	Rear Axle Yoke	=	12°
	Interaxle Drive Shaft	=	5°
2	Forward Axle Output Yoke	=	2° 30'
	Interaxle Drive Shaft	=	5°
3	Forward Axle Input Yoke	=	2° 30'
	Front Drive Shaft	=	4° 30'
4	Transmission Output Yoke	=	1°
	Front Drive Shaft	=	4° 30'
5	Good Cancellation of Journal Operating Angles		
6	Improper Cancellation of Journal Operating Angles		

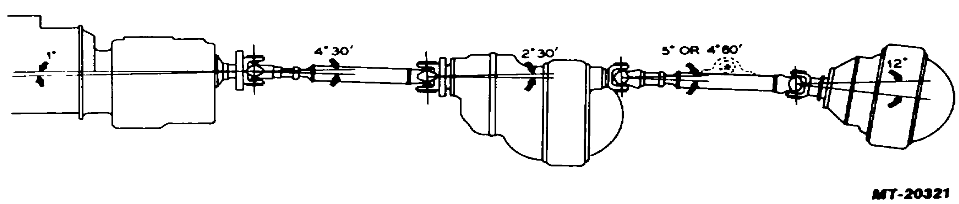


Fig. 45

11. With all the above angles recorded, these values are checked to obtain the journal cross operating angles of each driveshaft set to determine if they are operating to within a 3 deg. maximum of each other. If the operating angles or journals exceed 3 deg., it will cause early wear, and possible seizure of the journal to the needle bearing in the journal cap.

TORQUE ARM SHIMMING

The adding or removing of shims from the rear torque arm will change the angle of the inter-axle driveshaft. Therefore, it is necessary to take the inter-axle driveshaft angle and the rear axle yoke angle after each adjustment is made, to determine the journal operating angle.

SHORT COUPLED JOINTS

Short coupled joints must be installed so that the front and rear joints will have equal angles which should not exceed 3 deg.

CENTER BEARING

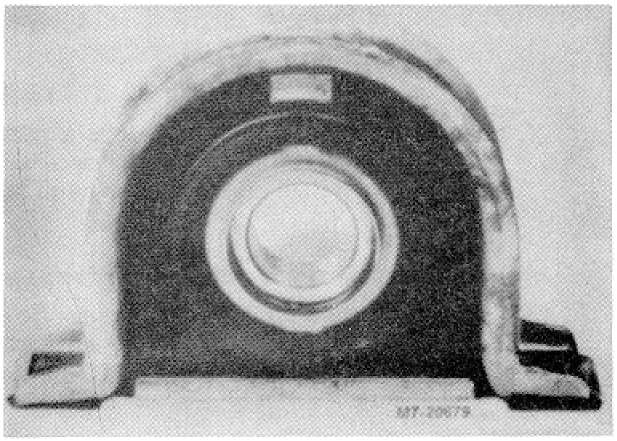


Fig. 46

GENERAL

Center bearings (Fig. 46) are provided to support the propeller shaft assembly and to smooth out the power delivered to the rear axle assembly.

Loose center bearing assembly mounting bolts should be tightened. Deteriorated or oil soaked center bearing insulators should be replaced. These conditions can cause excessive drive line vibration if not corrected.

BALL BEARING TYPE

Description

The center bearing used on some vehicles utilizes a ball bearing with the bearing housing enclosed in rubber.

No lubrication for this center bearing is provided as the bearing is filled with a waterproof grease for life of bearing.

REMOVE

1. Set parking brake.
2. Disconnect rear propeller shaft assembly (universal joint) at center bearing.
3. Remove companion flange nut, then remove the yoke assembly.
4. Remove the center bearing bracket mounting bolts and separate center bearing mounting bracket with bearing from center bearing bracket (on frame crossmember).
5. Remove center bearing assembly and both slingers from stud shaft.
6. The center bearing is serviced as a complete assembly, therefore separating the "U" shape bracket from rubber cushion is not required.

REASSEMBLY

The reassembly procedure is the reverse of the disassembly procedure. Be sure to inspect the center bearing bracket (on frame crossmember) for damage.

EXHAUST

CONTENTS

Subject	CTS No.
NOTE: No Service Manual Section with EXHAUST application available at this time.	

ELECTRICAL

CONTENTS

08

ELECTRICAL

Replace old section with this revised section in your CTS-4001 Service Manual.

IH HEAVY DUTY ALTERNATORS

CODE	RATING
08142	90 Amp

PRINTED IN UNITED STATES OF AMERICA

CHAPTER II

IH ALTERNATORS
LOW BLEED

PART NUMBER	RATING
585946C91	90 Amp

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

IDENTIFICATION CHART

IH IDENTIFICATION		MFGR'S. NO.	RATING	REGULATOR
CODE	PART NUMBER			PART NUMBER
08141	585945C91	2312JB	65 Amp	585949-C1
08142	585946C91	2512JB	90 Amp	
08143	585947C91	2612JB	105 Amp	
08158	585948C91	2812JB	145 Amp	
08172	547269C91	2912JB	160 Amp	

DESCRIPTION

The IH heavy duty alternators (Figure 1) are 14 volt self load limiting alternators which feature a built-in solid-state voltage regulator.

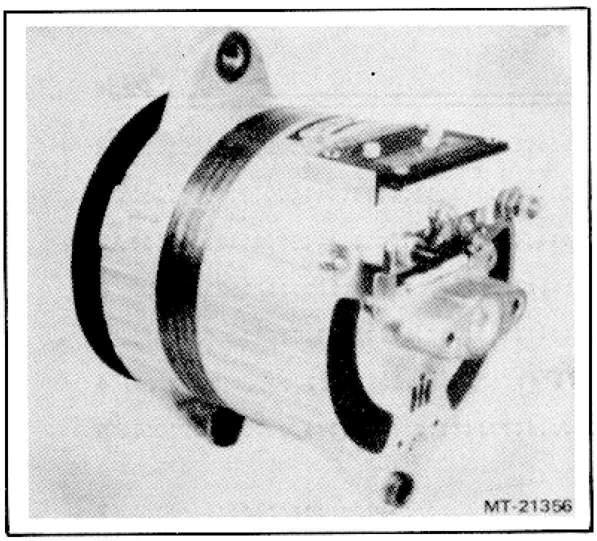


Figure 1 - Alternator Assembly.

Alternators built through late 1983 are equipped with adjustable voltage regulators.

Alternators built more recently are equipped with "fixed voltage" regulators which cannot be adjusted. These regulators are identified by the absence of the plastic screw that was used to plug the voltage adjustment access hole (Figure 2).

Adjustable and non-adjustable regulators are interchangeable and have the same part number. Only the non-adjustable type will be provided for service after stock of the adjustable type is depleted.

The alternators incorporate a 7/8" straight shaft, a large ball bearing at the drive end and a roller bearing at the slip ring end. The alternators have a two leg swivel mounting, one leg of which is equipped with a slideable bushing.

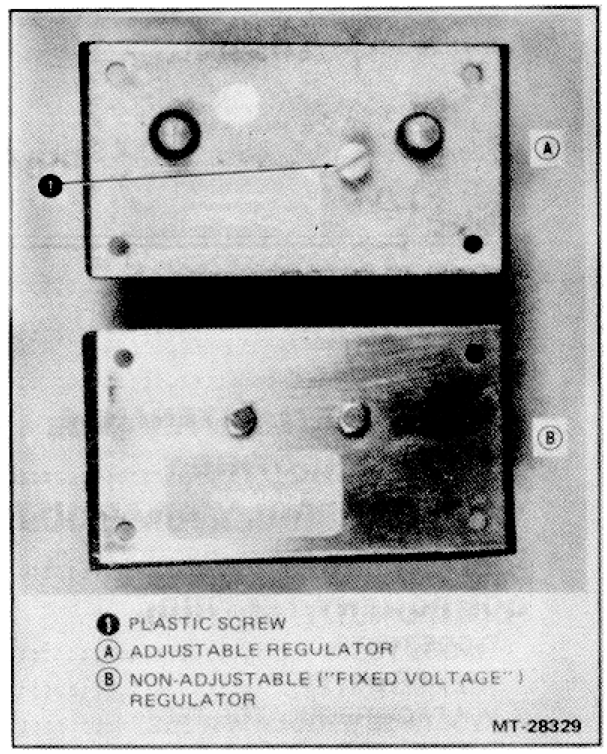


Figure 2 - Voltage Regulators.

Six silicon diodes mounted in heat sinks convert alternating current from the delta wound stator into direct current. A capacitor connected between the heat sinks assists in suppressing transient voltage spikes which could possibly injure the diodes.

The brushes and voltage regulator are located in a waterproof housing and may be removed for replacement or inspection without dismantling the entire machine.

OPERATION

Current is produced by rotating a magnet called a rotor inside a stationary winding called a stator.

The rotor is electrically magnetized by a small current flowing through it via brushes riding on smooth slip rings.

Alternating current is produced as the magnet poles of the rotor pass through the coil windings of the stator. For increased capacity, there are twelve (12) magnetic poles incorporated into the rotor and three (3) separate windings in the stator. Since alternating current is produced as the rotor passes the coil windings of the stator, increased engine speed produces more current.

The battery stores only direct current and cannot use alternating current. For this reason, rectifier assemblies are used to convert alternating current produced in the stator to direct current. Rectifiers consist of silicon diodes which function as electrical switches and permit current flow in only one direction.

The rectifier diodes are mounted in aluminum castings, called heat sinks, which are finned to dissipate heat.

A built-in solid state voltage regulator controls alternator output and the battery's state of charge. A lead from the vehicle's key switch provides turn-on voltage to the voltage regulator.

The regulator senses when the battery has received sufficient charge and then reduces the "field" (magnetizing) current flow to the rotor. Reducing the field current flow, in turn, reduces alternator output.

When headlights and/or accessories place a load on the battery, the regulator increases the field current flow to the rotor, thereby increasing alternator output.

PREVENTIVE MAINTENANCE

Mounting hardware including brackets and drive belts must be periodically inspected and adjustments or repairs performed as required. It is important that mounting bolts and nuts be kept securely tightened to maintain belt alignment and prevent vibration damage which will occur if mounting bolts work loose.

Vehicle wiring must be inspected at periodic intervals for loose or corroded connections and repairs made as needed.

TROUBLESHOOTING

1. Check the drive belts, wiring, and mounting hardware, and make sure that they are in proper working order.
2. Check the batteries according to manufacturer specifications to insure that they are in good condition. The batteries must be at least 75% charged. If necessary, charge or replace batteries.
3. To establish if the alternator is functioning properly, connect an accurate test voltmeter to the alternator output terminals (use a voltmeter capable of measuring 1/100 of a volt). With all electrical accessories off, run the engine at approximately 1000 RPM.

   Voltage reading should be within 13.8-14.2 volts.

   If the alternator is overcharging, continue with step 7. If a low output condition is noted, then continue with step 4.

4. Remove the regulator as shown under DISASSEMBLY section.

   Remove and inspect the brushes. If brushes are cracked, burned or worn to 3/16" or less, then the brushes must be replaced. Insure that each brush contact lead has a good connection to the brush and the contact cap.

   Clean each brush contact cap and the two contact pads on the regulator.

   Reinstall the brushes and regulator as shown under REASSEMBLY, steps 12 and 13.

5. Repeat the test in step 3. If the output voltage is below 13.8 volts, the unit should be full field tested as shown in step 6.

6. Shut off the engine and all electrical accessories. Measure the voltage at the alternator output terminals and make a note of the reading. Connect a short jumper to the alternator NEGATIVE output terminal and to a 1.5-2" piece of stiff wire (a piece of paper clip wire is suitable). Insert the wire in the full field access hole as far as it will go. See Figure 3.

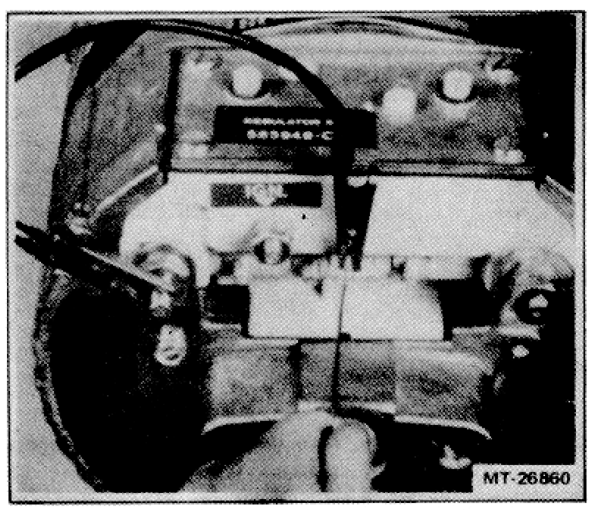


Figure 3 - Jumper Connections for Full Field Test.

   Run the engine at about 1000 RPM and check the output voltage. If the voltage rises rapidly above the voltage reading noted when the engine was off, the alternator is OK, continue with step 7.

   If the voltage rises slowly or remains the same, the alternator is defective. Continue with step 8.

7. If the alternator is found to be OK or if an "overcharging" condition exists, then the regulator must be adjusted. See VOLTAGE REGULATOR ADJUSTMENT.

   NOTE - If the alternator Is equipped with a "fixed voltage" (non-adjustable) regulator, then adjustments cannot be made. If the alternator is found to be OK, the "fixed voltage" regulator must be replaced.

   If adjustment has no effect on the output voltage, the regulator must be replaced.

8. To establish which component is causing the alternator to malfunction, perform an AC voltage test.

   The batteries must be fully charged and a 12-volt test lamp is needed to perform this test. The test lamp can be made of a two filament headlight unit, with both filaments wired in parallel. The lamp acts as an indicator as well as a load. With all electrical accessories off, run the engine at about 1000 RPM and connect the test lamp across the three AC terminals as shown in Figure 4.

   If the test lamp does not light, or if it lights with equal intensity on each phase, then the rotor is probably faulty. If one or two test points result in a dimmer light, then either the stator or a power diode is defective.

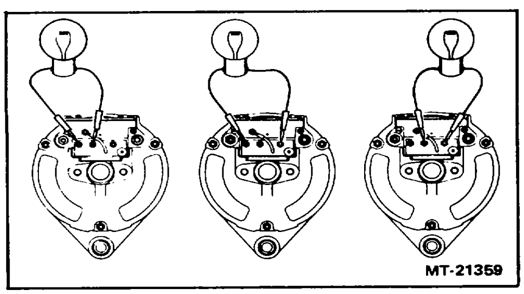


Figure 4 - AC Voltage Test.

The voltage regulator used in these alternators is a solid state device and for this reason will normally have an extremely long life. It can, however, be damaged by mechanical or electrical abuse.

If the system polarity is inadvertently reversed by installing a battery backwards, boosting or jump starting with the jumper connected backwards, or reversing the positive and negative alternator output leads when changing an alternator, the voltage regulator will be damaged. Although the polarity reversal may only be momentary and may not damage the alternator diodes, the regulator will still be damaged.

VOLTAGE REGULATOR ADJUSTMENT

NOTE - This procedure applies to alternators with adjustable regulator. If the alternator Is equipped with a "fixed voltage" regulator, adjustment cannot be made.

1. Check the drive belts, wiring, and mounting hardware, and make sure that they are in proper working order.

2. Check the batteries according to manufacturer's specifications to insure that they are in good condition. The batteries must be fully charged. If necessary, charge or replace batteries.

3. To adjust the regulator, shut off all electrical accessories and run the engine at about 1000 RPM. Check the voltage across the alternator output terminals. Remove the plastic screw from the regulator and engage a small screwdriver with the adjustment screw inside the access hole (Figure 5).

   CAUTION - TO AVOID DAMAGING REGULATOR, DO NOT EXERT EXCESS PRESSURE ON THE ADJUSTMENT SCREW.

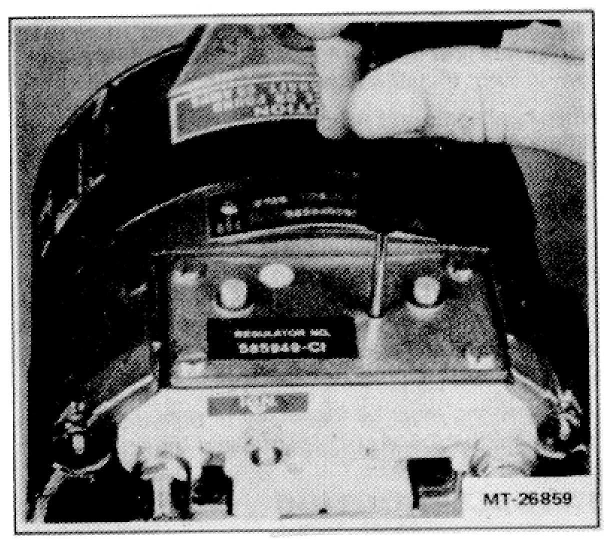


Figure 5 - Adjusting Voltage Regulator.

Turn the adjustment screw CLOCKWISE TO RAISE voltage or COUNTERCLOCKWISE TO LOWER the voltage.

CAUTION - TO AVOID DAMAGING REGULATOR, DO NOT FORCE THE ADJUSTMENT SCREW PAST THE STOPS AT EITHER END OF THE ADJUSTMENT RANGE.

Voltage should be set between 13.8-14.2 volts (or 14.0 volts nominal setting ± 0.2 volts). Reinstall the plastic screw in the access hole. If the above procedures have no effect on the output voltage, the regulator or alternator is defective. Perform TROUBLESHOOTING procedures to find cause of problem.

DISASSEMBLY

1. Remove pulley nut, pulley, fan, key and spacer. Use a suitable puller to avoid damage to the shaft and threads.

2. Remove four screws and carefully lift regulator free of housing. Remove red and black leads from regulator, noting their position to facilitate reassembly (See Figure 6).

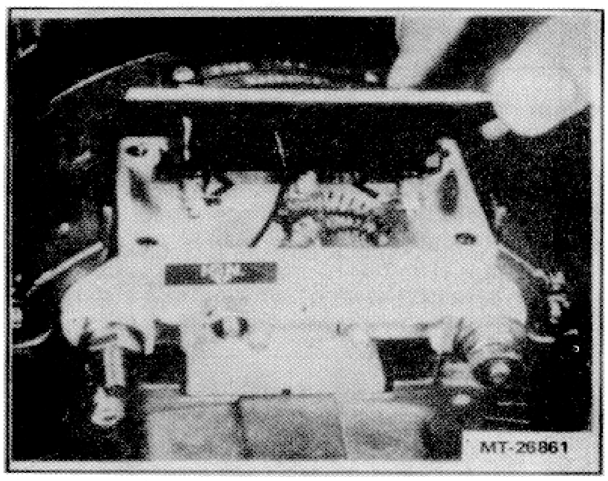


Figure 6 - Removing Regulator.

3. Remove nuts and washers from "IGN." terminal. Loosen inner nut, which will allow blue regulator lead to be withdrawn from under head of terminal screw. Remove regulator (See Figure 6).

4. Lift brush and spring assemblies out of housing.

5. Remove three self locking nuts and through bolts.

6. Remove rotor and drive end housing assembly from stator and slip ring end housing assembly. If drive end housing binds on stator, loosen by tapping gently on mounting ear with fibre hammer. Be sure that drive end housing separates from stator and that stator remains attached to slip ring end housing to avoid damage to stator leads (See Figure 7).

7. Remove three nuts which secure stator leads to terminals and remove stator.

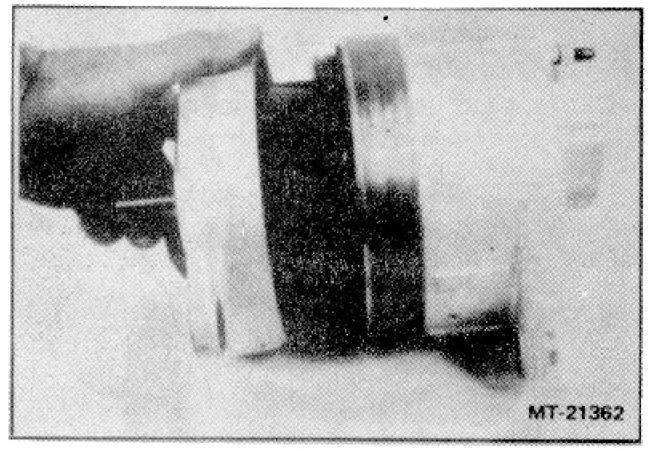


Figure 7 - Removing Drive End Housing and Rotor.

8. Remove nuts from positive and negative output terminal bolts and remove the bolts. Note the location of the red and black regulator leads on the heat sinks (See Figure 8).

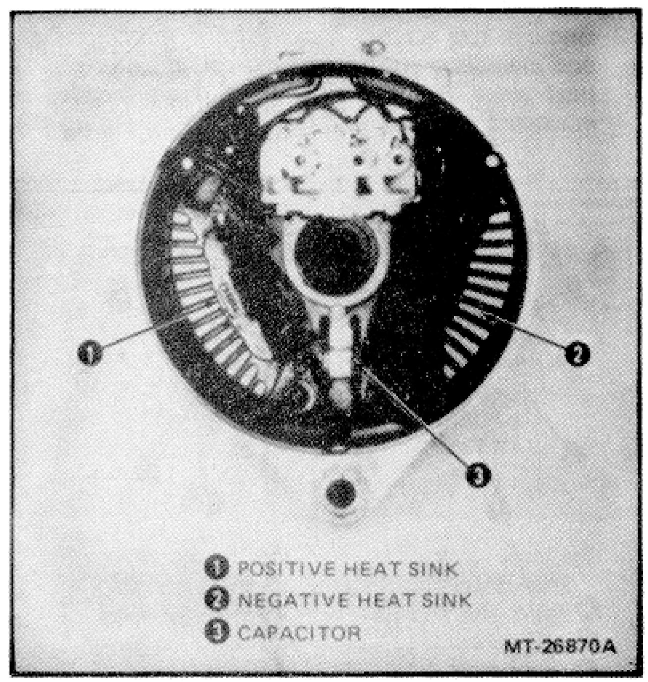


Figure 8 - Heat Sinks and Capacitor.

9. Remove three hex head screws and remove capacitor connected between the heat sinks (See Figure 8).

10. Remove regulator housing. Note location of gasket which seals brush compartment (See Figure 9).

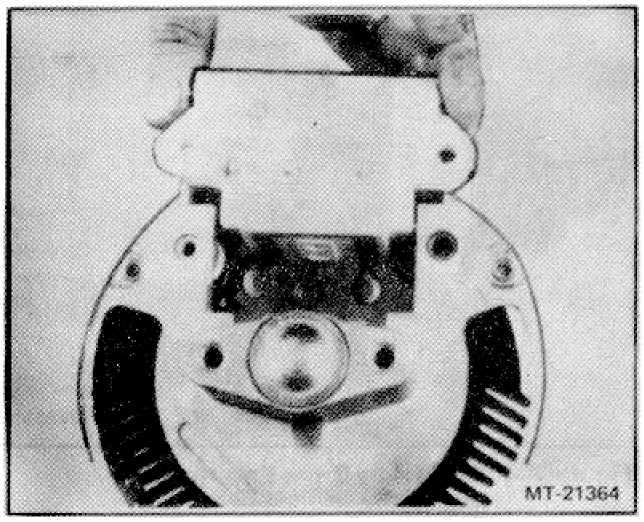


Figure 9 - Removing Regulator Housing.

11. Remove terminal stud insulating bushings from housing. There are two bushings in each terminal hole (See Figure 9).

12. Remove two screws, lockwashers, guardwashers and insulating washers which retain lower end of heat sinks. Remove heat sinks. Note location of insulating washers and bushings (See Figure 10).

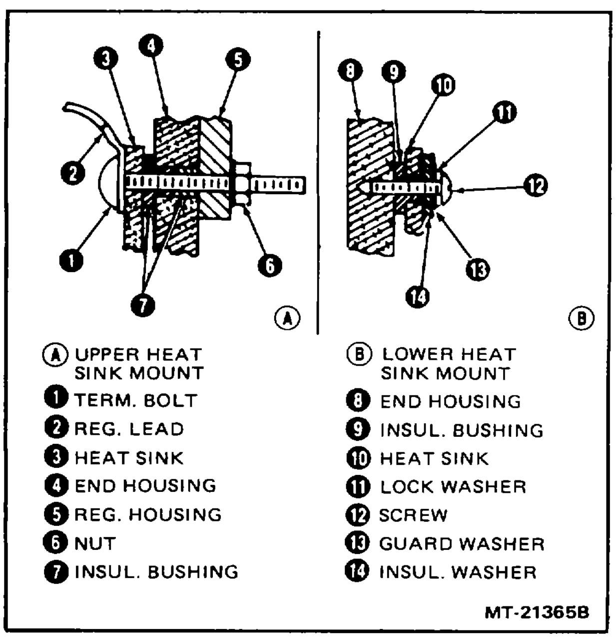


Figure 10 - Heat Sink Mountings.

13. Pry flanged dust cap out of housing (See Figure 11).

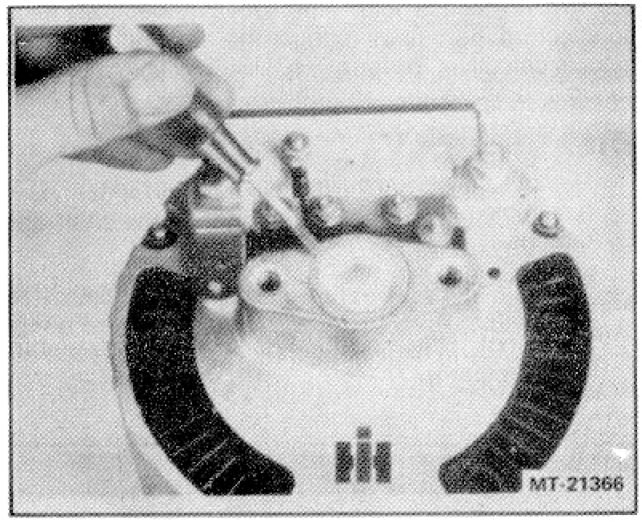


Figure 11 - Removing Dust Cap.

NOTE - Alternators equipped with a "closed" slip ring end bearing are not equipped with a dust cap.

14. Slip ring end bearing replacement should seldom be required. If it should become necessary; however, press the bearing from the inside of the housing outward (See Figure 12).

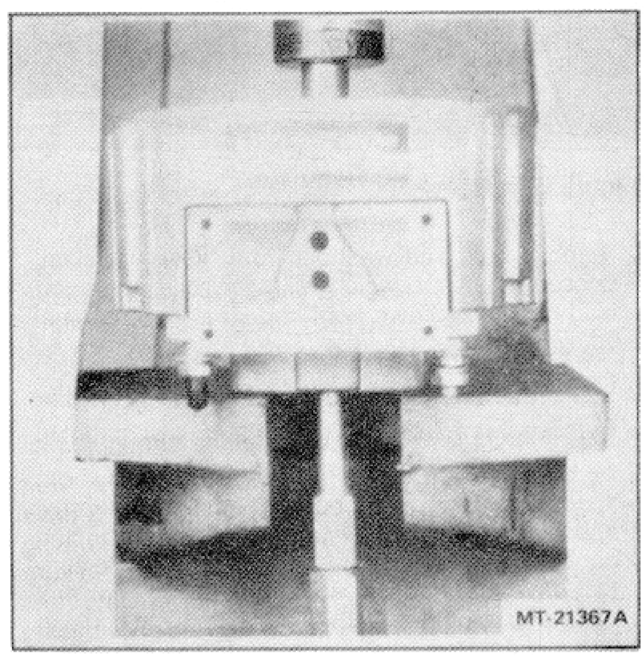


Figure 12 - Removing Slip Ring End Bearing.

15. Using a puller or arbor press, remove the drive end housing and bearing assembly from the rotor shaft (See Figure 13).

HEAVY DUTY ALTERNATORS

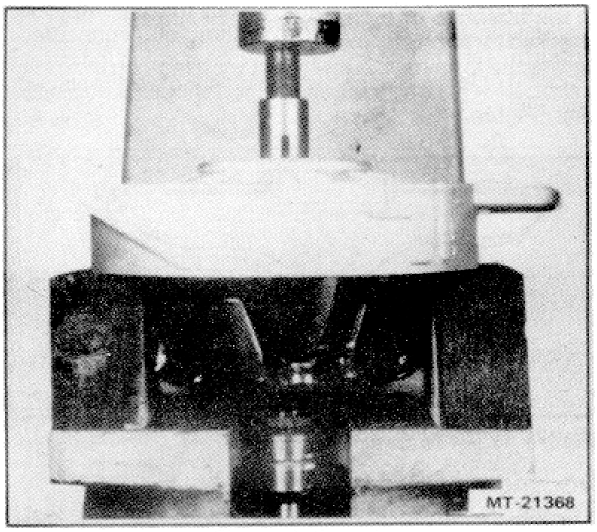


Figure 13 - Removing Drive End Housing From Rotor Shaft.

16. Remove four screws and bearing retainer (Figure 14) and press bearing out of drive end housing.

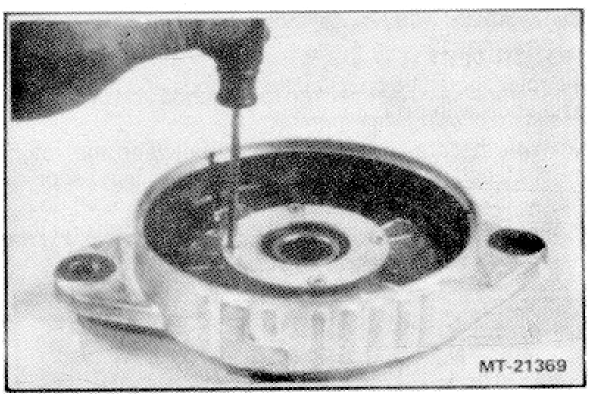


Figure 14 - Removing Drive End Bearing Retainer.

COMPONENT TESTING

Before performing these tests, carefully inspect all parts for wear, cracks, breakage, or other mechanical defects. Discard all damaged parts.

DIODE TESTS

These tests may be performed on heat sink assemblies without removing them from the end housing. If they are tested in this manner, remove the stator and be sure that the red and black leads are disconnected from the regulator and not touching each other. Disconnect the capacitor across the lower end of the heat sinks.

Diodes are tested to insure that they only pass current in one direction. Diodes which do not allow current to flow in either direction are open while diodes passing current both ways are shorted. Diodes should be checked with a diode tester, but in emergencies where one is not available, an ohmmeter or a battery powered test light may be substituted.

Positive Heat Sink Tests

The positive heat sink is the one to which the positive output terminal is connected. The square hole in the terminal end of the positive heat sink is larger than the terminal hole of the negative heat sink.

1. Connect the positive lead of the diode tester, ohmmeter, or test light to the positive heat sink and touch the negative test lead to each of the three diode terminals (Test 1, Figure 15). A high resistance should be indicated and if a test light is being used, it should not light. If any of the three diodes shows a low resistance, or the test lamp lights, the diode is shorted. See IMPORTANT on next page.

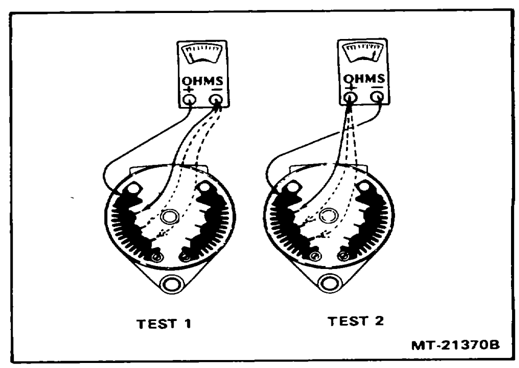


Figure 15 - Positive Heat Sink Tests.

2. Reverse the test leads so that the negative test lead is connected to the positive heat sink. The positive test lead should now be touched to each diode terminal (Test 2, Figure 15). A low resistance reading should be obtained. If a high resistance reading is obtained, or the test lamp fails to light, an open diode is indicated. See IMPORTANT on next page.

Negative Heat Sink Tests

1. Connect the negative test lead to the negative heat sink and touch the positive test lead to each diode terminal (Test 1, Figure 16). If a low resistance reading is obtained, or if the test lamp lights, the diode is shorted. See IMPORTANT on next page.

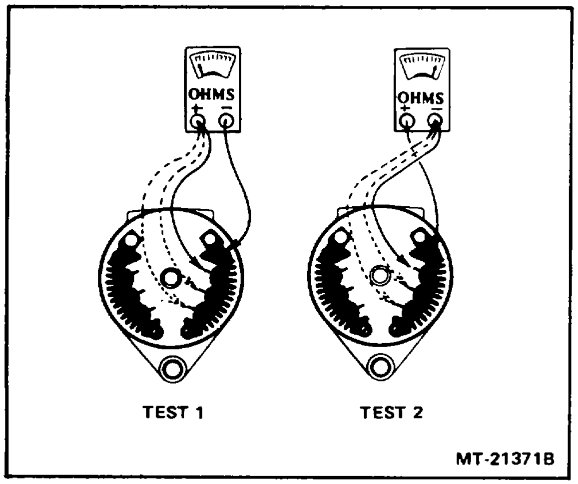


Figure 16 - Negative Heat Sink Tests.

2. Reverse the test leads so that the positive test lead is connected to the negative heat sink. Touch the negative lead to each of the three diode terminals (Test 2, Figure 16). A low resistance reading should be obtained, and if a test light is being used, the lamp should light. If high resistance is indicated or the lamp does not light, the diode is open. See IMPORTANT.

IMPORTANT - WHEN MAKING DIODE TESTS, SOME OHMMETERS MAY INDICATE RESULTS OPPOSITE OF THOSE SHOWN IN TEXT (I.E. A HIGH RESISTANCE WHEN TEXT CALLS FOR LOW RESISTANCE, ETC.). REGARDLESS OF THIS, EACH DIODE SHOULD GIVE ONE HIGH READING AND ONE LOW READING, IF BOTH READINGS ARE THE SAME, DIODE IS FAULTY.

If a shorted or open diode is detected in the preceding tests, the entire heat sink assembly should be replaced.

Heat sinks supplied as service replacements may differ slightly in thickness or general appearance from the original parts. This will in no way impair their interchangeability or reliability. To obtain the maximum serviceability, several different assemblies may be used as replacements. These will be listed in the appropriate parts list.

CAPACITOR TEST

The capacitor connected across the heat sinks may be tested on a capacitor tester if available. Its value is .5 MFD, and 200 working volts D.C.

In the absence of a capacitor tester, the unit may be checked for shorts by means of an ohmmeter connected across the terminals. A low resistance reading indicates a shorted or leaking capacitor which should be replaced (See Figure 17).

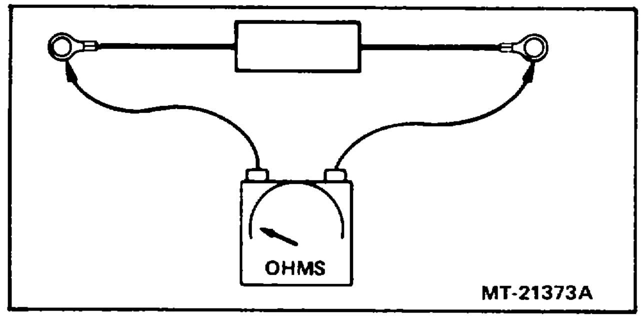


Figure 17 - Testing Capacitor.

VOLTAGE REGULATOR TEST

The regulators used in these alternators cannot be tested with ordinary test equipment. The easiest way to check a regulator is to install it in an alternator which is known to be in good working condition. Perform the voltage adjustment procedures shown in VOLTAGE REGULATOR ADJUSTMENT. If the alternator output cannot be modified or if the output voltage is unstable, the regulator must be replaced.

ROTOR TEST

The rotor should be checked for grounds and proper coil resistance with an ohmmeter.

1. With the ohmmeter connected between the rotor shaft and either slip ring, no reading (infinity) should be obtained. If an ohmmeter reading other than infinity is obtained, the rotor coil is grounded and the rotor must be replaced (See Figure 18).

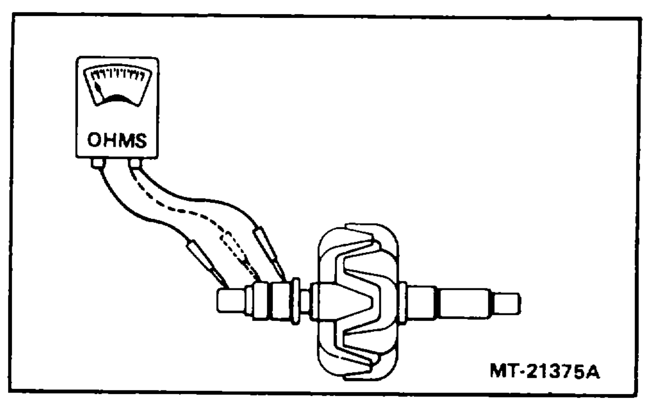


Figure 18 - Rotor Coil Ground Test.

2. Check rotor coil resistance by connecting the ohmmeter across the two slip rings (See Figure 19). The resistance of the rotor should be within the following limits:

2312JB	4.9-5.5 Ohms
2512JB	2.3-2.7 Ohms
2612JB	2.3-2.7 Ohms
2812JB	1.9-2.3 Ohms
2912JB	1.9-2.3 Ohms

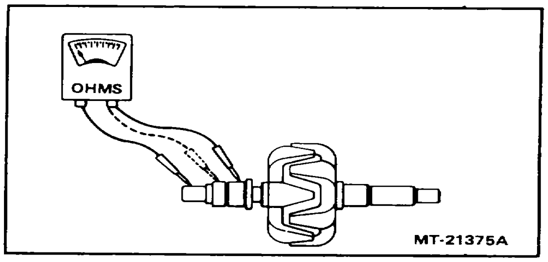


Figure 19 - Rotor Coil Resistance Test.

Discard rotors whose resistance values differ significantly from these figures. Before condemning a rotor for an open coil, check the solder joints at the slip ring leads, as a poor connection at either of these leads will test the same as an open coil. If the proper resistance is not obtained after resoldering these connections, discard the rotor.

STATOR TEST

Use a Wheatstone Bridge or an ohmmeter capable of measuring 1/1000 ohm to check stator for grounds and for phase resistance. Stator is OK when no circuit is present between lamination and each of the three leads, and resistance readings across each phase are approximately the same. It is suggested that stators be "high pot" tested by a qualified electrical shop to help identify borderline stators: **Stator must be disconnected from alternator to perform these tests** (See Figure 20).

Defective stators or ones with damaged or charred windings must be discarded regardless of how they test.

Several stators are available which can be used as service replacements on these alternators. The part numbers of these stators will be listed in the appropriate parts list.

SLIP RING REPLACEMENT

The slip ring assembly used in these alternators is of extremely sturdy construction and will seldom require replacement. If it should become damaged in some way, such as dropping the rotor, it may be replaced in the following manner.

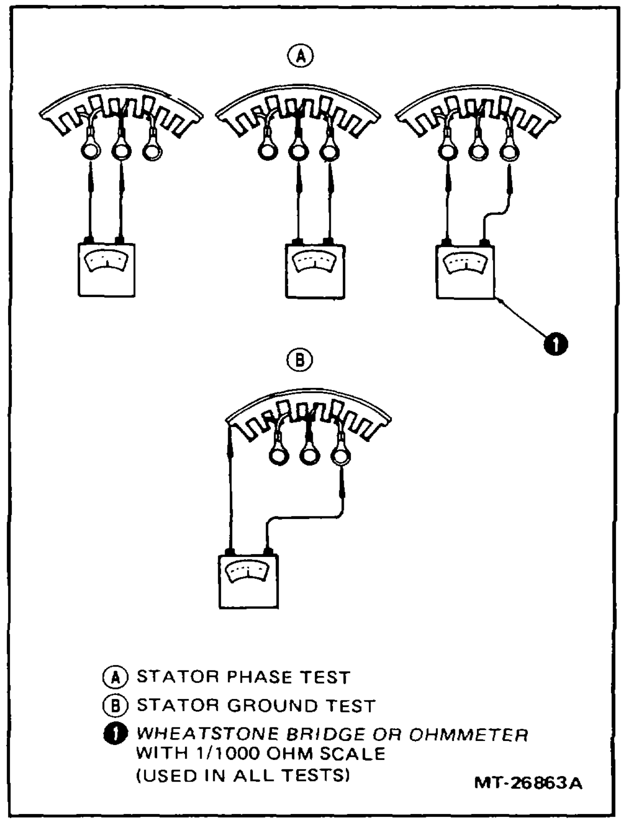


Figure 20 - Stator Test.

1. Unsolder the slip ring leads and lift them clear of the eyelets which serve to retain them to the rotor coil leads. Do not lose or damage the eyelets (See Figure 21).

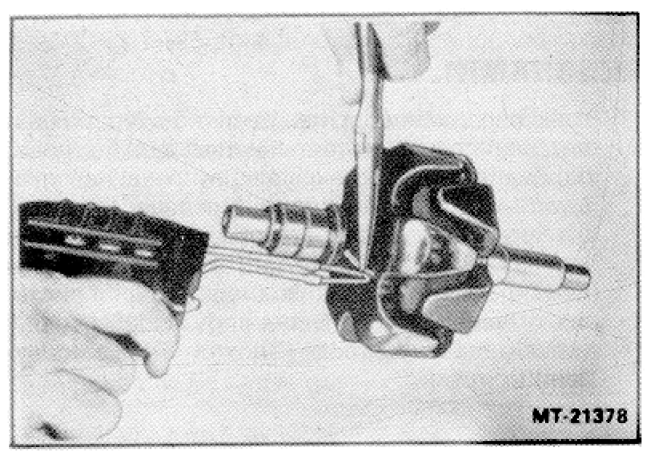


Figure 21 - Disconnecting Slip Ring Leads.

2. With a suitable puller, the slip ring assembly may now be pulled from the shaft (See Figure 22).

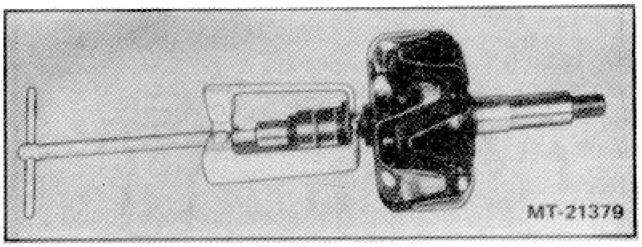


Figure 22 - Removing Slip Ring Assembly.

3. Clean the rotor shaft and apply a small amount of Loctite "Sleeve N' Bearing Mount" to the shaft on the section normally occupied by the slip ring assembly.

4. Position the new slip ring assembly on the shaft so that the two leads are aligned with the two rotor coil eyelets on the rotor, and carefully press the slip ring assembly onto the shaft.

   There is no stop on the shaft to prevent the slip rings from being pressed on too far. It is therefore necessary to press the slip rings only to a point where there is 9.5 mm (3/8") space between the inner edge of the slip rings and the rotor (See Figure 23).

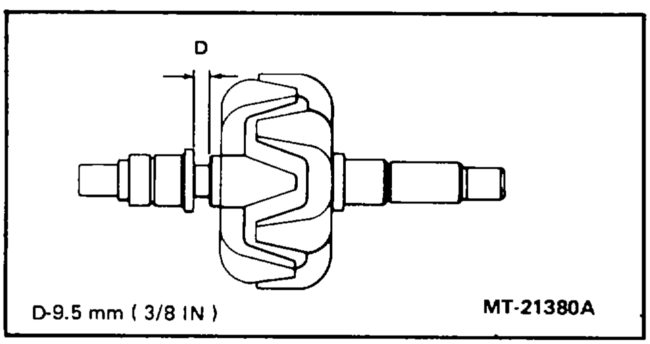


Figure 23 - Slip Ring Locating Dimension.

REASSEMBLY

1. If slip ring end bearing has been removed, press a new bearing in place from the outside of the housing. Bearing should be installed with seal facing in toward slip rings. When properly installed, the manufacturer's part number stamped on the end of the bearing will be facing toward the outside of the housing. Bearing should seat against lip on inside end of bearing bore. After bearing is installed, apply a small amount of grease (Chevron SRI 2 or equivalent) to rollers.

2. Reinstall heat sinks in slip ring end housing. Be sure that upper and lower insulating washers are in their proper location. Install but do not tighten lower heat sink retaining screws, lockwashers, guardwashers and insulating washers (See Figure 10). Replacement heat sinks may differ in thickness or appearance from the original assemblies, but will fit and function interchangeably.

3. Install terminal bolts and regulator lead wires. Red wire goes on positive heat sink and black wire goes on negative. Be sure that mating surfaces of heat sinks, terminals and terminal bolts are clean and free of paint to insure a good electrical connection (See Figure 8).

4 Install two insulating bushings on each terminal bolt and install regulator housing. Be sure that red and black regulator leads are properly routed through cutaway section of end housing, and install and tighten nuts on terminal bolts (See Figure 4).

5. Tighten lower heat sink screws and check all leads for proper routing, being sure that no lead is pinched under heat sink.

6. Reinstall capacitor.

7. Reinstall stator and terminal nuts. It is advisable to align stator and housing by temporarily installing the through bolts.

8. Press drive end bearing into housing and reinstall bearing retainer and four screws. When installing bearing, press on outer race to avoid transmitting force through the bearing balls which could brinnell the bearing.

9. Press drive end housing and bearing on to rotor shaft. Using a sleeve around the shaft, press on the inner race to avoid brinnelling the bearing.

10. Install rotor and housing assembly into stator and slip ring end housing assembly, being sure that mounting ears are aligned.

11. Install three through bolts and self locking nuts. Torque to 5.6-6.8 Nom (50-60 in. lbs.). Place a small amount of grease (Chevron SRI 2 or equivalent) in housing and reinstall the metal dust cap by carefully pressing it into place.

12. Insert outer brush and spring assembly into the housing and compress the brush spring, using a small screwdriver or similar tool. While holding the spring compressed, insert a pin through the hole in the rear of the housing so that the spring will be held in a compressed position. (A suitable pin can be made from a piece of 1.6 mm [1/16"] drill rod.) Install and compress the remaining brush and spring assembly in a similar manner. Hold the spring in a compressed position by pushing the pin farther into the housing (See Figure 24).

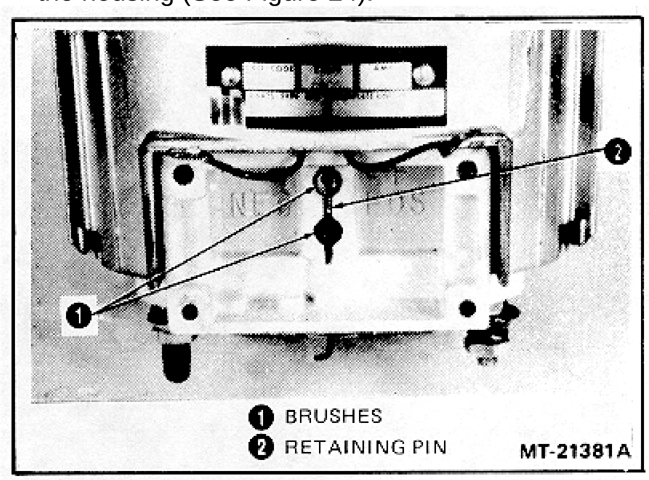


Figure 24 - Using Pin to Hold Brush Springs Depressed.

13. Position regulator above regulator holder and install RED lead to LEFT regulator terminal with lockwasher and nut. Install the BLACK lead to RIGHT regulator terminal.

    Attach blue regulator lead to "IGN." terminal screw by placing the spade terminal under the head of the screw. Tighten nut on terminal screw (See Figure 6). Install regulator.

    Be sure that the red and black leads are properly routed through their slots in the regulator housing. Install four regulator screws. **Withdraw brush retaining pin before tightening these screws.**

14. Install spacer, key, fan, pulley and nut. Torque nut to 95-108 N-m (70-80 ft. lbs.). Due to the design of the alternator, a certain amount of shaft end play will be present in new or rebuilt units. This end play is designed into the unit and will vary between 0.1 to 0.3 mm (.004-.012 inch).

    CAUTION - DO NOT FORCE OR POUND PULLEY ON SHAFT.

TESTING

Because of the integral regulator used on this alternator, the test bench hookup is very simple, consisting of connecting the positive and negative output leads. If a commercial test bench is not available, the test setup shown in Figure 25 may be used.

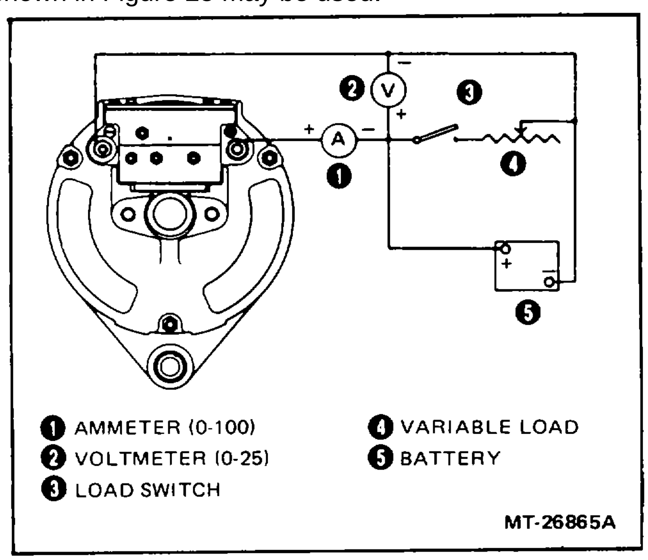


Figure 25 - Bench Test Wiring Diagram.

ELECTRICAL

Replace old section with this revised Section In your CTS-4001 Service

BATTERY

(FLEETRITE, INTERNATIONAL)

LOW MAINTENANCE AND MAINTENANCE FREE TYPES

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

CONTENTS (Continued)

PRECAUTIONS
BATTERIES CAN EXPLODE!
Batteries generate explosive gasses. Keep sparks, flames, burning cigarettes or other ignition sources away at all times.

BATTERIES CONTAIN SULFURIC ACIDI
Sulfuric acid Is poison and can cause severe burns.

No one should work near a battery either in a vehicle or on the bench without knowing and observing the precautions described in this manual.

Service personnel should be familiar with the proper procedures to be used before attempting to test or charge a battery or to "jump" start a vehicle having a discharged battery.

The equipment manufacturer's instructions must be followed when any equipment such as a battery charger or tester is used.

DANGER OF EXPLODING BATTERY
Hydrogen and oxygen gases are produced during normal battery operation. These gases escape through the battery vents and may form an explosive atmosphere around the battery if ventilation is poor. Explosive gases may continue to be present in and around the battery for several hours after it has been charged.

To prevent ignition of gases within the battery, sparks, flames or other Ignition sources should be kept well away from the battery.

Be careful that tools or other metallic objects do not fall across the battery terminals or between the ungrounded terminal and any adjacent metallic part which is grounded. Do not break "live" circuits at the terminals of batteries because a spark usually occurs at a point where a "live" circuit is broken. Make certain the charger cable clamps or booster leads are clean and making good connections. A poor connection can cause an electrical arc which could ignite the gas mixture and explode the battery.

Anyone in the vicinity of the battery when it explodes could receive injuries, including eye injury from flying pieces of the case or cover or acid thrown from the battery. It is for these reasons that eye protection must always be worn when working near batteries.

WARNING - DO NOT SMOKE, STRIKE A MATCH OR BRING OTHER FLAME INTO THE VICINITY OF THE BATTERY. THE EYES MUST BE SHIELDED WHEN WORKING NEAR A BATTERY. NEVER LEAN OVER A BATTERY DURING CHARGING, TESTING OR "JUMP STARTING" OPERATIONS.

HANDLING BATTERY ACID
Use extreme care to avoid spilling or splashing battery electrolyte (which is diluted sulfuric acid) as it can destroy clothing and burn the skin. When working with battery electrolyte, as when filling batteries, wear goggles to shield eyes. Protective clothing is advisable.

Do not place a battery or acid within the reach of children.

Electrolyte splashed Into the eyes is extremely dangerous. If this should happen, force the eye open and flood It with cool, clean water for approximately five minutes. A doctor should be called immediately.

If acid (electrolyte) Is taken Internally, drink large quantities of water or milk. Follow with milk of magnesia, beaten egg or vegetable oil. Call physician immediately.

If electrolyte is spilled or splashed on clothing or the body, or any surface of the vehicle, it should be neutralized immediately with a solution of baking soda and water and then rinsed with clean water.

If it becomes necessary to prepare electrolyte of a desired specific gravity, always pour the concentrated acid into the water - do this slowly - never pour water into acid. A dangerous "spattering" of the liquid would result. This is caused by extreme heat which is generated whenever water is mixed with strong acid. Stir the liquid continually while acid is being added.

When handling a plastic cased battery, excessive pressure placed on the end walls could cause electrolyte to spew through the vents. Therefore, always use a battery carrier to lift these batteries or lift with your hands placed at opposite corners.

BATTERY CHARGING PRECAUTIONS
Do not attempt to charge a battery unless you are thoroughly familiar with the step by step procedure to use. Follow the manufacturer's instructions on the charger. If the instructions are no longer legible and you do not have literature containing the instructions, obtain them from the manufacturer of the charger. **Never use a charger without instructions.**

The room or compartment in which the battery is being charged should be well ventilated. Follow precautions to prevent battery explosion. Explosive mixtures of hydrogen gas are generated during battery charging. This gas can be exploded by a torch, match flame, lighted cigarette, sparks from loose connections or metal tools making contact between the terminals or the ungrounded terminal and adjacent metal parts which are grounded.

Always shield eyes when working around the battery.

It is recommended that filler caps, where used, be left on the battery during charging. Additionally, a wet cloth should be placed over the battery and vents.

DO NOT ATTEMPT TO CHARGE A FROZEN BATTERY. Allow the battery to warm to 15.50C (60°F) before placing on charge.

Always turn the charger to the "OFF" position before connecting the leads to the battery. If you have any doubts that the charger is actually "OFF", disconnect it from the power source.

Never break a "live" circuit at the battery terminals or touch the charger leads when the charger is "ON". This could create a spark which could ignite the explosive gases in the battery**. Always turn the charger "OFF" before removing a charger lead from the battery.**

EMERGENCY STARTING PRECAUTIONS

Each step in the procedure outlined under EMERGENCY (JUMPER) STARTING must be followed with extreme care to avoid (1) bodily injury due to a gush of electrolyte through the vents, (2) bodily injury or damage to the vehicles due to explosion of one of the batteries, or (3) damage to the electrical system of either or both vehicles.

Wear eye protection. Never lean over the battery during the starting operation. Follow precautions to avoid making a spark or bringing a flame near the battery.

DESCRIPTION

The storage battery is an electro-chemical device. It stores chemical energy. When the battery is connected to an external load such as a starter, the chemical energy is converted into electrical energy and current flows through the circuit.

The three main functions of the automotive battery are to:

1. Supply power to the starter and ignition system so the engine can be cranked and started.
2. Supply the extra power required when the vehicle's electrical load requirements exceed the supply from the charging system.
3. Act as a voltage stabilizer in the electrical system. The battery smooths out or reduces temporarily high voltages (transient voltages) which occur in the vehicle electrical system. This could occur in the vehicle electrical system. This could occur in making or breaking a circuit, etc. These excessively high voltages would damage other components in the electrical system if it were not for the protection provided by the battery. The battery partially absorbs and greatly reduces these peak voltages and protects components such as diodes from being damaged.

"Fleetrite" and "International" batteries are available in conventional (low maintenance) type (Figure 1) and maintenance free type (Figure 2) as described herein.

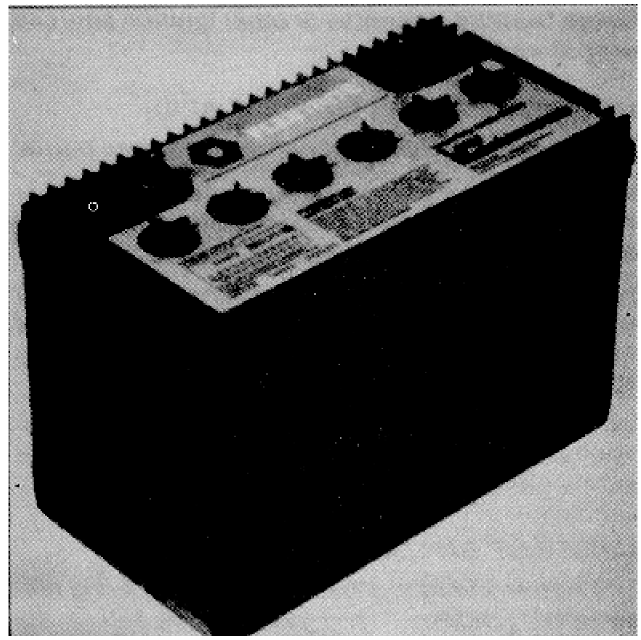


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Figure 1 - Low Maintenance {Conventional) Battery

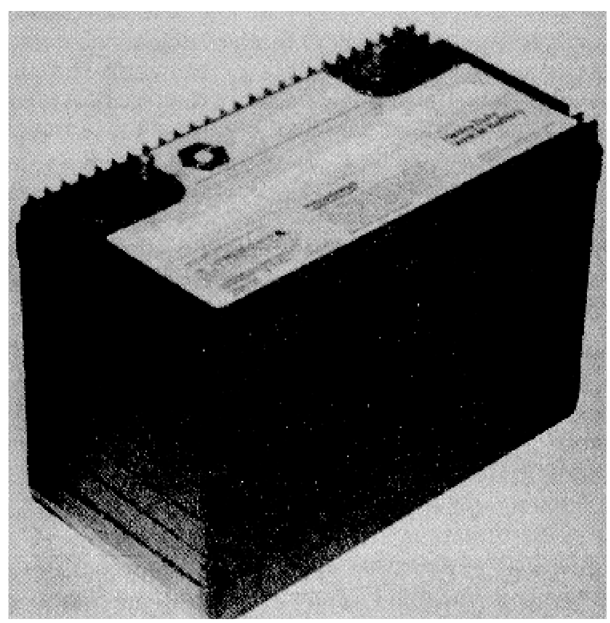

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Figure 2 - Maintenance Free Type Battery

Batteries are provided with side, top stud and top post type terminals (Figure 3) for various vehicle applications.

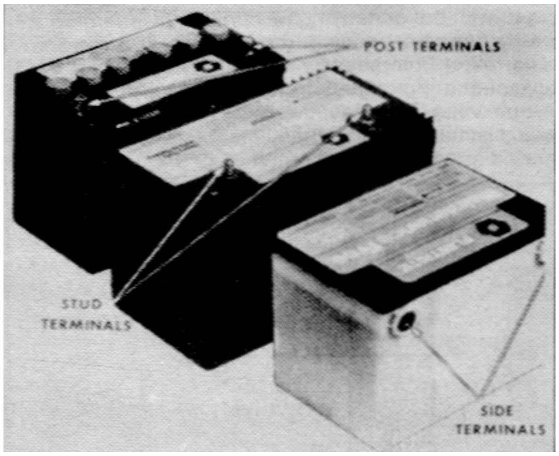

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Figure 3 - Types of Battery Terminals

LOW MAINTENANCE BATTERIES

These are conventionally vented lead-acid batteries requiring normal periodic battery maintenance.

A small amount of antimony has been added to the lead to improve grid strength. The antimony tends to cause "gassing" (breaking down of water into hydrogen and oxygen gases) during battery operation, thereby lowering the electrolyte level. Hence, periodic addition of water to the battery cells is required.

"Fleetrite" and "International" low maintenance batteries are provided with easily accessible cell filler caps.

MAINTENANCE FREE BATTERIES

Maintenance free batteries do not require the addition of water during normal service life. This is due to the fact that maintenance free batteries utilize calcium rather than antimony to improve grid strength. The advantage of calcium is that it greatly reduces the tendency for the battery to gas at normal charging voltages. Consequently, very little water is used.

Maintenance free batteries are not sealed. All batteries (including maintenance free) generate gases, especially during charge. While the volume of gases produced by the maintenance free battery is reduced by more than 75%, there are small vent openings to allow this gas to escape of the battery is turned upside down or placed on its side

"Fleetrite" and "International" maintenance free batteries have concealed cell caps which can be removed to permit battery testing and addition of water if required.

ELECTROLYTE AND SPECIFIC GRAVITY

The electrolyte in a lead-acid storage battery is a dilute sulfuric acid solution. The sulfuric acid in the electrolyte is one of the necessary ingredients in the chemical actions taking place inside the battery. It supplies the sulfate which combines with the active material of the plates. It is also the carrier for the electric current as it passes from plate to plate. When the battery terminals are connected to an external load, the sulfate combines with the active materials of the positive and negative plates forming lead sulfate and releasing electrical energy.

SPECIFIC GRAVITY

Specific gravity is a unit of measurement for determining the sulfuric acid content of the electrolyte. The recommended fully charged specific gravity of most 12-volt batteries today is 1.265 corrected to 26.7°C 80°F). A battery with a fully charged specific gravity of 1.265 contains an electrolyte with approximately 36% sulfuric acid by weight or 25% by volume. The remainder of the electrolyte is water. Pure (concentrated) sulfuric acid has a specific gravity of 1.835. Water has been assigned a value of 1.000. Therefore, electrolyte with a specific gravity of 1.265 means it is 1.265 times heavier than pure water.

The state-of-charge of a battery can be determined by the specific gravity of the electrolyte. The specific gravity can be measured directly with a hydrometer (Figure 4). A hydrometer is a bulb-type syringe which will extract electrolyte from the cell. A glass float in the hydrometer barrel is calibrated to read in terms of specific gravity.

The lower the float sinks in the electrolyte, the lower its specific gravity.

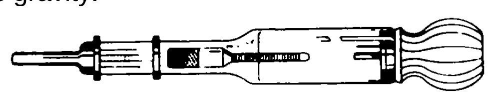

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Figure 4 - Battery Hydrometer

Figure 5 graphically illustrates the relationship between gravity readings and the combination of the sulfate from the acid with the positive and negative plates for various states of charge. The black dots represent the sulfate radical. A fully charged battery has all of the sulfate in the acid. As the battery discharges, some of the sulfate begins to appear on the plates. The acid becomes more dilute and its specific gravity drops as water replaces some of the sulfuric acid. A fully discharged battery has more sulfate in the plates than in the electrolyte. Note that the hydrometer float sank lower and lower in the electrolyte as the specific gravity became lower.

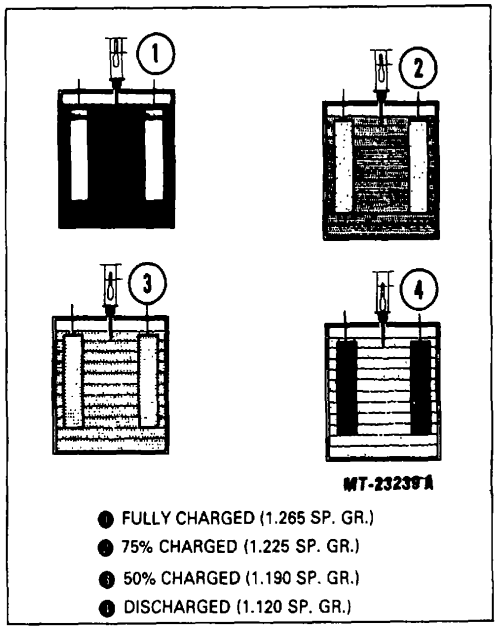

Figure 5 - Relationship of Specific Gravity to Transfer of Sulphate From Electrolyte to Plates

Table 1 illustrates typical specific gravity values for a cell in various stages of charge. A fully charged specific gravity of 1.265 corrected to 26.70C (800F) is assumed.

TABLE 1

Specific Gravity	State of Charge
1.265	100% charged
1.225	75% charged
1.190	50% charged
1.155	25% charged
1.120	Discharged

HOW TO USE A HYDROMETER

Figure 6 illustrates the correct method of reading a hydrometer. The barrel must be held vertically so the float is not rubbing against the side. The electrolyte should be drawn in and out of the hydrometer barrel a few times to bring the temperature of the hydrometer float and barrel to that of the acid in the cell. Draw an amount of acid into the barrel so that with the bulb fully expanded, the float will be lifted free, touching neither the side, top nor bottom stopper of the barrel.

When reading the hydrometer, your eye should be on a level with the surface of the liquid in the hydrometer barrel. Disregard the curvature of the liquid where the surface rises against the float stem and the barrel due to surface tension. Keep the float clean. Make certain it is not cracked.

Never take a hydrometer reading immediately after water is added to the cell. The water must be thoroughly mixed with the underlying electrolyte, by charging, before hydrometer readings are reliable. If a reading is being taken immediately after the battery has been subjected to prolonged cranking, it will be higher than the true value. The water formed in the plates during the rapid discharge has not had time to mix with the higher specific gravity acid above the plates.

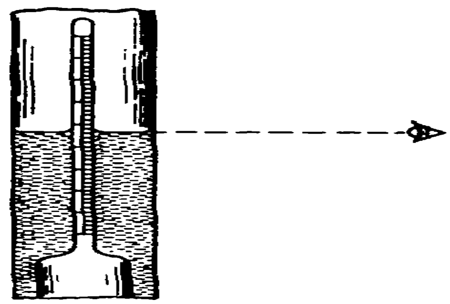

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Figure 6 - Correct Method of Reading Hydrometer (Eye on Level With Liquid Surface)

Because there are many different types of battery hydrometers available, always follow manufacturer's instructions.

TEMPERATURE CORRECTION

Hydrometer floats are calibrated to give a true reading at one fixed temperature only. A correction factor must be applied for any specific gravity reading made when the electrolyte temperature is not 26.7°C (80°F).

A temperature correction must be used because the electrolyte will expand and become less dense when heated. The float will sink lower in the less dense solutions and give a lower specific gravity reading. The opposite occurs if the electrolyte is cooled. It will shrink in volume, becoming more dense. The float will rise higher and read too high.

A correction factor of .004 specific gravity (sometimes referred to as 4 "points" of "gravity") is used for each 5.5°C (10°F) change in temperature. Four "points of gravity" (.004) are added to the indicated reading for each 5.50C (100F) increment above 26.7°C (80°F) and four points are subtracted for each 5.5°C (10°F) increment below 26.70C (800F). This correction is important at extremes of temperature because it can become a substantial value.

Figure 7 illustrates the correction for hydrometer readings when the acid temperature is above or below 26.7°C (80°F). In example No. 1, in cold weather, a partially discharged battery in a vehicle at 6.7°C (+ 20°F) might read 1.250 indicating it was almost fully charged. However, when the correction factor is applied, the true value is only 1.226. Example No. 2 could be encountered in a battery exposed to the sun In hot weather. Also, electrolyte frequently reaches 43°C (1000F) in service in warm weather. The 1.235 specific gravity reading might indicate too low a state of charge to install in a vehicle or that there is a problem in the electrical system if the battery is in service. However, the true reading of 1.246 may not be unreasonably low depending on the length of storage of the battery or the type of service which it has been experiencing in the vehicle.

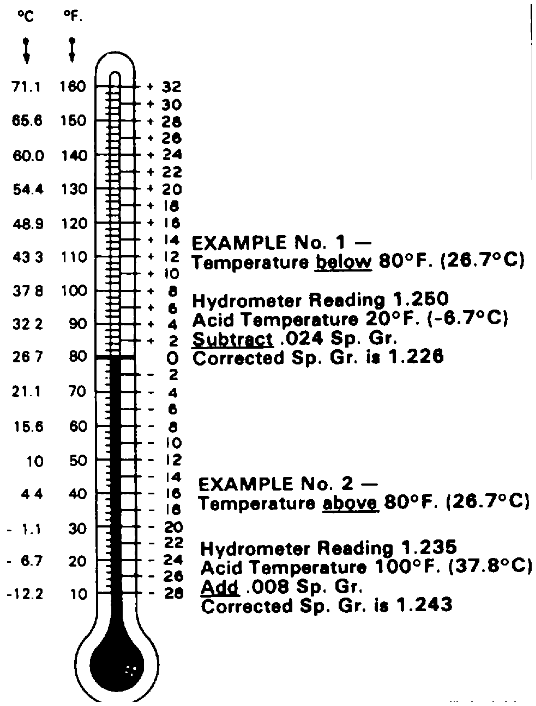

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Figure 7 - Specific Gravity Temperature Correction Valves

SPECIFIC GRAVITY DETERMINES ELECTROLYTE FREEZING POINT

Specific gravity of the electrolyte determines the temperature at which a battery will be harmed or damaged by freezing. A fully charged battery can be stored at sub-freezing temperatures without freezing the electrolyte. However, as a battery approaches the discharged condition, the electrolyte will freeze at higher temperatures. Table 2 shows the approximate freezing points of electrolyte at various specific gravities.

TABLE 2

Specific Gavity	State of Charge	Freezing Point
1.265	100%	-59.5°C (-75°F)
1.225	75%	-37.2°C (-35°F)
1.190	50%	-26.1°C (-15°F)
1.155	25%	-15.0°C (+15°F)
1.120	Discharged	- 9.4°C (+15°F)
Batteries must be kept fully charged when batteries or vehicles are stored in sub-freezing temperatures.		

TEMPERATURE AFFECTS BATTERY OUTPUT CAPACITY (CRANKING POWER)

Battery temperature affects the output capacity of a battery with respect to cranking an engine. The cranking power of the battery is reduced as battery temperature is lowered.

Table 3 lists the approximate percentage of output capacity of a fully charged battery at various temperatures.

Note that a fully charged battery at - 17.8°C (0°F) gives only 40 percent of its cranking power at 26.7°C (800F).

TABLE 3

Temperature	Percentage of Battery Capacity (Fully Charged)
26.70C (80°F)	100%
0°C (32°F)	65%
-17.8°C (0°F)	40%
-28.8°C (-20°F)	20%
Batteries at less than the fully charged state will provide even less of their output capacity. This emphasizes the importance of keeping vehicle batteries fully charged when low temperatures will be encountered.	

MAINTENANCE (IN VEHICLE)

The battery is a perishable item and requires attention. With a reasonable amount of care the life of a battery can be appreciably extended. Neglect and abuse will invariably cause shorter battery service life.

The battery should be inspected at the time of chassis lubrication or other periodic services.

Battery maintenance includes the following:

1. Inspect battery and mounting (Figure 8).
2. If corrosion is found on the terminal posts, remove the cable terminals from the battery (ground cable first) using the proper end wrench and a cable puller. A terminal cleaning brush can be used to clean tapered posts and the mating surfaces of the

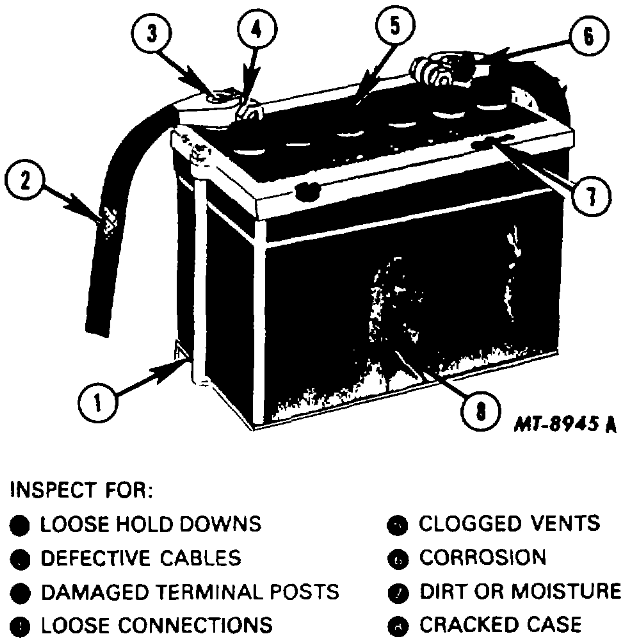


Figure 8 - Battery Maintenance Inspection

cable clamps. Other type terminals can be cleaned with a wire brush. The cable terminals should then be cleaned with an acid neutralizing solution of baking soda and water. Clean dirt from the battery top with a cloth moistened with baking soda and water. Then wipe with a cloth moistened with clear water. A wire brush can be used to remove dirt, corrosion or rust from the battery tray or hold down parts.

After rust is removed, rinse with clear water, dry with air and repaint.

After cleaning, reinstall battery and hold down parts as instructed under REMOVAL AND INSTALLATION. Coat battery and cable terminals with terminal grease (IH part number 472121C1) and connect cables to battery terminals. Connect ground cable last.

3. On low maintenance (conventional) batteries, check the electrolyte level. If necessary, add distilled water to bring the liquid level to the level indicator. If the battery does not have a level indicator, bring the level to 13 mm (1/2 inch) above the tops of the separators. Do not overfill any cell. When a cell is overfilled, the excess electrolyte may be forced from the cell by the gas formed In the battery. This will cause excessive corrosion of adjacent metal parts, reduced performance and shorter life.

Frequent need for refilling battery cells may indicate that battery is being over-charged. Check charging system and readjust voltage regulator as needed.

Maintenance free type batteries do not require addition of water under normal operating conditions. If loss of electrolyte is suspected, check electrolyte level as instructed under TESTING and determine cause for low level.

EMERGENCY (JUMPER) STARTING

The procedure outlined below should be followed exactly if it becomes necessary to use a booster battery to start a vehicle with a discharged battery.

CAUTION - BOTH BOOSTER AND DISCHARGED BATTERIES MUST BE TREATED CAREFULLY WHEN USING JUMPER CABLES. BE CAREFUL NOT TO CAUSE SPARKS. OBSERVE ALL PRECAUTIONARY MEASURES LISTED UNDER PRECAUTIONS.

WEAR GOGGLES TO SHIELD EYES.

ANY PROCEDURE OTHER THAN THAT OUTLINED BELOW COULD RESULT IN (1) PERSONAL INJURY CAUSED BY ELECTROLYTE SQUIRTING OUT THE BATTERY VENT, (2) PERSONAL INJURY OR PROPERTY DAMAGE DUE TO BATTERY EXPLOSION, (3) DAMAGE TO THE CHARGING SYSTEM OF THE BOOSTER VEHICLE OR OF THE IMMOBILIZED VEHICLE.

Make sure booster and discharged batteries are the same voltage (6-volt or 12-volt).

Make certain the stalled vehicle and the one containing the booster battery do not touch. If the two vehicles are in contact, a ground connection could be established which could cause sparking when jumper cables are attached.

1. On both vehicles: Set parking brake. Place transmission in NEUTRAL or PARK. Turn lights, heater and other electrical loads "OFF". Make certain ignition key is turned "OFF".

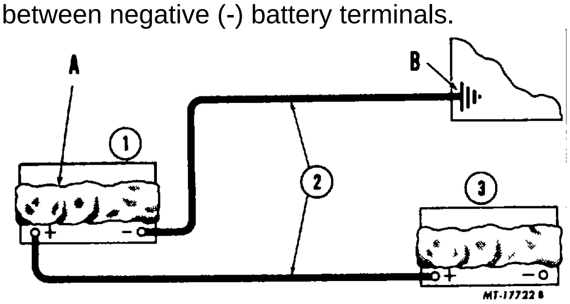
2. Determine whether the discharged battery has the negative (-) or positive (+) terminal grounded. The ground cable is connected to the engine block, vehicle frame or other good metallic ground. The battery cable connected to the starter relay is the one which is NOT grounded.

3. Be sure vent caps are tight on both batteries. Place a damp cloth over the vents of each battery. Make certain cloth is clear of fan blades, belts and other moving parts.

4. On negative ground vehicles, attach one end of the jumper cable to the positive (+) terminal of the

booster battery and the other end of same cable to positive (+) terminal of discharged battery (Figure 9).

On positive ground vehicles, connect jumper cables between negative (-) battery terminals.



- BOOSTER BATTERY
- JUMPER CABLES
- DISCHARGED BATTERY

A COVER VENTS WITH CLOTH (BOTH BATTERIES)
B GROUND AT LEAST 30 CM (12 INCHES) FROM BATTERY

Figure 9 - Proper Jumper Cable Connections (Negative Ground Vehicles Shown)

5. On negative ground vehicles, attach one end of the remaining jumper cable to the negative terminal of the booster battery and the other end to a ground at least 304 mm (12 inches) from the battery of the vehicle being started (Figure 9). (DO NOT connect directly to the negative post of the dead battery.) The ground connection must provide good elec-trical conductivity and current carrying capacity.

On the positive ground vehicles, connect jumper cable between positive (+) terminal of booster battery and ground on the stalled vehicle.

CAUTION - TAKE CARE TO BE SURE THE CLAMPS FROM ONE CABLE DO NOT INADVERTENTLY TOUCH THE CLAMPS ON THE OTHER CABLE.

DO NOT LEAN OVER THE BATTERY WHEN MAK-ING CONNECTIONS.

AVOID MOVING, HOT OR ELECTRICAL HAZARDS SUCH AS FANS, MANIFOLDS AND SPARK PLUG TERMINALS WHEN CONNECTING CABLES.

6. Be sure everyone is standing away from vehicles. Start the engine of the vehicle with the booster battery. Wait a few minutes, then attempt to start the engine of the vehicle with the discharged battery.
7. Do not operate the starter for more than 15 seconds. Wait at least 15 seconds between starting attempts to allow starter motor to cool. If the engine does not start after several cranking attempts, check to be sure that the clamps are secure. If the engine still continues to not start, refer to the appropriate service manual for troubleshooting procedures.
8. After starting, allow the engine to return to idle speed. Remove ground cable connection from the vehicle with discharged battery. Then remove the other end of the same cable from the booster battery.
9. Remove the other cable by disconnecting from the discharged battery first and then disconnect the opposite end from the booster battery.
10. Remove and discard cloths covering battery vents.

TESTING

A battery test should be performed whenever battery trouble is suspected.

Battery testing will determine if:

1. Battery is satisfactory and can remain in service.
2. Battery should be recharged before placing it back in service.
3. Battery must be replaced.

A complete battery test, as outlined below, will include these steps:

1. Visual Inspection
2. State of Charge Test
3. Battery Capacity (Load) Test

CAUTION - WHEN PERFORMING BATTERY TEST, OBSERVE RULES OF SAFETY. REFER TO PRECAUTIONS.

ALWAYS FOLLOW INSTRUCTIONS OF TEST EQUIPMENT MANUFACTURER.

STEP 1. VISUAL INSPECTION

a. Visually Inspect the outside of the battery for obvious damage such as cracked or broken case or cover which would allow electrolyte loss. Check for terminal damage. If obvious physical damage Is found, replace the battery. If possible, determine the cause of damage and correct.
b. Check electrolyte level.

On maintenance free type batteries, access to battery cells can be obtained as follows:
Side Terminal Batteries:
Use a knife blade to cut through top plaque cen-ter section. (Cut on dotted lines.) Pry up ends of vent manifold with a screwdriver. Remove mani-

fold by pulling straight up at the ends (Figure 10). After testing cells, reinstall manifold by placing it in position and pushing it down firmly until seated.

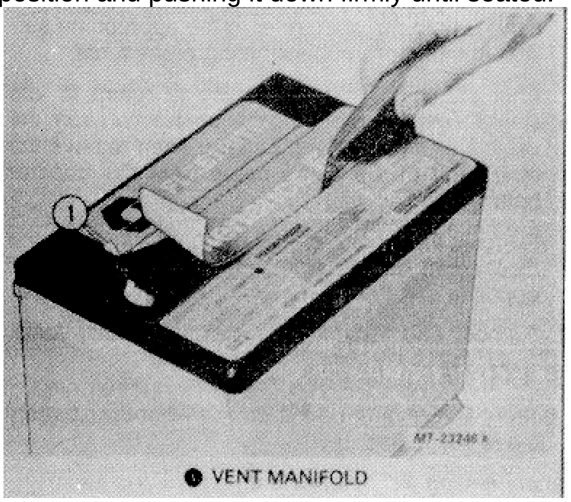


Figure 10 - Removing Vent Manifold to Gain Access to Cells (Side Terminal Maintenance Free Battery)

Top Terminal Batteries:

Use a knife blade to cut through the top plaque center section on the dotted lines (Figure 11). After removal of the section of the plaque, individual caps can be unscrewed to allow access to each cell. When reinstalling cell caps after testing, make sure caps are properly seated.

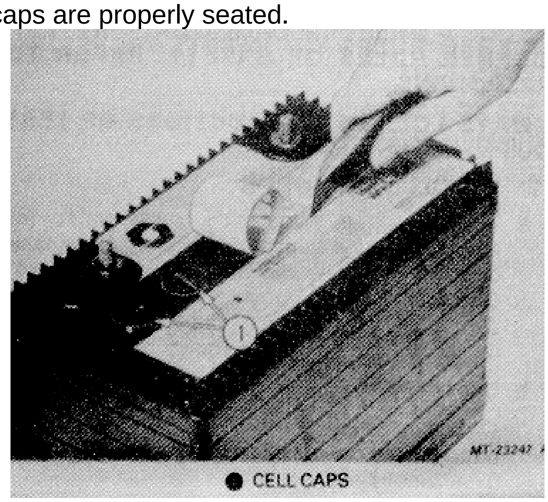


Figure 11 - Removing Section of Top Plaque to Gain Access to Cell Caps (Top Terminal Maintenance Free Battery)

c. If electrolyte level is above the plates in all cells, proceed to Step 2.
d. If electrolyte level is below the tops of the plates in one or more cells, add distilled water until electrolyte level is just above the tops of the separators. Charge the battery 15 minutes at 15-25 amperes to mix the water with the electrolyte. After charging, proceed to Step 2.

STEP 2. STATE OF CHARGE TEST

The battery's state of charge can be determined by either the specific gravity (hydrometer) test or by the stabilized open circuit voltage test.

Specific Gravity (Hydrometer) Test

Perform specific gravity (hydrometer) test on all cells (Figure 12a). (Refer to instructions for reading hydrometer under ELECTROLYTE AND SPECIFIC GRAVITY.)

a. Measure and record specific gravity, corrected to 26.7°C (80°F), of each cell. Compare readings obtained with Table 4a to determine battery's state of charge.

b. If specific gravity readings are 1.225 or higher and are within 50 points (.050 specific gravity) between, highest and lowest cells, proceed to Step 3.

TABLE 4a

Specific Gravity (Corrected to 26.7°C or 80°F)	State of Charge
1.265	Fully Charged
1.225	75% Charged
1.190	50% Charged
1.155	25% Charged
1.120	Discharged

c. If specific gravity readings are low (below 1.225) or vary more than 50 points between highest and lowest cells, recharge battery as instructed under CHARGING and inspect vehicle's electrical system to determine cause for low state of charge.

d. If, after charging, specific gravity readings are within 50 points between highest and lowest cells, proceed to Step 3. If readings still vary more than 50 points after charging, replace the battery.

BATTERY

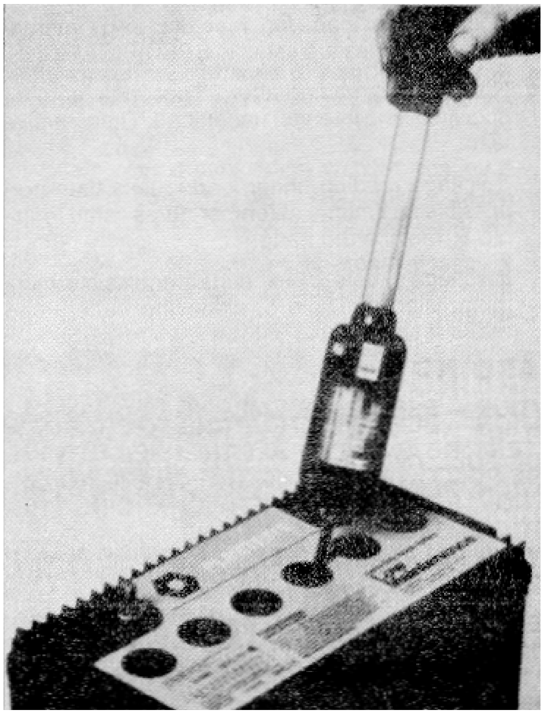


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Figure 12a - Testing Specific Gravity

Stabilized Open Circuit Voltage Test

a. If the battery has just been recharged or has been in vehicle service, the surface charge must be removed before an accurate voltage measurement can be made.

To remove surface charge, crank engine for 15 seconds. DO NOT allow engine to start. To prevent engine starting:

Gasoline Engine: Disconnect coil high tension lead from distributor cap. Ground lead to engine.

Diesel Engine: Apply engine stop control or disconnect fuel solenoid valve lead as required to prevent engine start.

After cranking engine, allow battery to rest for 15 minutes.

b. Connect voltmeter across battery terminals (Figure 12b) and observe reading. Compare reading obtained with Table 4b to determine battery's state of charge.

c. If stabilized voltage is above 12.4 volts, proceed to Step 3.

STABILIZED OPEN CIRCUIT VOLTAGE TEST

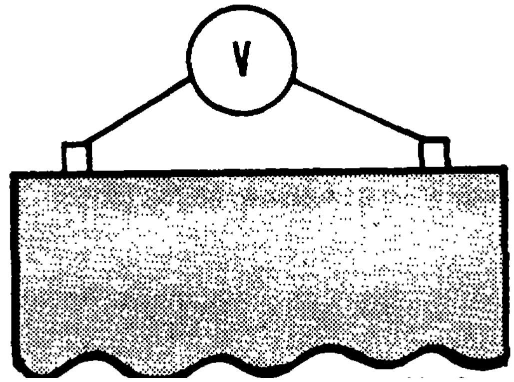

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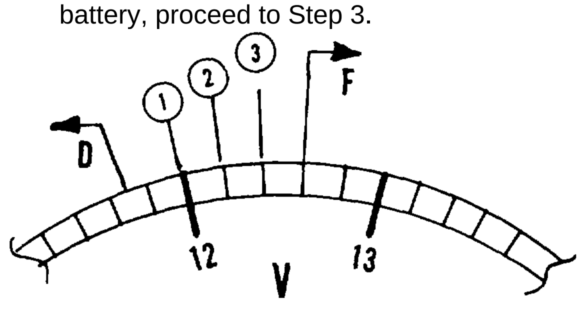
Figure 12b - Voltmeter Connection for Stabilized Open Circuit Voltage Test

TABLE 4b

Stabilized Open Circuit Voltage	State of Charge
12.6 V or More	Fully Charged
12.4 V	75% Charged
12.2 V	50% Charged
12.0 V	25% Charged
11.7 V or Less	Discharged

d. If stabilized voltage is below 12.4 volts, recharge battery as instructed under CHARGING and inspect vehicle's electrical system to determine cause for low state of charge. After charging battery, proceed to Step 3.



D DISCHARGED
1 25% CHARGED
2 50% CHARGED
3 75% CHARGED
F FULLY CHARGED
V VOLTAGE SCALE

Figure 12c - Relationship of Stabilized Open Circuit Voltage to State of Charge

STEP 3. BATTERY CAPACITY (LOAD) TEST
Perform battery capacity (load) test using battery test equipment available commercially.

NOTE - Always follow manufacturer's Instructions and precautions when using battery test equipment.

A satisfactory capacity (load) test can be made only when battery electrolyte equals or exceeds 1.225 specific gravity when corrected to 26.'7C (80°F).

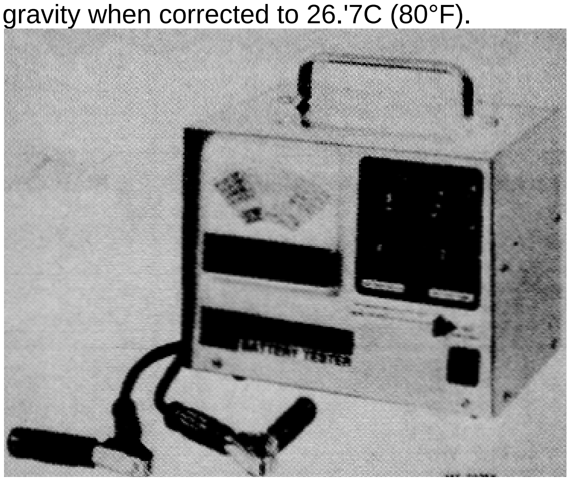


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Figure 13 -- Battery Tester

a. Disconnect battery cables from battery. (Disconnect ground cable first.)
b. Connect tester leads to battery terminals following tester manufacturer's instructions.
c. Apply specified test load to battery for 15 seconds or as specified in tester instructions.

   Test load (amperes) is equal to one-half of the cold cranking amperes at - 1 8°C (9°F) rating of the battery.

   Specified test loads for "Fleetrite" and "International" batteries are listed in SPECIFICATIONS.
d. Note voltage reading after 15 seconds (or other specified time interval) under load. Then remove load.
   If voltage reading under load is less than permissible minimums at temperatures listed in Table 5, replace the battery.
   If voltage meets or exceeds permissible minimum listed in Table 5, clean the battery and return it to service.

CHARGING
CAUTION - BEFORE ATTEMPTING TO CHARGE A BATTERY, BE AWARE OF ALL THE PRECAUTIONS TO BE FOLLOWED DURING THE CHARGING OPERATION. REFER TO BATTERY CHARGING PRECAUTIONS UNDER PRECAUTIONS.

ALWAYS FOLLOW BATTERY CHARGER MANUFACTURER'S INSTRUCTIONS.

WHEN POSSIBLE, USE A BATTERY CHARGER WITH ALTERNATOR OR POLARITY PROTECTION THAT PREVENTS CHARGING THE BATTERY IN REVERSE POLARITY.
Two methods of recharging a battery, the Slow Charge Method and the Fast Charge Method, are described below.

The charge a battery receives is equal to the charge rate in amperes multiplied by the time in hours. Thus a five ampere rate applied to a battery for ten hours would be a 50 ampere-hour charge to the battery. To fully recharge a battery, you must replace the ampere-hours or ampere-minutes removed from it, plus an extra 20%charge. This is due to the fact that batteries are not 100% efficient on recharging.

The Battery Charging Guides, Tables 6 and 7, show approximately how much recharge a fully discharged battery requires. For partially discharged batteries, reduce the charging current or charging time (ampere hours) accordingly.

For example: If the battery is 25% charged (75% discharged), reduce charging current or time by one-fourth (1/4). If the battery is 50% charged, reduce charging current or time by one-half (1/2).

TABLE 5

Ambient Temperature	**21° C (70° F) & above**	**16° C (60° F)**	**10° C (50° F)**	**4° C (40° F)**	**-1° C (30° F)**	**-70° C (20° F)**	**- 12° C (10° F)**	**-18° C (0° F)**
12 Volt Battery	9.6	9.5	9.4	9.3	9.1	8.9	8.7	8.5
6 Volt Battery	4.8	4.75	4.7	4.6	4.5	4.4	4.3	4.2

Minimum Permissible Voltage

If time is available, the lower charging rates in amperes are recommended.

While battery is being charged, periodically measure the temperature of the electrolyte. If the temperature exceeds 51 .6°C (1 250F) or if violent gassing or spewing of electrolyte occurs, the charging rate must be reduced or temporarily halted. This must be done to avoid damage to the battery.

NOTE - DO NOT OVERCHARGE batteries, particularly maintenance free type batteries. Overcharging causes excessive and needless loss of water from the electrolyte.

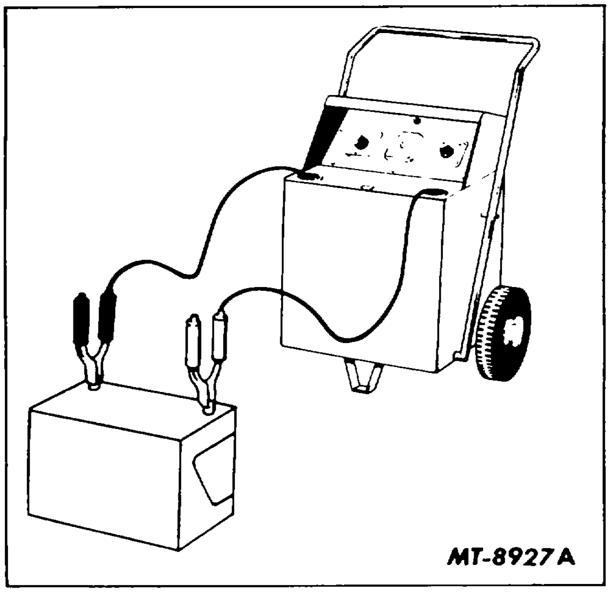


Figure 14 - Charging Battery

SLOW CHARGING

The Slow Charge method uses a low charging rate for a relatively long period of time. The recommended ratefor slow charging is one ampere per positive plate per cell. If the battery has nine plates per cell, normally four of the nine will be positive plates. Therefore, the slow charge rate would be four amperes. Charging periods as long as twenty-four hours may be needed to bring a battery to full charge.

The best method of making certain a battery is fully charged, but not overcharged, is to measure the specific gravity of a cell once per hour. The battery is fully charged when no change in specific gravity occurs over a three hour period or when charging current stabilizes (constant voltage type charger).

If low maintenance (conventional) battery is to be charged overnight (10-16 hours) use the specified Slow Charge rate (Table 6).

Maintenance free batteries must not be charged at rates greater than specified in the Maintenance Free Battery Charging Guide (Table 7).

If a maintenance free battery is to be recharged overnight (16 hours), a timer or voltage controlled charger is recommended. If the charger does not have such controls, a 3 ampere rate should be used for batteries of 80 minutes or less capacity and 5 amperes for above 80 to 125 minutes reserve capacity batteries. Batteries over 125 minutes should be charged at the specified Slow Charge rate (Table 7).

Batteries that have stood in a discharged condition for long periods of time without a recharge have become sulfated and must be recharged at a low rate to avoid overheating and excessive gassing. It may require two or three days of slow charging to bring a sulfated battery to a fully charged condition. Care should be taken not to overcharge maintenance free type batteries.

Some batteries are so badly sulfated they cannot be restored to a normal operating condition, regardless of the rate of charge or the length of time the charge is applied. Therefore, if a battery cannot be restored to a fully charged condition by slow charging, it should be rejected.

FAST CHARGING

The Fast Charge method provides a high charging rate for a short period of time. The charging rate should be limited to 60 amperes for 12-volt batteries. Maximum charging rate for 6-volt batteries (above 180 reserve capacity miniutes) can be approximately double this value.

Ideally, fast charges should be limited to the charging times shown under Fast Charge in the Battery Charging Guides, Tables 6 and 7. The battery generally cannot be fully charged within these time periods, but will re- ceive sufficient charge (70 to 90%) for practical service. To completely recharge a battery, follow the fast charge with a slow charge until no change in specific gravity occurs over'a three hour period.

A battery with electrolyte specific gravity of 1.225 or above should never be charged at a high rate. If the charger has not tapered to a low rate, adjust to a slow charge, preferably at a rate of one ampere per positive plate per cell.

CHARGING INSTRUCTIONS

Before placing a battery on charge, clean the battery terminals if necessary. Add distilled water sufficient to cover the plates. Fill to the proper level near the end of charge. If the battery is extremely cold, allow it to warm before adding distilled water because the level will rise as it warms. In fact, an extremely cold battery will not accept a normal charge until it becomes warm. Following instructions of charger manufacturer, con- nect charger to battery.

TABLE 6

BATTERY CHARGING GUIDE
6 and 12 Volt Low Maintenance (Conventional Batteries)
Recommended Rate* and Time for **Fully Discharged** Condition

Rated Battery Capacity (Reserve Minutes)	Slow Charge	Fast Charge
80 Minutes or Less	14 Hours @ 5 Amperes 7 Hours @ 10 Amperes	1-3/4 Hours @ 40 Amperes 1 Hour @ 60 Amperes
Above 80 to 125 Minutes	20 Hours @ 5 Amperes 10 Hours @ 10 Amperes	2-1/2 Hours @ 40 Amperes 1-3/4 Hours @ 60 Amperes
Above 125 to 170 Minutes	28 Hours @ 5 Amperes 14 Hours @ 10 Amperes	3-1/2 Hours @ 40 Amperes 2-1/2 Hours @ 60 Amperes
Above 170 to 250 Minutes	42 Hours @ 5 Amperes 21 Hours @ 10 Amperes	5 Hours @ 40 Amperes 3-1/2 Hours @ 60 Amperes
Above 250 Minutes	33 Hours @ 10 Amperes	8 Hours @ 40 Amperes 5-1/2 Hours @ 60 Amperes

*Initial rate for standard taper charger.

TABLE 7

BATTERY CHARGING GUIDE
12 Volt Maintenance Free Batteries
Recommended Rate* and Time for **Fully Discharged** Condition

Rated Battery Capacity (Reserve Minutes	Slow Charge	Fast Charge
80 Minutes or Less	10 Hours @ 5 Amperes 5 Hours @ 10 Amperes	2-1/2 Hour @ 20 Amperes 1-1/2 Hours @ 30 Amperes 1 Hour @ 45 Amperes
Above 80 to 125 Minutes	15 Hours @ 5 Amperes 7-1/2 Hours @ 10 Amperes	3-3/4 Hours @ 20 Amperes 2-1/2 Hours @ 30 Amperes 1-3/4 Hours @ 45 Amperes
Above 125 to 170 Minutes	20 Hours @ 5 Amperes 10 Hours @ 10 Amperes	5 Hours @ 20 Amperes 3 Hours @ 30 Amperes 2-1/2 Hours @ 45 Amperes
Above 170 to 250 Minutes 30	30 Hours @ 10 Amperes 15 Hours @ 10 Amperes	7-1/2 Hours @ 20 Amperes 5 Hours @ 30 Amperes 2-1/2 Hours @ 45 Amperes
Above 250 Minutes20	20 Hours @ 10 Amperes	10 Hours @ 20 Amperes 6-1/2 Hours @ 30 Amperes 4-1/2 Hours @ 45 Amperes

*Initial rate for standard taper charger

Connect the positive (+) charger lead to positive battery terminal and negative (-) lead to negative terminal. If the battery is in the vehicle, connect the negative lead to the engine block if the vehicle has a "negative ground" (negative battery terminals is connected to ground). Connect the positive lead to ground if vehicle has a "positive ground." "Rock" the charger lead clamps to make certain a good connection has been made.

Turn the charger "ON" and slowly increase the charging rate until recommended ampere value is reached.

CAUTION - IF SMOKE OR DENSE VAPOR COMES FROM THE BATTERY, SHUT OFF THE CHARGER AND REJECT THE BATTERY. IF VIOLENT GASSING OR SPEWING OF ELECTROLYTE OCCURS, REDUCE OR TEMPORARILY HALT THE CHARGING.

If the engine does not crank satisfactorily when a recharged battery is installed, load test the battery as outlined under TESTING. If the battery passes the "Load Test", the vehicle’s fuel, ignition, cranking and charging systems should be checked to locate and correct the problem. If it does not pass the load test, the battery should be replaced.

When an engine does not crank satisfactorily with a battery which was not recharged before installation, recharge the battery and subject it to the load test. If the battery fails, replace it; if it tests satisfactorily and the engine still does not crank satisfactorily check the vehicle systems mentioned above to locate and correct the problem.

REMOVAL AND INSTALLATION

REMOVAL

1. Make sure all electrical loads (lights, ignition, accessories) are turned "OFF".

2. Remove battery cover (where used).

3. Note locations of battery positive and negative terminals in relation to surrounding vehicle components. Battery must be installed in the same position.

4. Loosen battery hold-down hardware and remove battery from carrier tray.

5. Inspect battery cables and replace if necessary. Clean cable connector terminals with a wire brush.

   Clean and tighten battery cable ground, starter relay and starter connections.

6. Inspect battery hold-down hardware and battery tray. Replace worn or damaged parts. Remove corrosion with a wire brush and/or wash with a weak solution of baking soda and water. Rinse and dry. Repaint parts if needed to prevent rusting.

   Make sure no foreign objects such as stones, bolts, nuts, etc. which could damage battery are left in battery tray.

INSTALLATION

When replacing the battery, make sure that battery to be installed has sufficient capacity to cover the electrical requirements of the vehicle. Use of an under-capacity battery will result in poor performance and premature battery failure. The original equipment battery can be used as a minimal guide, but is often misleading since the vehicle owner may have installed additional electrical accessories on the vehicle.

Be sure battery is at full charge when installed. If the battery has been in storage for some time or if the installation is being made in sub-freezing temperatures, the battery should be given a boost charge before being installed.

1. Place battery in battery tray with terminals in proper position. Battery should rest level in tray.

2. Install battery hold down hardware and tighten until battery is firm and secure.

CAUTION - DO NOT OVERTIGHTEN BATTERY HOLD-DOWNS. OVERTIGHTENING COULD DAMAGE BATTERY RESULTING IN EARLY FAILURE.

3. Apply light coat of terminal grease (IH part number 472141-C1) to battery and cable terminals to inhibit corrosion.

4. Connect battery cables to battery. Check for proper battery polarity with respect to the vehicle. "Reversed" polarity may cause serious damage to the electrical system. Connect ground cable last.

Tighten terminal fasteners as follows: DO NOT OVERTIGHTEN.

Side Terminals:
7-10 N•m (60-90 lb. in. or 5-7 lb. ft.)

Top Terminals:
13-20 N•m (10-15 lb. ft.)

Taper Post Terminals:
5.5-8 N•m (50-60 lb. in. or 4-6 lb. ft.)

NOTE - New batteries must be coded to Indicate month and year of installation.

5. Start engine and check operation of vehicle’s charging system. If necessary, adjust or repair charging system to obtain correct charging output.

6. Install battery cover (where used).

STORAGE INSTURCTIONS

Always store batteries in an upright position. Never allow batteries to be laid on their sides as electrolyte may escape through the vent holes.

Never stack batteries on top of one another. Simple battery storage racks can be made from loose, flat boards supported by the batteries themselves, as shown in Figure 15.

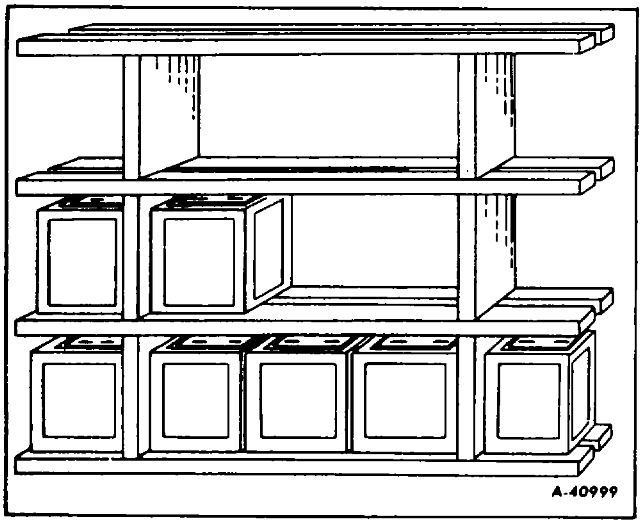


Figure 15 Battery Storage Rack

Batteries will slowly discharge while standing and will discharge much faster when warm than when cold. On wet type conventional batteries, self-discharge can amount to about an average of .001 specific gravity per day over a 30 day period. To minimize self-discharge, store batteries In as cool a place as possible, away from heat ducts in winter and shielded from direct sunlight in summer.

Ideal storage conditions would be in a clean dry area where temperature would be stable and as cool as possible between 0OC (320F) and 26°C (80°F). Storage in ambient temperatures above 260C (800F) is not recommended as this increases the rate of self-discharge. Temperatures below 0OC (32°F) should be avoided to prevent freezing should a battery become discharged.

Wet batteries in storage should be checked for state of charge every 30 days and charged whenever they fall to 1.225 specific gravity. A charge rate of one ampere for each positive plate In one cell should be used to recharge the battery.

NOTE - Batteries of vehicles standing In storage should be considered as batteries In storage. Vehicles In Inventory should be maintained regularly to keep their batteries clean and dry, properly filled with water and, most Important, fully charged.

Because of their chemical composition, maintenance free batteries self-discharge at a slower rate than conventional batteries. When stored as recommended, a shelf life of up to twelve months or more, depending upon storage temperatures, is possible before charging is required.

Maintain proper battery stock rotation. The first batteries placed in storage should be the first ones taken out. (Be sure to check date codes on the batteries and the cartons.)

If a battery has been in storage for some time, it should be charged before being installed in a vehicle.

ACTIVATING DRY CHARGED BATTERIES

Dry charged batteries provided for replacement installation must be "activated" before they can be used. Following the instructions outlined below will assure proper activation regardless of temperature and conditions of storage.

NOTE - Always refer to and follow manufacturer's activation Instructions furnished with battery.

1. Fill each cell of the battery to the top of the separators with the correct battery-grade electrolyte as specified by the manufacturer's instructions. Using higher or lower specific gravity electrolyte than recommended can impair battery performance. Originally filling each cell to the top of the separators permits expansion of the electrolyte as battery is boost charged.

2. Gently rock battery. This will help to force out trapped air and to saturate the plates with electrolyte.

3. Boost charge 12-volt batteries at 15 amps (6-volt and 12-volt heavy duty batteries at 30 amps) until the specific gravity of the electrolyte is 1.250 or higher and electrolyte temperature is at least 15.5°C (60°F). BOTH CONDITIONS MUST BE MET. If electrolyte bubbles violently while charging, reduce charging rate until excessive bubbling action subsides, then continue charging until 1.250 specific gravity and 15.50C (600F) are reached.
   If the ambient temperature is 0°C (320F) or less, it is imperative that the above instructions be followed.

4. Check volume of electrolyte in all cells and adjust to prescribed level with additional electrolyte as required.

5. Install battery in vehicle as instructed under REMOVAL AND INSTALLATION. Be sure of proper polarity.

Dry charged batteries may be placed in service immediately after activation. However, to insure good performance these additional steps are recommended.

BATTERY

Check the specific gravity of all cells. Under good storage conditions, the electrolyte specific gravity on activating a dry-charged battery will drop approximately .010 and temperature will rise 40 to 5.60C (7 to 100F) within twenty minutes of filling the battery. A battery under these conditions requires little boost charging. However, should the specific gravity drop .030 or more with a corresponding increase in temperature, the negative plates have been oxidized and the battery should be fully recharged before use. Also, the battery should be recharged if one or more cells gas violently after the addition of electrolyte. After electrolyte is added, check the open circuit terminal voltage of the battery. If a 12-volt battery reads less than 10 volts (less then 5 volts on a 6-volt battery), this indicates a reverse cell or an "open" circuit and the battery should be replaced.

After the dry charged battery has been activated, it must be serviced, handled and kept charged like any other wet battery. After battery has been in service, add only distilled water. DO NOT ADD ACID.

SPECIFICATIONS

LOW MAINTENANCE BATTERIES

BCI Group	Battery Model	Volts	No. of Plates Per Cell	Reserve Capacity (Minutes) 25 Amps at 27°C (80°F)	Cold Cranking Current (Amps)		Test Load (Amps.)
					At −18°C (0°F)	At −29°C (−20°F)	
4	ZBDPP4	6	21	275	700	570	350
4H	ZBDCH4	6	33	420	975	775	485
24*	ZBDMF243	12	8	70	345	258	180
27*	ZBDMF274	12	12	120	500	395	250
30H	ZBDHC30H	12	17	190	580	460	290
71*	ZBDMF715	12	9	70	375	300	190
74*	ZBDMF744	12	10	90	420	330	210
74*	ZBDMF745	12	12	120	500	395	250
4D	ZBDHC4DA	12	23	310	800	640	400
8D	ZBDCM8DA	12	29	440	900	700	450

*Calcium/Antimony (Hybrid) Construction - Also considered maintenance free.

DIMENSIONS

BCI Group	Length Inches (mm)	Width Inches (mm)	Height Inches (mm)
4	12.68 (322.1)	7.00 (177.8)	9.42 (239.3)
24	10.29 (261.4)	6.82 (173.2)	9.07 (230.3)
27	12.00 (305.0)	6.80 (172.7)	8.80 (223.5)
30H	13.50 (342.9)	6.81 (173.0)	9.21 (233.9)
71	12.00 (305.0)	6.80 (172.7)	8.80 (223.5)
74	10.29 (261.4)	7.16 (181.9)	8.75 (222.3)
4D	20.75 (527.0)	8.75 (222.3)	9.82 (249.4)
8D	20.75 (527.0)	11.00 (279.4)	9.82 (249.4)

SPECIFICATIONS
MAINTENANCE FREE BATTERIES

BCI Group	Battery Model	Volts	No. of Plates Per Cell	Reserve Capacity (Minutes) 25 Amps at 27°C (80°F)	Cold Cranking Current (Amps)		Test Load (Amps.)
					At −18°C (0°F)	At −29°C (−20°F)	
31*	ZBDMF31C	12	17	170	700	520	250
31*	ZBDMF31CS	12	17	170	700	520	250
31*	ZBDMF31D	12	15	160	625	465	310
31*	ZBDMF31DS	12	15	160	625	465	310
31	ZBDMF31E	12	17	170	700	520	350
31	ZBDMF31ES	12	17	170	700	520	350
31	ZBDMF31F	12	15	160	625	465	310
31	ZBDMF31FS	12	15	160	625	465	310
31*	ZBDMF31	12	12	100	500	375	250
31*	ZBDMF31S	12	12	100	500	375	250
31	ZBD31H500S	12	12	100	500	375	250

*Calcium M.F.

DIMENSIONS

BCI Group	Length Inches (mm)	Width Inches (mm)	Height Inches (mm)
31	13.00 (330.2)	6.80 (172.7)	9.45 (240.0)

SERVICE MANUAL

ELECTRICAL

Insert this new **Section in your** CTS-4001 Service Manual.

ELECTRICAL CIRCUIT DIAGRAMS

S-SERIES

CONTENTS

SERVICE MANUAL

CHAPTER I

ELECTRICAL CIRCUIT DIAGRAMS
S-SERIES LEFT HAND DRIVE

CONTENTS

S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS

NOTES

(THESE NOTES APPLY TO * ON PAGE 14, CHAPTER 1.)

A2 UNDER SHORT CIRCUIT CONDITIONS USE OF A CIRCUIT BREAKER CAN ALLOW DAMAGE TO THE INSTRUMENT CLUSTER PRINTED CIRCUIT.

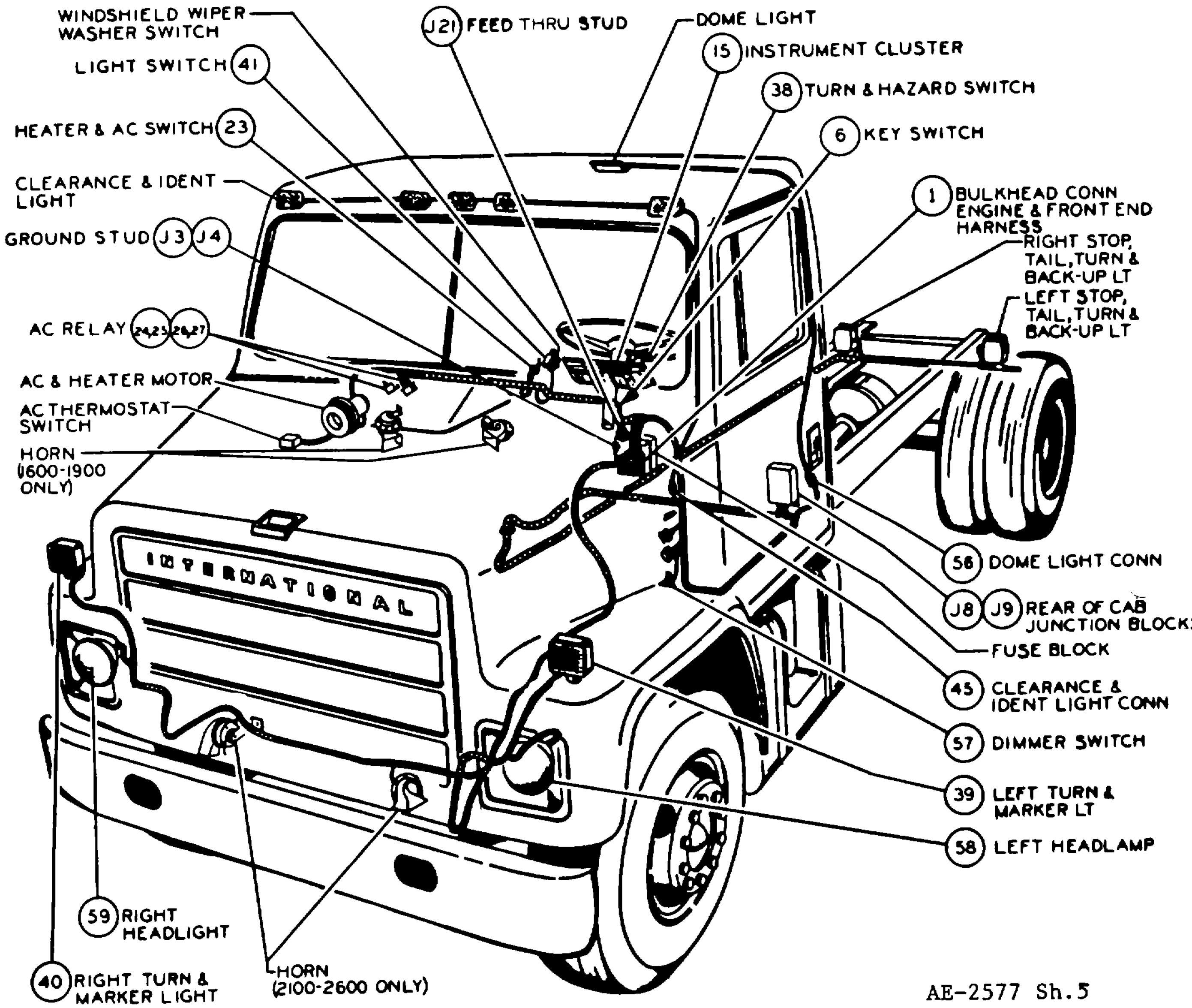
C3 UNDER SHORT CIRCUIT CONDITIONS USE OF A CIRCUIT BREAKER CAN ALLOW DAMAGE TO THE FLASHER.

F3 UNDER SHORT CIRCUIT CONDITIONS USE OF A CIRCUIT BREAKER CAN ALLOW DAMAGE TO THE HORN RELAY.

GI UNDER SHORT CIRCUIT CONDITIONS USE OF A CIRCUIT BREAKER CAN ALLOW DAMAGE TO THE HEATER BOX (BLOWER MOTOR) RESISTOR.

1-17 AE-2577 Sh.1 Rev. H
18-35 AE-2577 Sh.2 Rev. G

S-SERIES LH DR ELECTRICAL CIRCUIT DIAGRAMS
COMPONENTS & MAJOR CONNECTOR LOCATION DIAGRAM-REGULAR CAB



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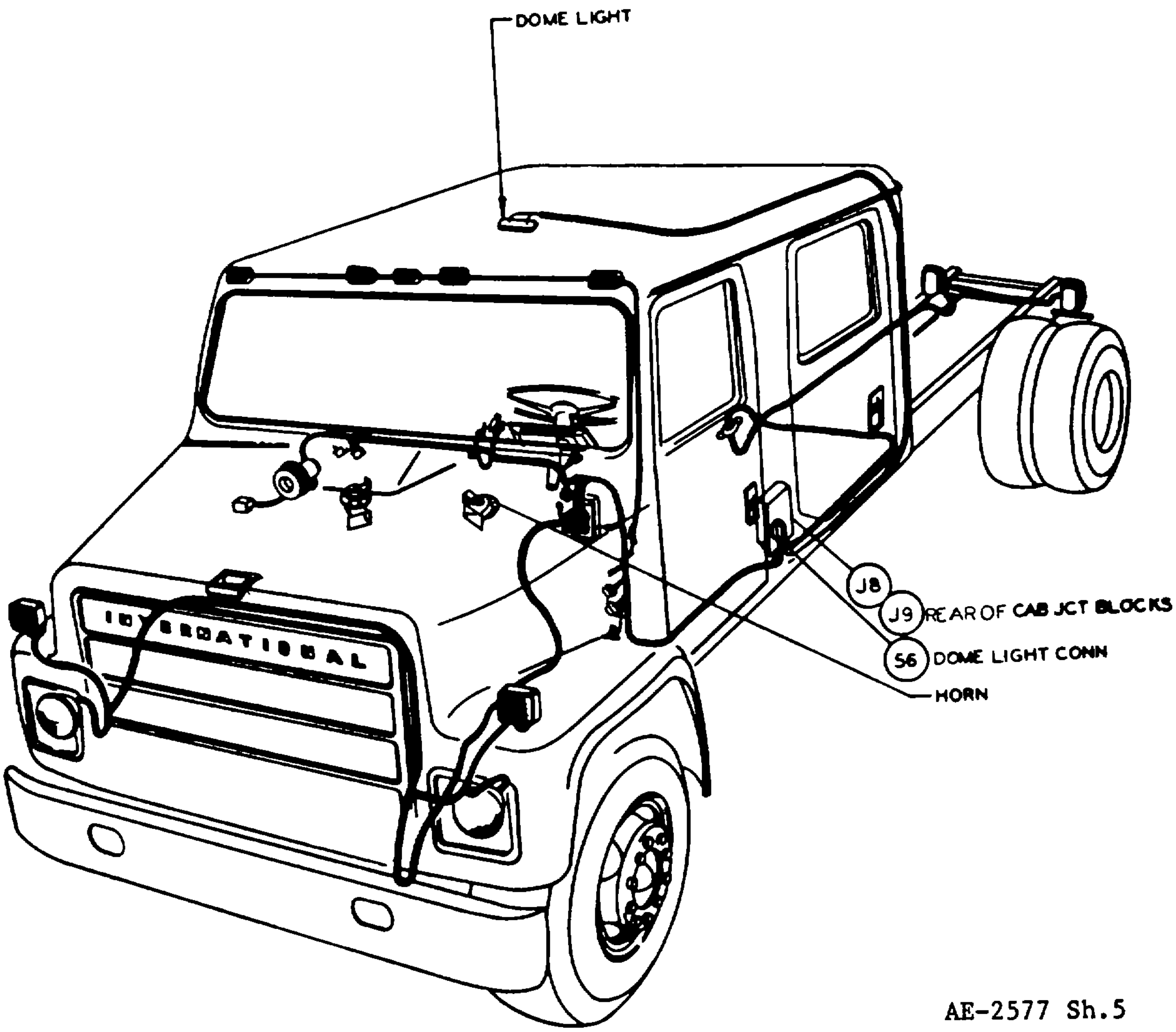
S-SERIES LH DR ELECTRICAL CIRCUIT DIAGRAMS
COMPONENTS & MAJOR CONNECTOR LOCATION DIAGRAM-TRAVELCREW CAB



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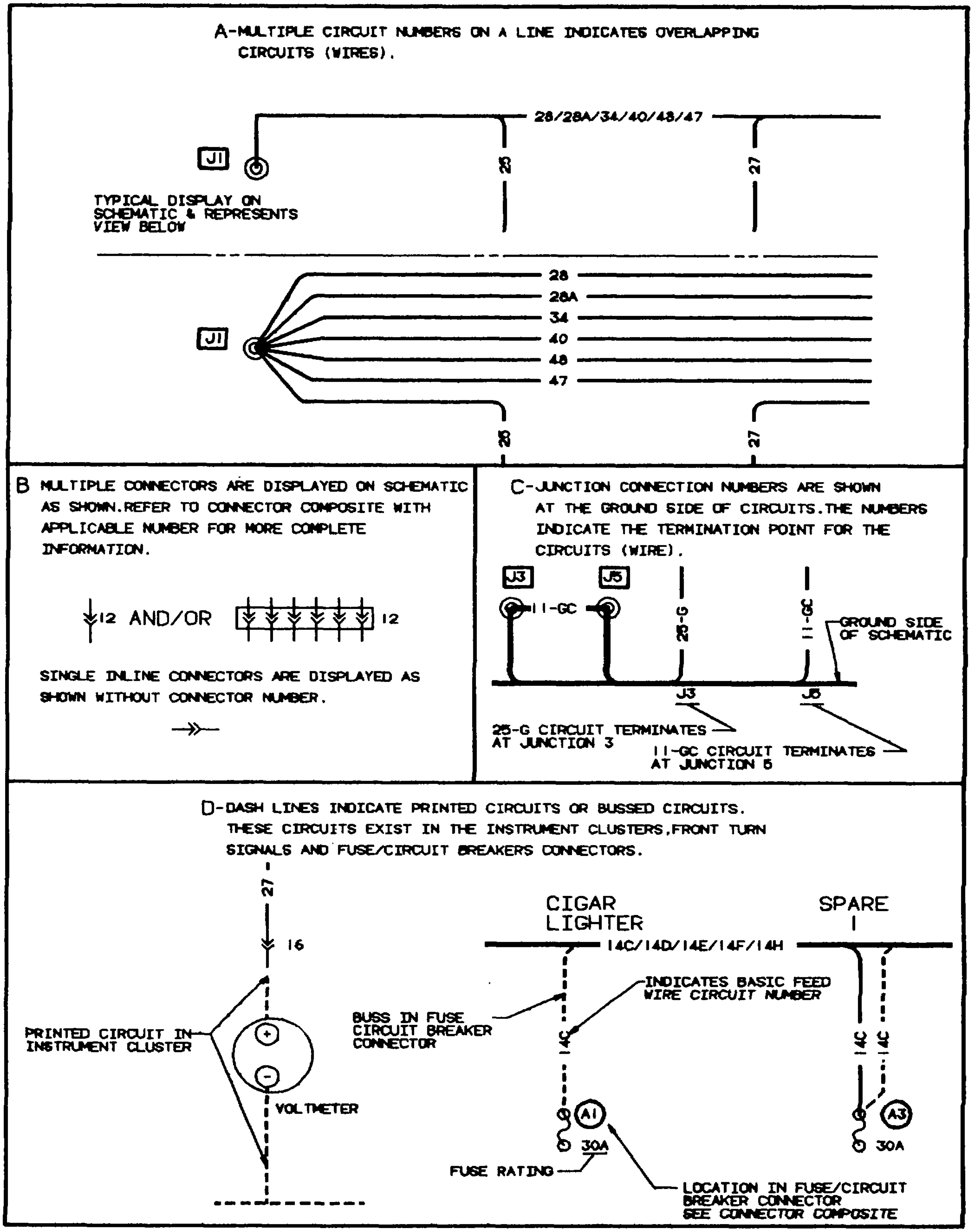
S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
CIRCUIT DIAGRAM INSTRUCTIONS



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S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
CIRCUIT DIAGRAM INSTRUCTIONS

E-CIRCUIT 11 DENOTES ANY COMMON GROUND,(MORE THAN ONE CIRCUIT). ANY INDIVIDUAL GROUND CIRCUIT IS IDENTIFIED WITH THAT PARTICULAR CIRCUIT NUMBER (E.G.-CIRCUIT 97,CRUISE CONTROL,IS IDENTIFIED PER EXAMPLE).

GROUND CIRCUITS ARE DESCRIBED THUS:

11-G
11-GA
11-GB
SUFFIX
G IS NOT A SUFFIX BUT INDICATES GROUND CIRCUIT.
COMMON GROUND CIRCUIT NUMBER

—OR—

97-G
97-GA
97-GB
SUFFIX
G IS NOT A SUFFIX BUT INDICATES GROUND CIRCUIT.
INDIVIDUAL GROUND CIRCUIT NUMBER

NOTE:FOR CIRCUIT DESCRIPTIONS OTHER THAN GROUNDS, THE LETTER G WILL NOT BE USED.

F - ABBREVIATIONS:COLOR AND NOUNS

COLOR ABBREVIATION:

AQ-AQUA
BK-BLACK
BL-BLUE
BN-BROWN
DK GN-DARK GREEN
GD-GOLD
GY-GRAY
GN-GREEN
LT BL-LIGHT BLUE
LT GN-LIGHT GREEN
OR-ORANGE
PK-PINK
RD-RED
SIL-SILVER
TN-TAN
VT-VIOLET
WH-WHITE
YL-YELLOW

NOUN ABBREVIATIONS:

A,OR,ACC-ACCESSORY
AUX-AUXILLARY
AWG-AMERICAN WIRE GAUGE
B,OR,BAT-BATTERY
ENG-ENGINE
GA-GAUGE
G,OR,GND-GROUND
I,OR,IGN-IGNITION
L-LEFT
LT-LIGHT
OPT-OPTIONAL
R-RIGHT
S-START OR SENDER
THERMO-THERMOSTAT
W/O-WITH OUT
W/-WITH
XMSN-TRANSMISSION

G-SWITCH AND RELAY POSITIONS AS SHOWN ON CIRCUIT DIAGRAMS INDICATE NORMAL POSITION WITH IGNITION OFF UNLESS OTHERWISE NOTED.

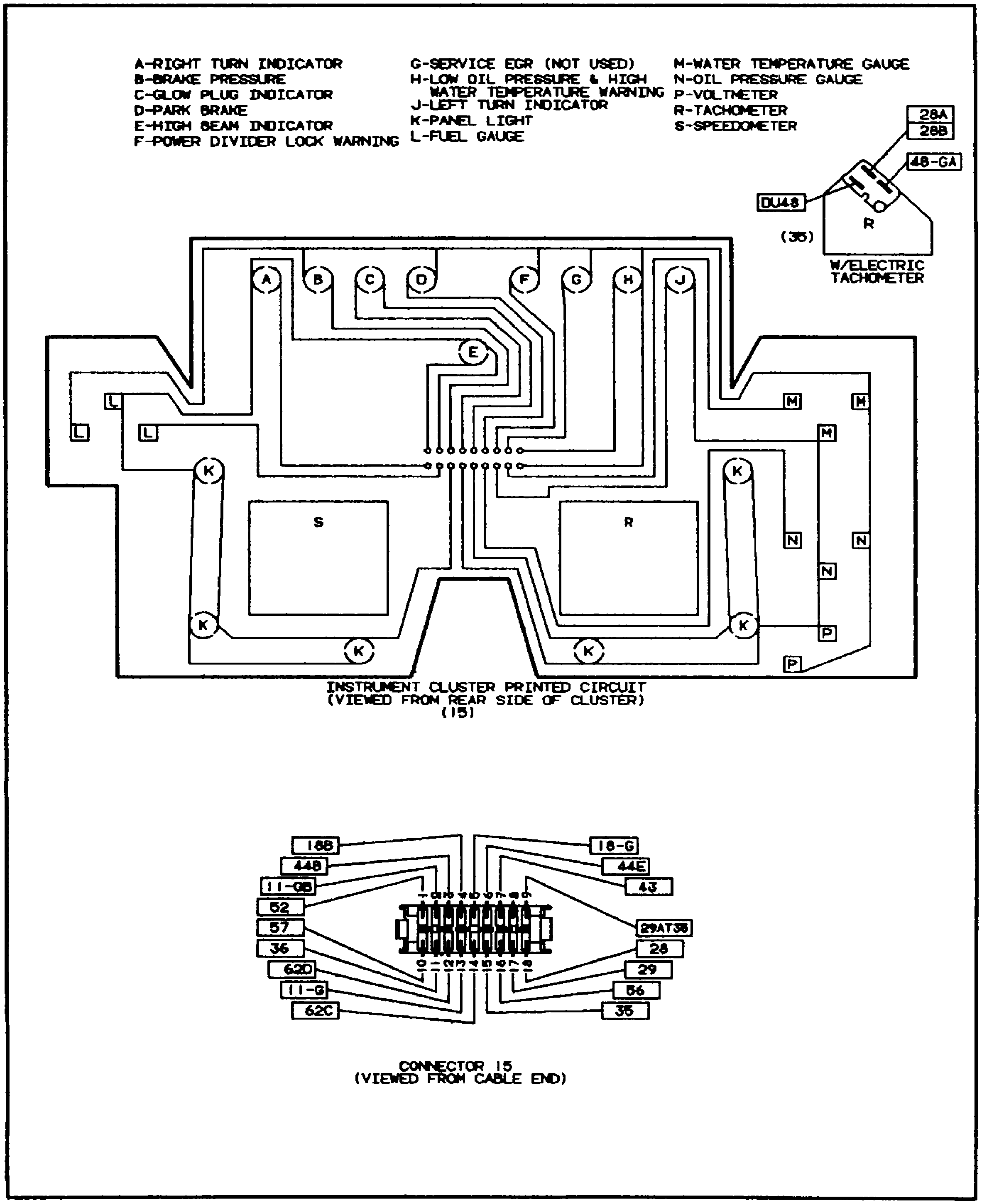
CTS-4341

S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
CABLE GAUGE AND COLOR IDENTIFICATION

CIRCUIT NUMBER	CABLE GAUGE	CABLE COLOR
GENERATOR (CHARGE)		
1	16	BK
CS 1	24*	BN-WH
2	8	BK
7	16	BK
MAJOR GROUND		
11	14	BK
11	16	BK
11A	16	BK
11B	16	BK
11B	14	BK
11C	16	BK
11D	16	BK
11-G	18	BK
11-GA	14	BK
11-GB	18	BK
MAJOR IGNITION FEED		
13	14	BK
13A	14	BK
BTRY POWER (MAIN FEED)		
14	10	BK
14A	10	BK
14B	12	BK
KEY SWITCH FEED		
15	10	BK
15A	10	BK
START CONTROL FEED		
17	6	BK
17	8(D9.0L)	BK
17	10(6.9L)	BK
17	16	BK
17A	16	BK
17B	6	BK
AS17	16	BK
GLOW PLUG		
18	16	BK
18A	6	BK
18B	18	BK
18-G	18	BK
18-G	16(6.9L)	BK
ENGINE SHUT-OFF		
19	16	BK
19A	14	BK
19A	16-DT466	BK
19B	16	BK
19C	14	BK
19C	16-DT466	BK
19D	14	BK
19D	18-DT466	BK
19E	14	BK
19F	14	BK
19H	16	BK
19J	16	BK
19K	14	BK
19L	14	BK
19M	18	BK
19P	14	BK
BS19	16	BK
19-G	16	BK
19-GA	18	BK
ETHER START		
21	16	BK
21A	16	BK
ENGINE FAN		
23	16	BK
DT23	16	BK
23A	16-N-SER	BK
INSTRUMENT FEED		
28	16	BK
28A	18	BK
28B	18	BK
ENGINE WATER TEMP		
29	18	BK
29	16-DT466	BK
29A	18	BK
29AT35	18	BK
29AT35	16-DT466	BK
29AT35-D9.L	16	LTGN/VT
D629	16	BK
ENGINE OIL TEMP		
AU30	16	WH
TRANSMISSION OIL TEMP		
31	16	RD
DU31	16	RD
ENGINE OIL PRESSURE		
35	18	BK
35	16	LTGN//VT
BT35	16	BK
FUEL LEVEL		
36	18	BK
PDL WARNING		
43	18	BK
BRAKE SYSTEM		
44	16	BK
44A	16	BK
44B	18	BK
44C	16	BK
44D	16	BK
44E	18	BK
TACHOMETER		
DU48	16	BK
48-G	16	BK
48-GA	16	BK
LIGHT SWITCH FEED		
50	12	BK
DIMMER SWITCH		
51	14	BK
HEADLIGHT (HI BEAM)		
52	18	BK
AY52	14	BK
AY52A	14	BK
HEADLIGHT (LO BEAM)		
BY53	14	BK
BY53A	14	BK
TURN SIGNAL		
55	16	BK
55A	16	BK
TURN SIGNAL LIGHTS-LEFT		
56	18	BK
56A	16	YL
CY56	16	OR
TURN SIGNAL LIGHTS-RIGHT		
57	18	BK
57A	16	LTGN
DY57	16	LTBL
CLEAR-IDENT-TAIL LIGHTS		
58	12	BK
58A	12	BK
58B	16	BK
58B	12	BK
58C	12	BK
58C	14	BL
58D	12	BK
58E	14	BK
58F	16	BK
58-G	14	BK
58-GA	18	BK
58H	12	BK
58H	12	RD
58J	12	BN
58K	16	BK
58L	18	BK
58M	18	BK
BX58	16	BK
BX58A	16	BK
HAZARD SWITCH		
60	16	WH
PANEL LIGHTS		
62	16	BK
62A	18	BK
62B	18	BK
62C	18	BK
62D	18	BK
62E	18	BK
62F	18	BK
62H	18	BK
62J	16	BK
62K	16	BK
62-G	18	BK
62-GA	18	BK
62-GB	18	BK
62-GC	18	BK
DOME/COUSTESY LIGHTS		
63	18	BK
63A	18	BK
STOP LIGHTS		
70	14	BK
70A	14	BK
70B	16	RD
70C	14	BK
BACK-UP LIGHTS		
		BK
71	16	
71A	16	BK
BU71	14	BK
CU71	14	BK
TRAILER FEED		
72	14	BK
72A	14	BK
72B	14	BK
HEATER		
75	12	BK
75	14 (A/C)	BK
75A	14	BK
75B	14	BK
75C	14	BK
75D	14	BK
75E	12	BK
75F	12	BK
75H	14	BK
75J	14	BK
75-G	14	BK
75-GA	12	BK
AIR CONDITIONER		
77	14	BK
77A	14	BK
77B	14	BK
77C	14	BK
77D	14	BK
AV77	14	BK
AV77	16-DT466	BK
AW77	14	BK
77-G	14	BK
MIRROR		
78	16	BK
78A	16	BK
78B	16	BK
78C	16	BK
78D	16	BK
78-G	16	BK
78-GA	16	BK
78-GB	16	BK
ACCESSORY FEED		
80	10	BK
80A	14	BK
80B	14	BK
WINDSHIELD WIPER		
82	14	BK
CIGAR LIGHTER		
84	16	BK
HORN		
85	16	BK
85A	16	BK
AX85	16	BK
RADIO		
86	16	BK
86A	16	RD///OR
86-GA	18	BK
86-GB	16	WH
WINDSHIELD WASHER		
87	16	BK
CZ87	16	BK
HY POWER BRAKE		
90	10	BK
90A	16	BK
90B	12	BK
90C	16	BK
90D	16	BK
90E	16	BK
90F	16	BK
90H	16	BK
90J	16	BK
90K	16	BK
TWO SPEED AXLE		
93	14	BK
93A	16	BK

CTS-4341

S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
CONNECTOR BODY COMPOSITE-INSTRUMENT CLUSTER



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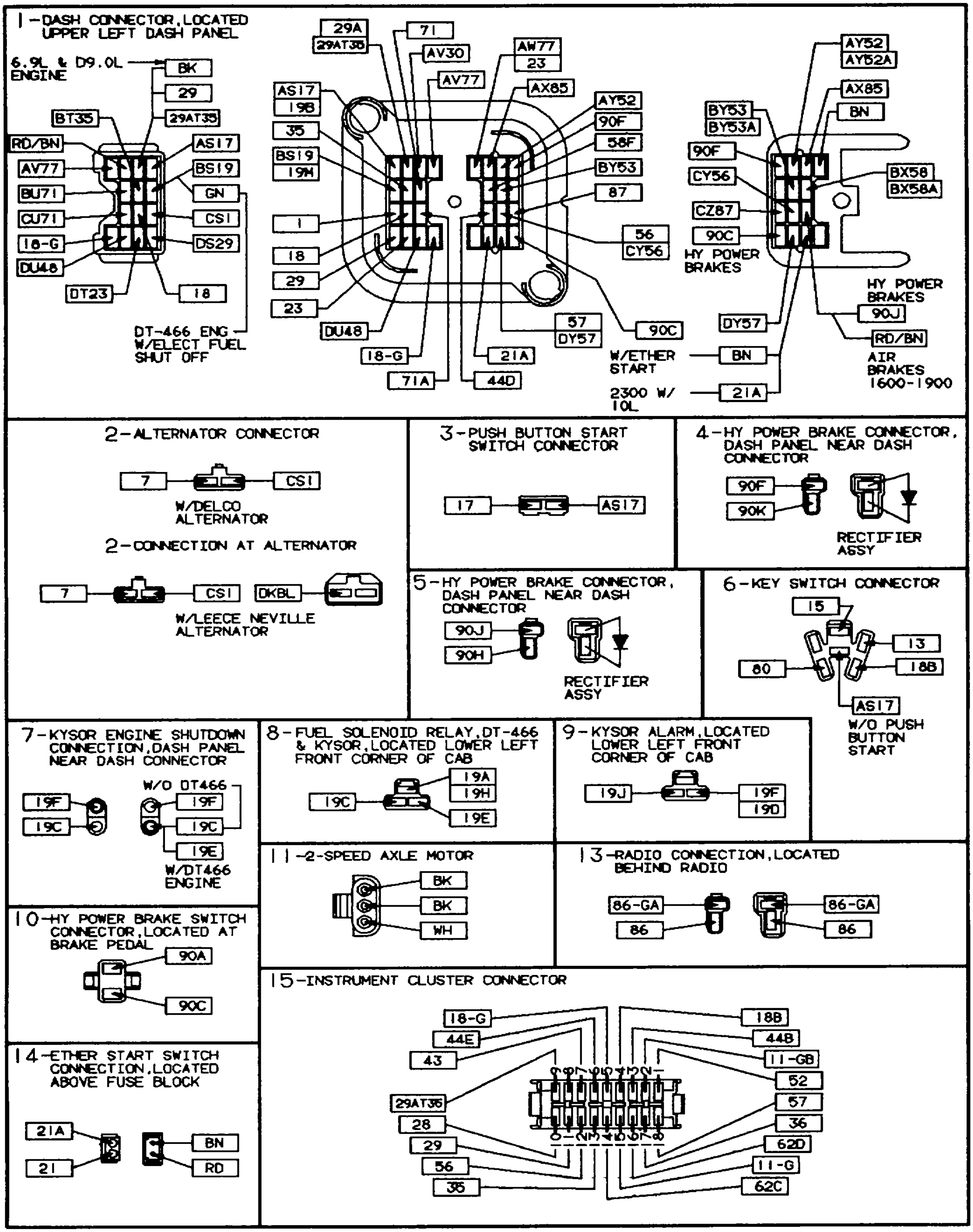
S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
CONNECTOR BODY COMPOSITE - (CONNECTOR VIEWED FROM MATING END)



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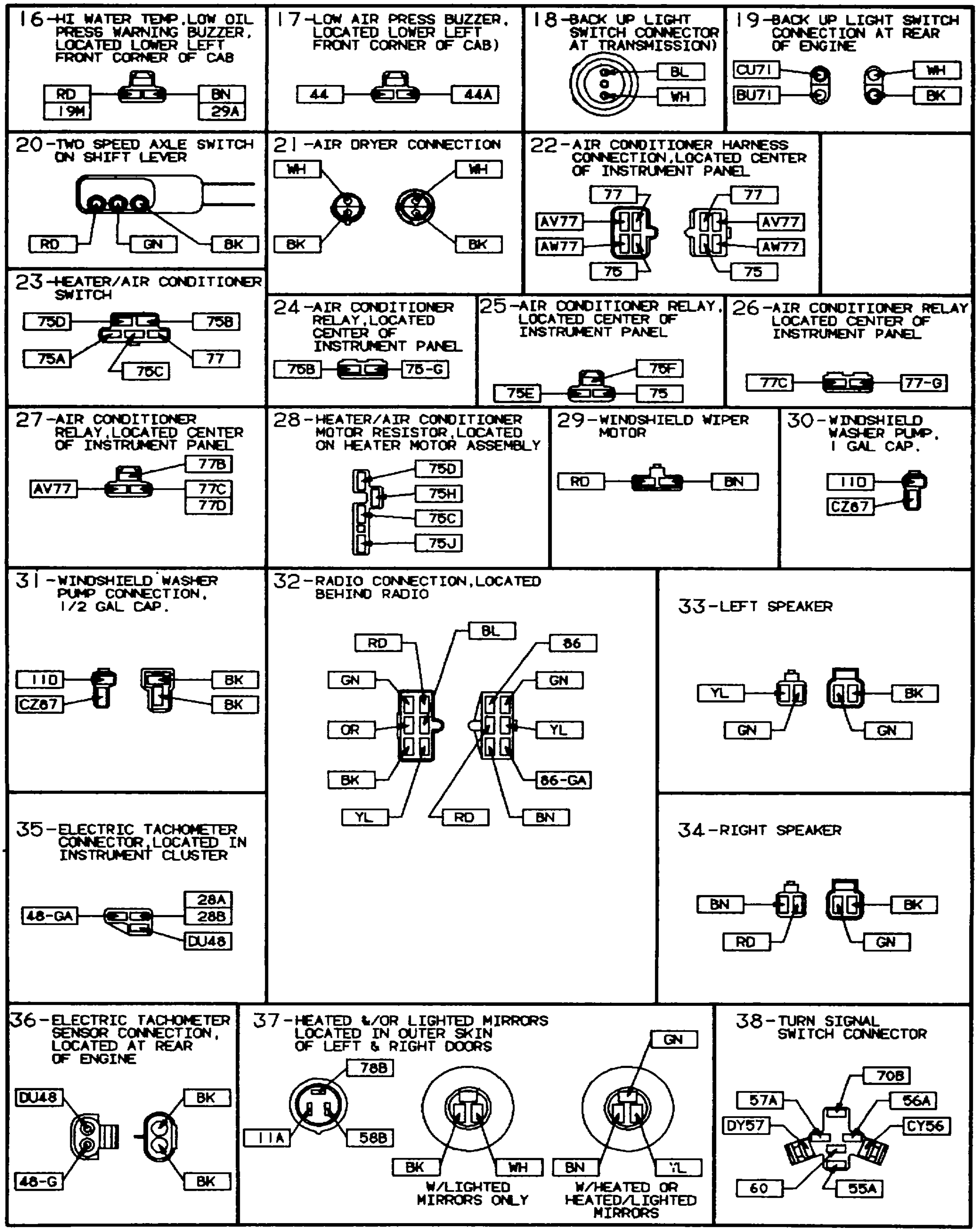
S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
CONNECTORBODY COMPOSITE-CONNECTOR VIEWED FROM MATING END)



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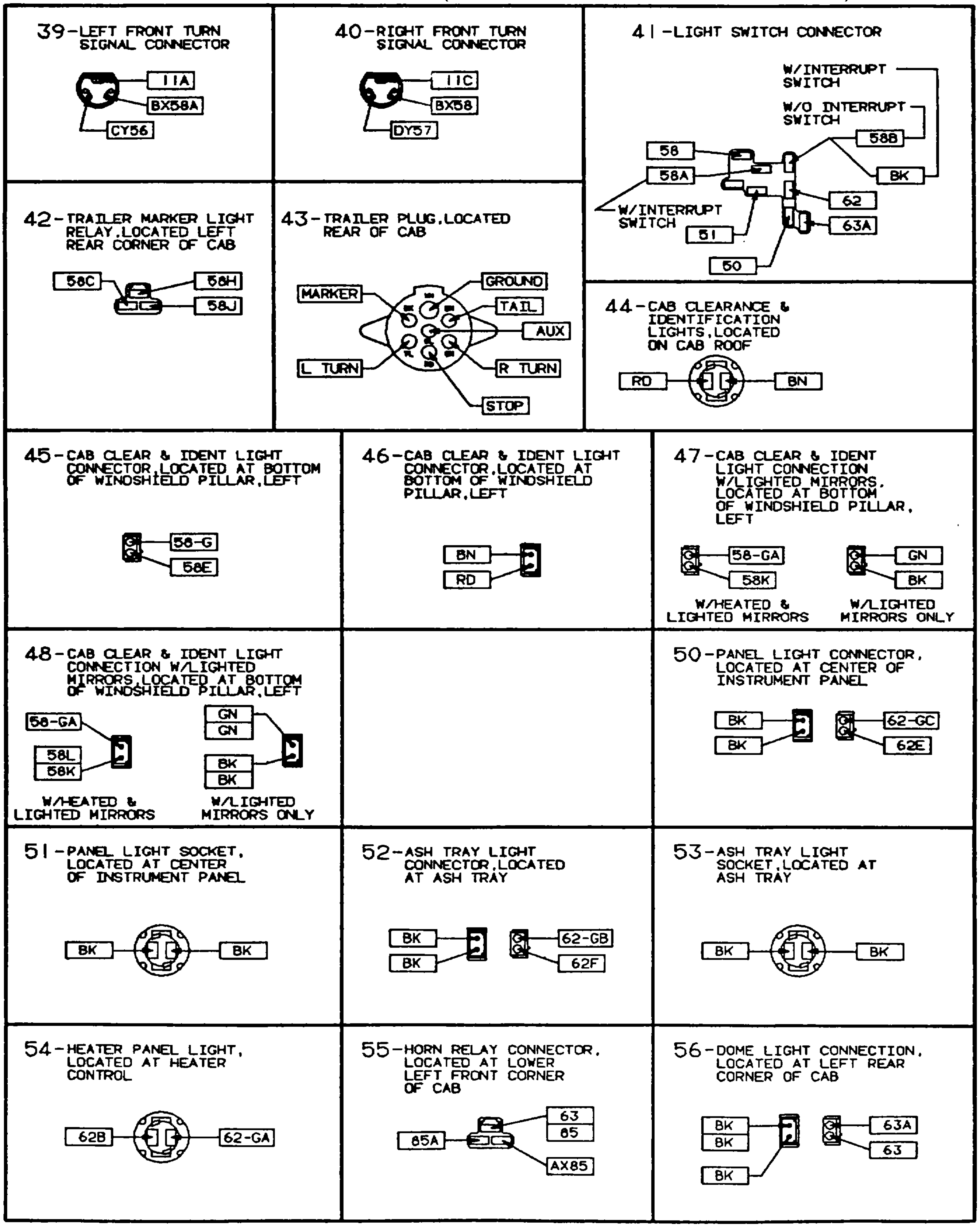
S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
CONNECTOR BODY COMPOSITE-(CONNECTOR VIEWED FROM MATING END)



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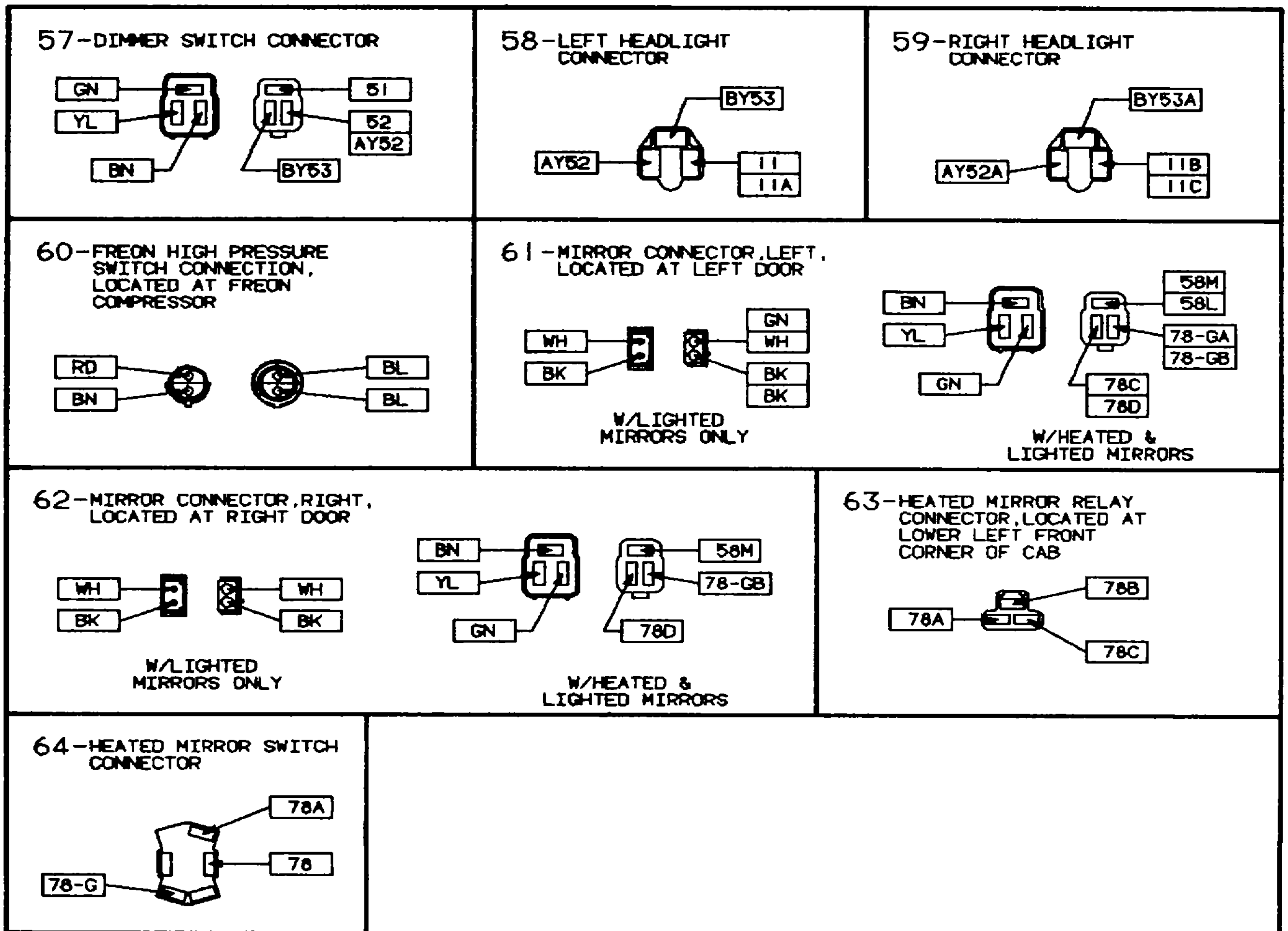
S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
CONNECTOR BODY COMPOSITE-(CONNECTOR VIEWED FROM MATING END)



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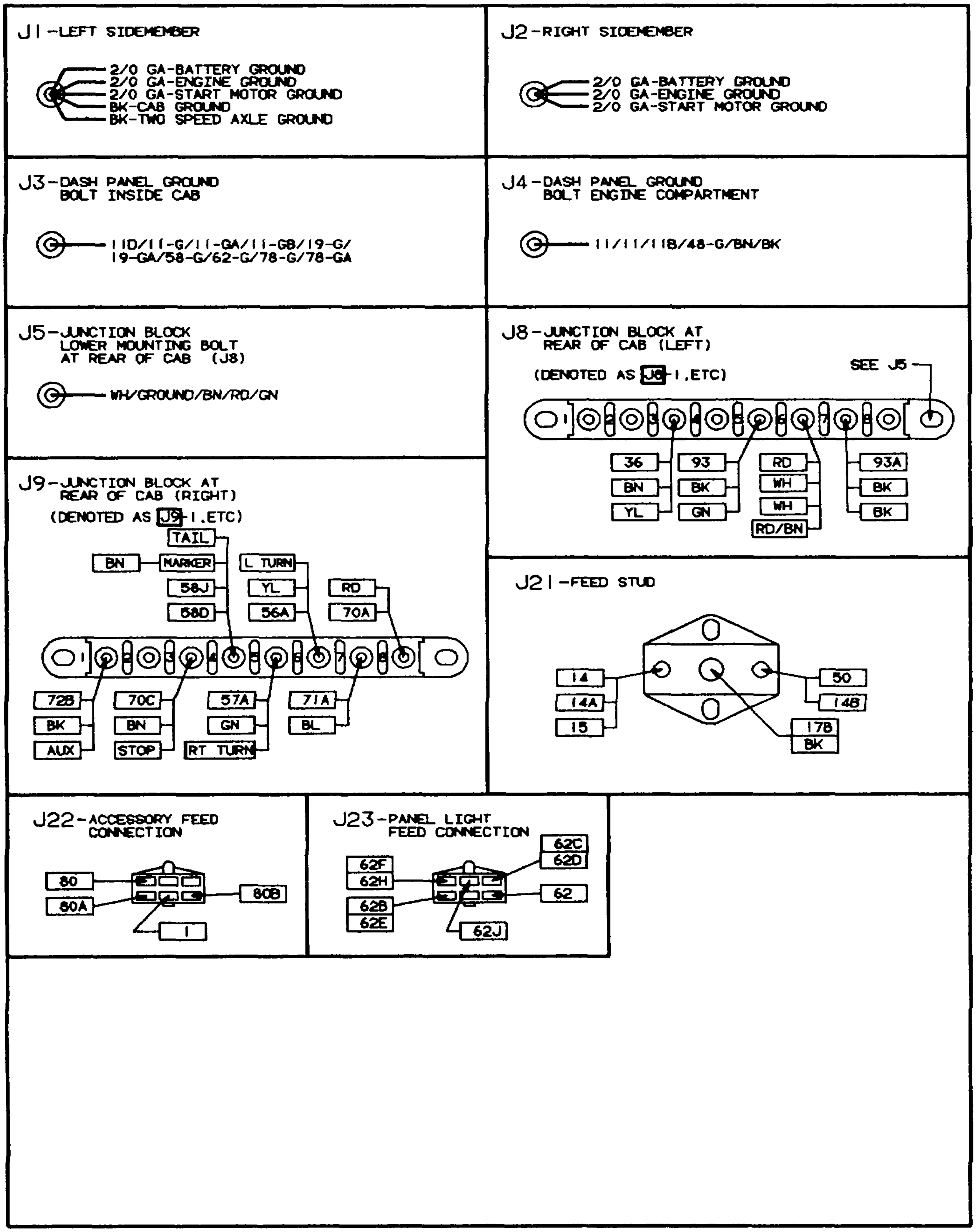
S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
JUNCTION POINTS- (CONNECTOR VIEWED FROM MATING END)



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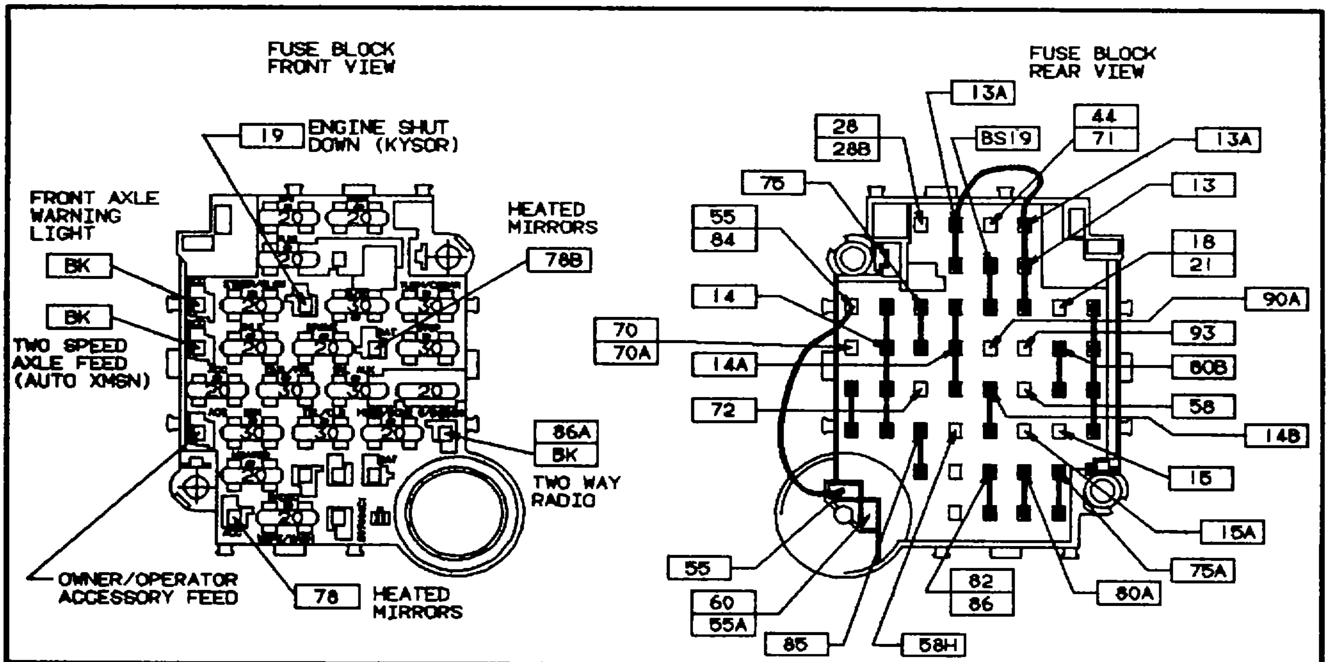
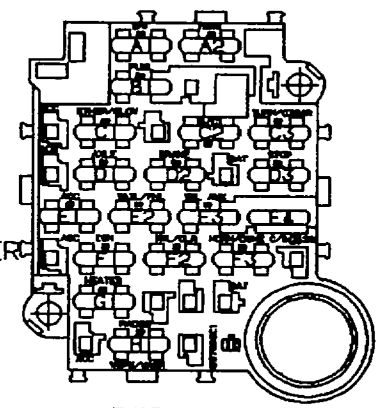
S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
FUSE BLOCK



FUSE/CIRCUIT BREAKER CHART

* FUSE ONLY, SEE NOTE ON PAGE 2

LOCATION	SIZE	DESCRIPTION
A1	20AMP	BACK-UP LIGHT, LOW AIR BUZZER
* A2	20AMP	INSTRUMENT CLUSTER, ELECT TACH, OPT GAUGES (FUSE ONLY)
B1	20AMP	FUEL SHUT OFF
B2	---	NOT USED
C1	20AMP	ETHER START OR GLOW PLUG
C2	30AMP	AIR CONDITIONER-HIGH SPEED BLOWER OR HEATED MIRRORS
* C3	30AMP	TURN SIGNAL, CIGAR LIGHTER (FUSE ONLY)
D1	20AMP	2-SPEED AXLE, AIR DRYER W/MANUAL XMSN
D2	20AMP	HY-POWER BRAKES
D3	30AMP	STOP LIGHT
E1	20AMP	ACCESSORY, FRONT AXLE WARN LT 2 SPEED W/AUTO XMSN
E2	30AMP	PANEL, PARK, STRAIGHT TRUCK TAIL, MARKER
E3	30AMP	TRAILER AUXILLARY
E4	20AMP	CB RADIO/-C.B. WILL NOT PLUG IN
F1	30AMP	IGNITION SWITCH FEED
F2	30AMP	TRAILER MARKER & TAIL, TRUCK TAIL W/TRAILER
* F3	20AMP	HORN, DOME LIGHT (FUSE ONLY)
* G1	20AMP	HEATER, A/C CLUTCH OR HTD MIRRORS (FUSE ONLY)
H1	20AMP	RADIO, WIPER, WASHER



FUSES SHOWN
CIRCUIT BREAKERS OPTIONAL

NOTE:
FUSE BLOCK LOCATED ON LOWER LEFT CORNER OF DASH PANEL

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S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
BULB CHART

BULB APPLICATION	WATTS OR CANDLEPOWER	TRADE NUMBER
HEADLIGHT:		6014
HIGH BEAM	60 WATTS	
LOW BEAM	50 WATTS	
FRONT TURN	32	1156
SIDE MARKER	2	1895
PARK	3	181
IDENTIFICATION/CLEARANCE	3	168
MIRROR LIGHT	2	1895
FLOOD LIGHT	12	561
INSTRUMENT CLUSTER:		
ILLUMINATION	3	168
INDICATOR	2	194
WARNING	2	194
INFORMATION	2	194
HEATER & AIR CONDITIONER CONTROLS:	3	168
RADIO	0.75	1892
DOME	12	211-2
STOP-TAIL-TURN-LICENSE	32/3	1157
BACK-UP	32	1156
CONTROL IDENTIFICATION OR WARNING LIGHT:		
ENGINE STOP	0.50	**
FRONT AXLE	0.50	**
GAUGE ILLUMINATION:		
ENGINE OIL TEMPERATURE	1	53
XMSN OIL TEMPERATURE	1	53
INSTRUMENT PANEL CONTROLS	0.50	**
ASH TRAY	0.50	**
AUTOMATIC XMSN CONTROL	1	53

**-BULB IS PART OF LIGHT ASSEMBLY AND IS NOT SERVICEABLE

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S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS

SYMBOL	DESCRIPTION
	MALE/FEMALE IN-LINE CONNECTION
	MALE TERMINAL
	FEMALE TERMINAL
	GROUND
	LIGHT,SINGLE FILAMENT
	LIGHT,DOUBLE FILAMENT
	FUSE/FUSIBLE LINK
	DIODE
	SWITCH/RELAY CONTACTS OPEN
	SWITCH/RELAY CONTACTS CLOSED
	JUNCTION POINT
JI	JUNCTION POINT IDENTIFICATION
A1	FUSE/CIRCUIT BREAKER IDENTIFICATION
	SPLICE
	SWITCH,PUSH BUTTON
	SWITCH,MANUAL/MECHANICAL
	SWITCH,PRESSURE
	SWITCH,W/LIGHT
	RELAY
	SENDER,OIL/WATER/FUEL
	CIRCUIT BREAKER

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S-SERIES LEFT HAND DRIVE ELECTRICAL CIRCUIT DIAGRAMS
NOTES

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S-SERIES LH DR ELECTRICAL CIRCUIT DIAGRAMS

CIRCUIT DIAGRAM INDEX

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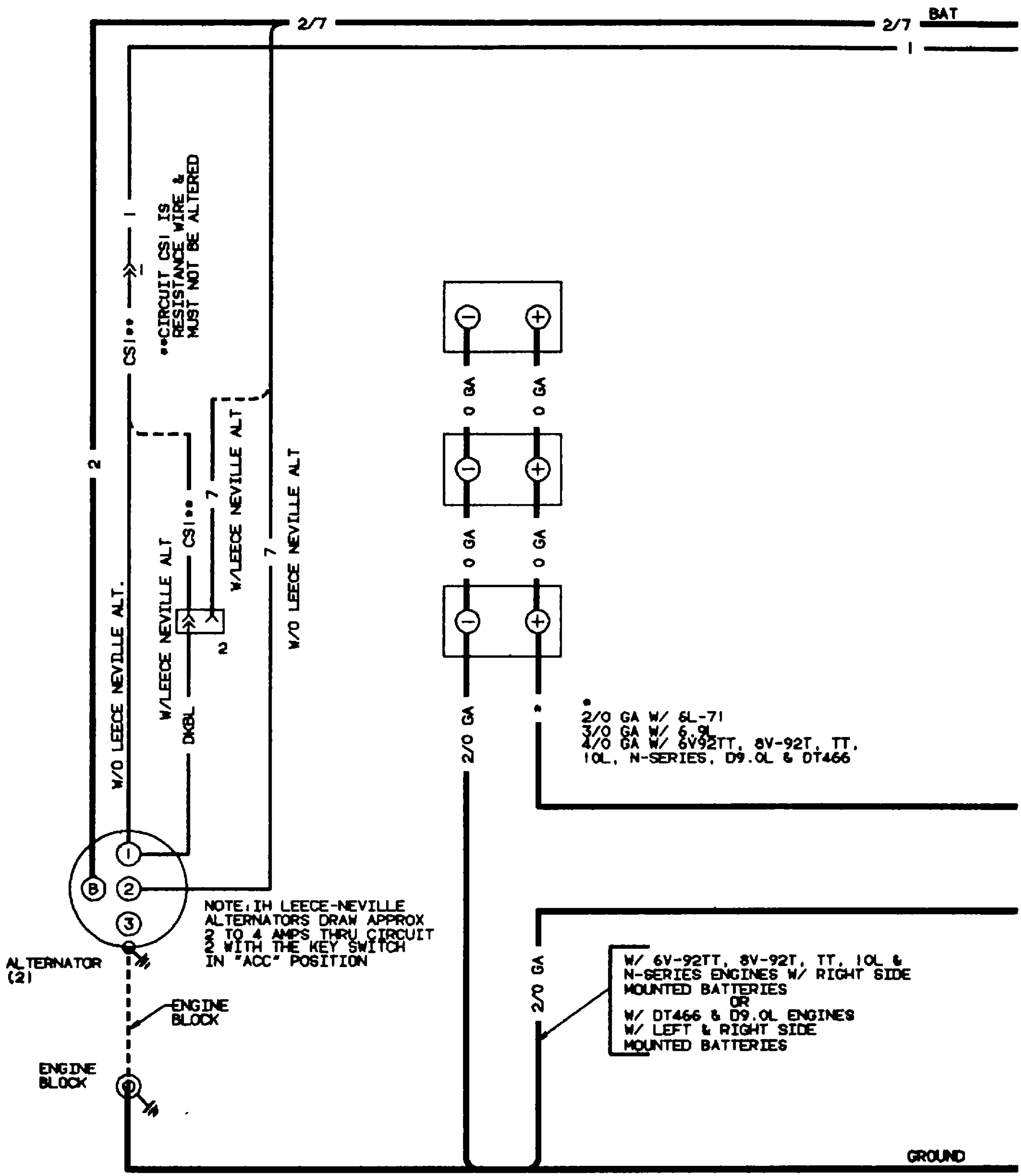
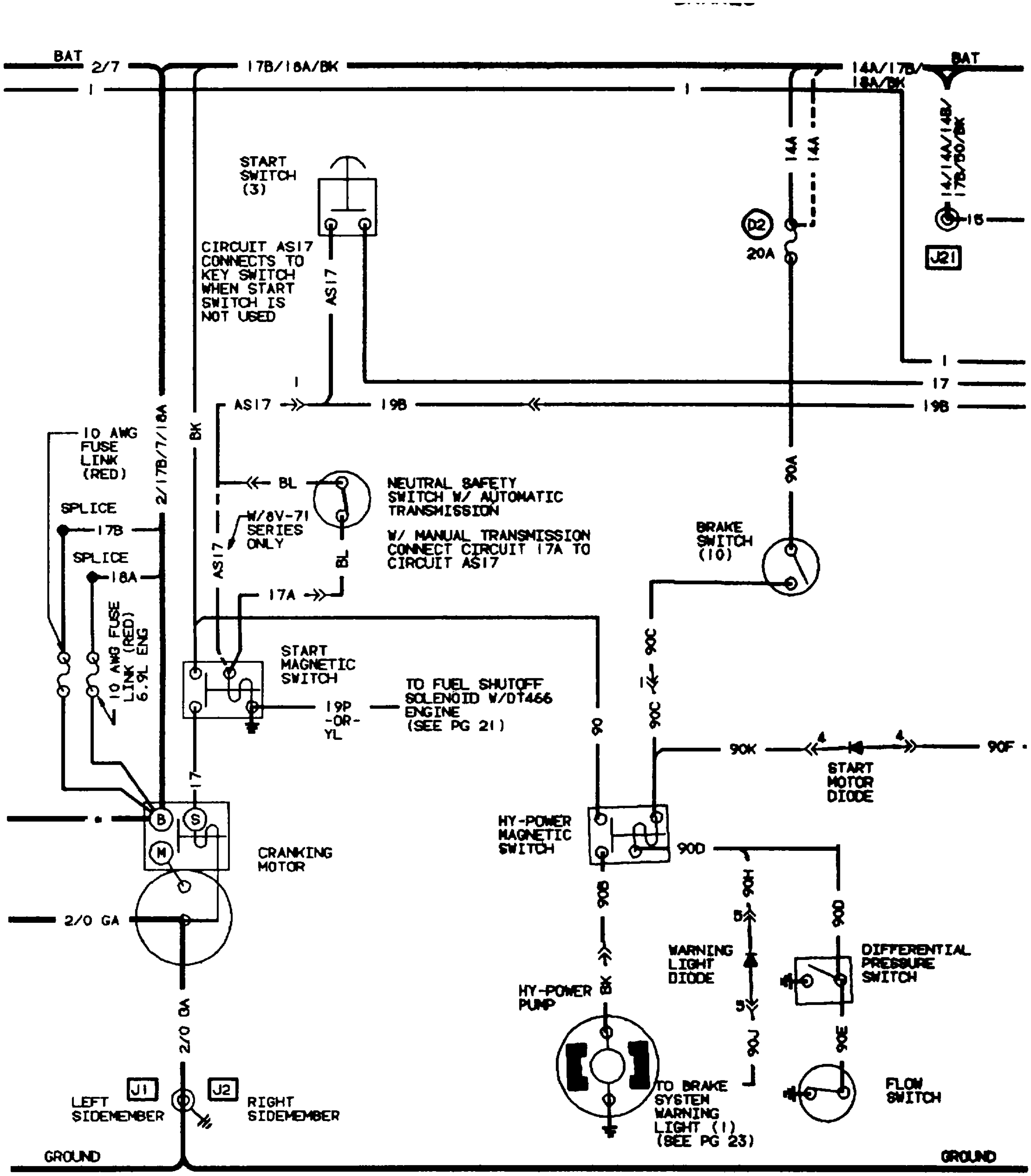
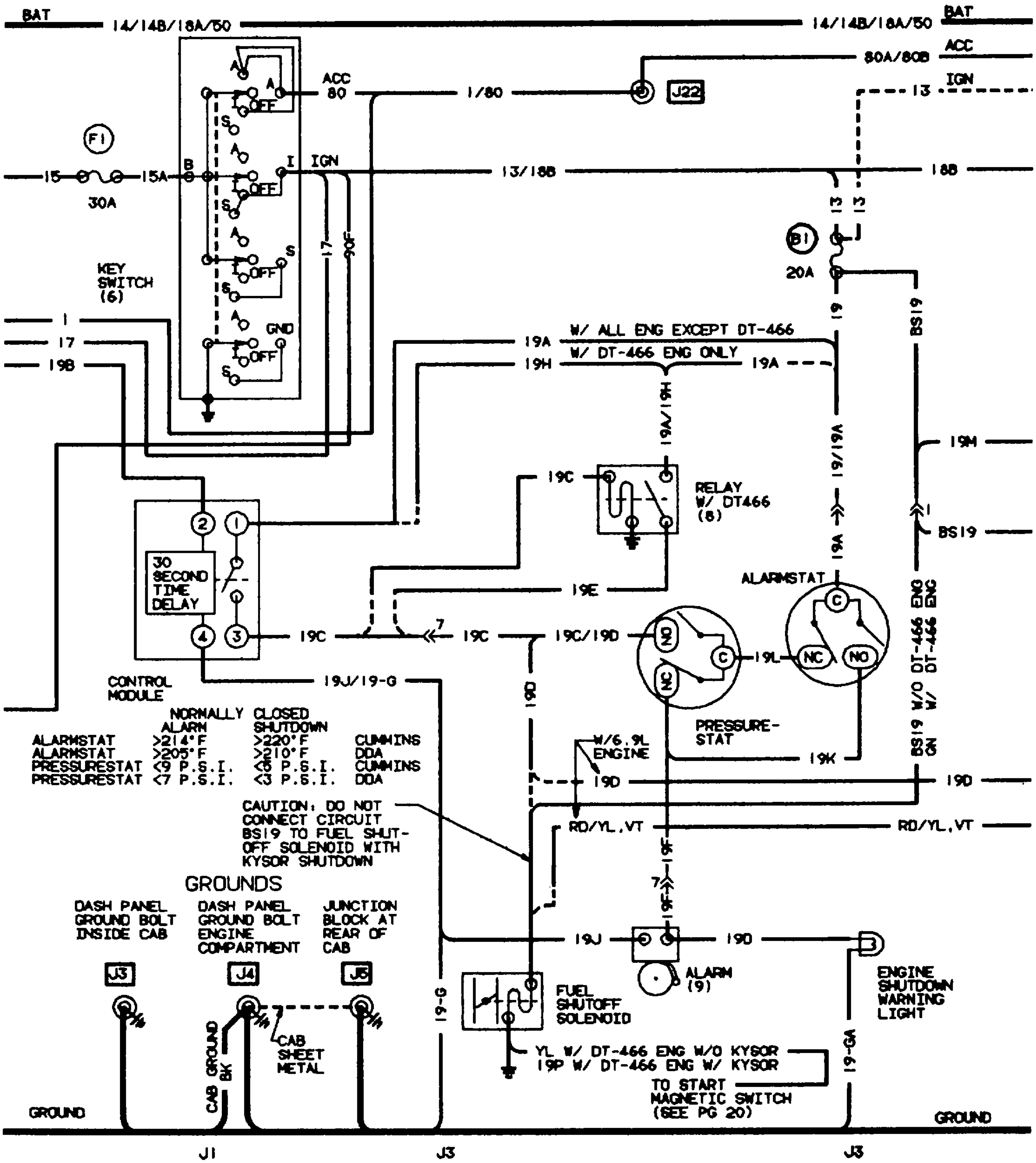
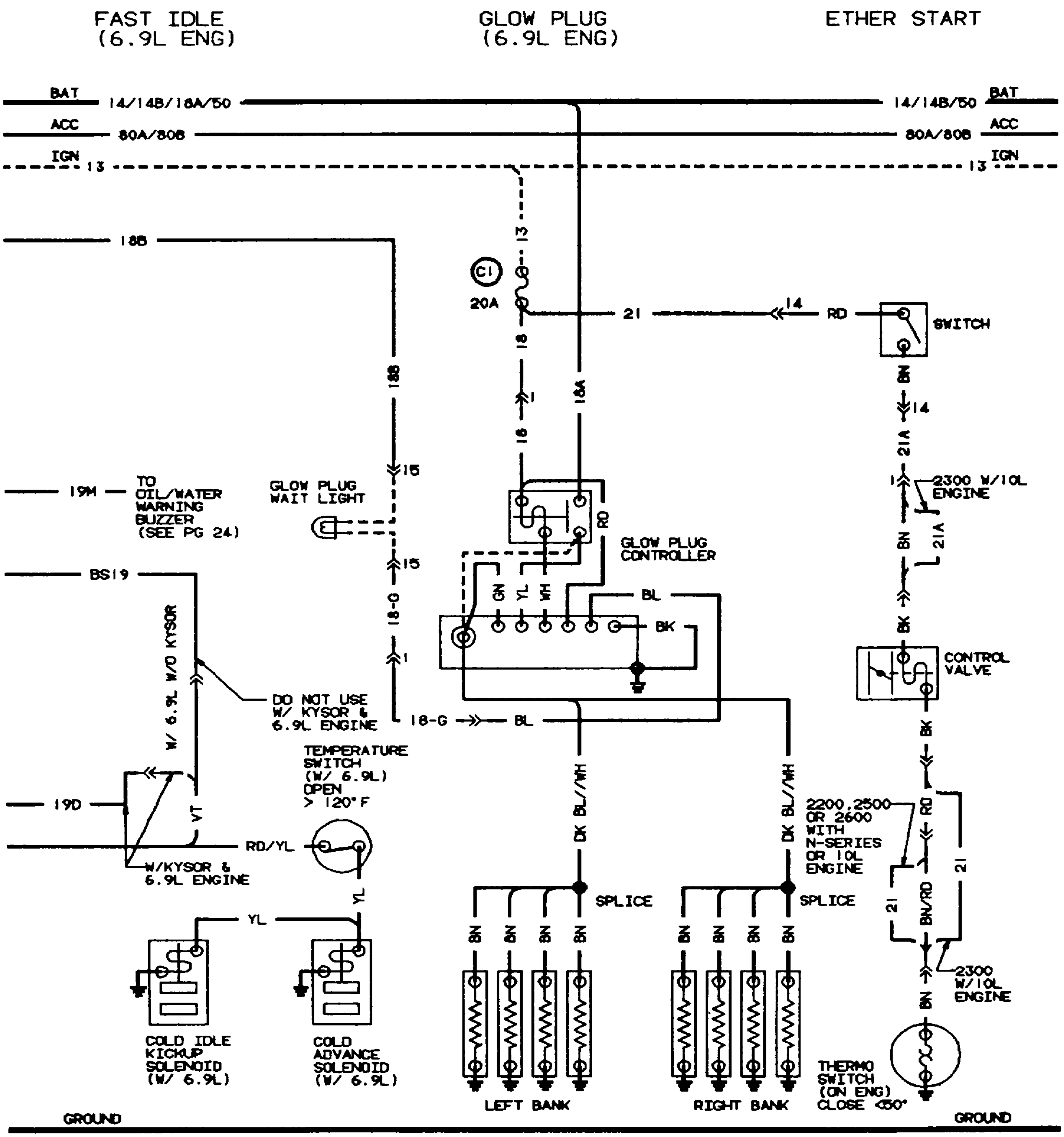

2/7
2/7
BAT
1
CS1**
**CIRCUIT CS1 IS
RESISTANCE WIRE &
MUST NOT BE ALTERED
2
W/O LEECE NEVILLE ALT.
W/LEECE NEVILLE ALT
DKBL
CS1**
7
W/LEECE NEVILLE ALT
7
W/O LEECE NEVILLE ALT
2
0 GA
0 GA
0 GA
0 GA
2/0 GA
*
*
2/0 GA W/ 6L-71
3/0 GA W/ 6.9L
4/0 GA W/ 6V92TT, 8V-92T, TT,
10L, N-SERIES, D9.0L & DT466
B
1
2
3
NOTE: IH LEECE-NEVILLE
ALTERNATORS DRAW APPROX
2 TO 4 AMPS THRU CIRCUIT
2 WITH THE KEY SWITCH
IN "ACC" POSITION
ALTERNATOR
(2)
ENGINE
BLOCK
ENGINE
BLOCK
2/0 GA
W/ 6V-92TT, 8V-92T, TT, 10L &
N-SERIES ENGINES W/ RIGHT SIDE
MOUNTED BATTERIES
OR
W/ DT466 & D9.0L ENGINES
W/ LEFT & RIGHT SIDE
MOUNTED BATTERIES
GROUND


BAT
2/7
17B/18A/BK
14A/17B/18A/BK
BAT
START SWITCH (3)
CIRCUIT AS17 CONNECTS TO KEY SWITCH WHEN START SWITCH IS NOT USED
AS17
D2
20A
14A
14/14A/14B/17B/90/BK
15
J21
17
19B
AS17
10 AWG FUSE LINK (RED)
2/17B/7/18A
BK
BL
NEUTRAL SAFETY SWITCH W/ AUTOMATIC TRANSMISSION
W/ MANUAL TRANSMISSION CONNECT CIRCUIT 17A TO CIRCUIT AS17
W/8V-71 SERIES ONLY
SPLICE
17B
18A
17A
90A
BRAKE SWITCH (10)
10 AWG FUSE LINK (RED) 6.9L ENG
START MAGNETIC SWITCH
TO FUEL SHUTOFF SOLENOID W/DT466 ENGINE (SEE PG 21)
19P -OR- YL
90
90C
90K
START MOTOR DIODE
90F
HY-POWER MAGNETIC SWITCH
90D
CRANKING MOTOR
2/0 GA
90B
90H
WARNING LIGHT DIODE
DIFFERENTIAL PRESSURE SWITCH
HY-POWER PUMP
90J
90E
TO BRAKE SYSTEM WARNING LIGHT (1) (SEE PG 23)
FLOW SWITCH
J1
J2
LEFT SIDEMEMBER
RIGHT SIDEMEMBER
GROUND
GROUND

KEY SWITCH FUEL SOLENOID KYSOR EMERGENCY ENGINE SHUTDOWN



FAST IDLE (6.9L ENG) | **GLOW PLUG (6.9L ENG)** | **ETHER START**



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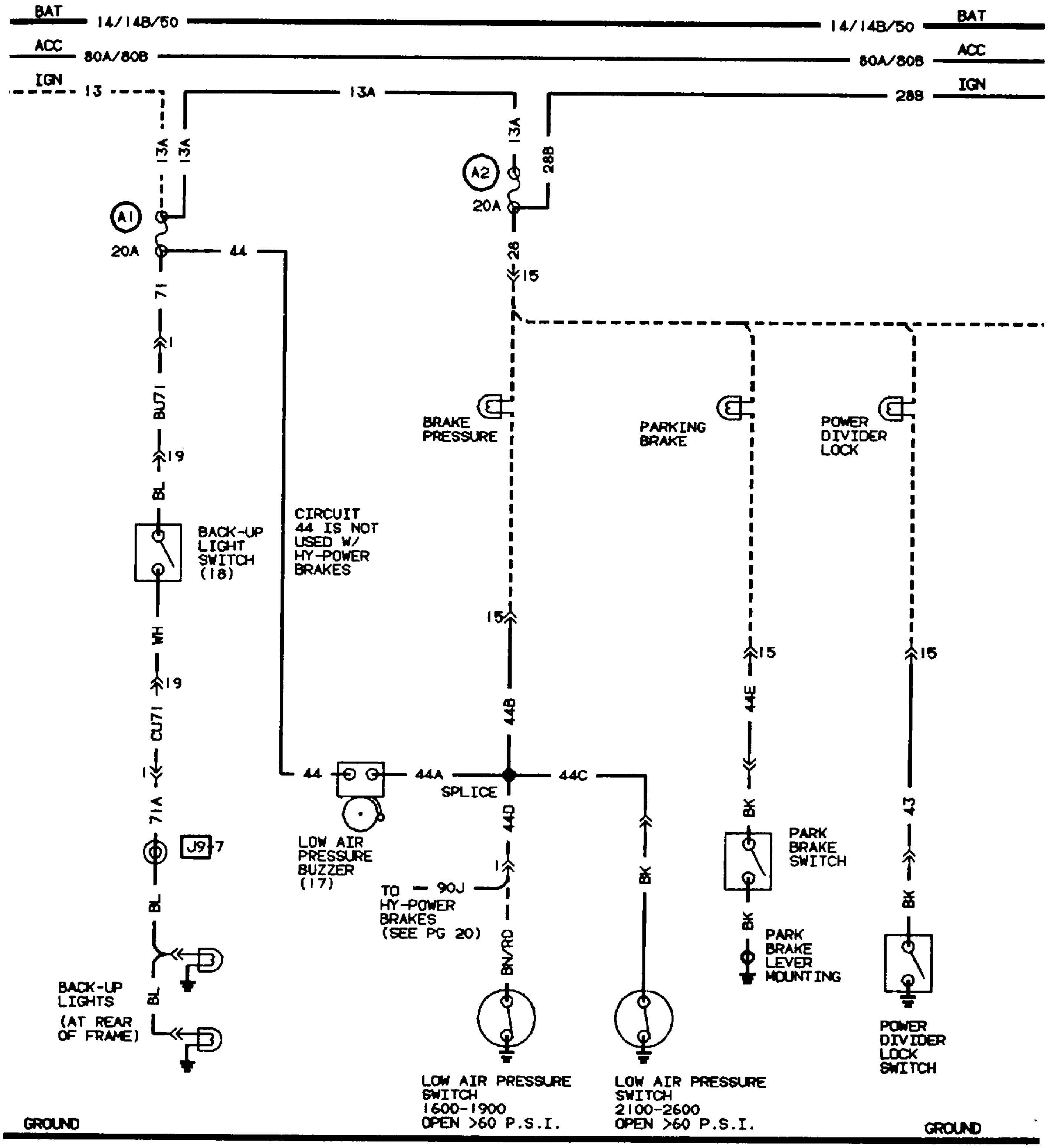
BACK-UP LIGHTS LIGHT | **BRAKE PRESSURE LIGHT** | **PARKING BRAKE** | **POWER DIVIDER LOCK LIGHT**

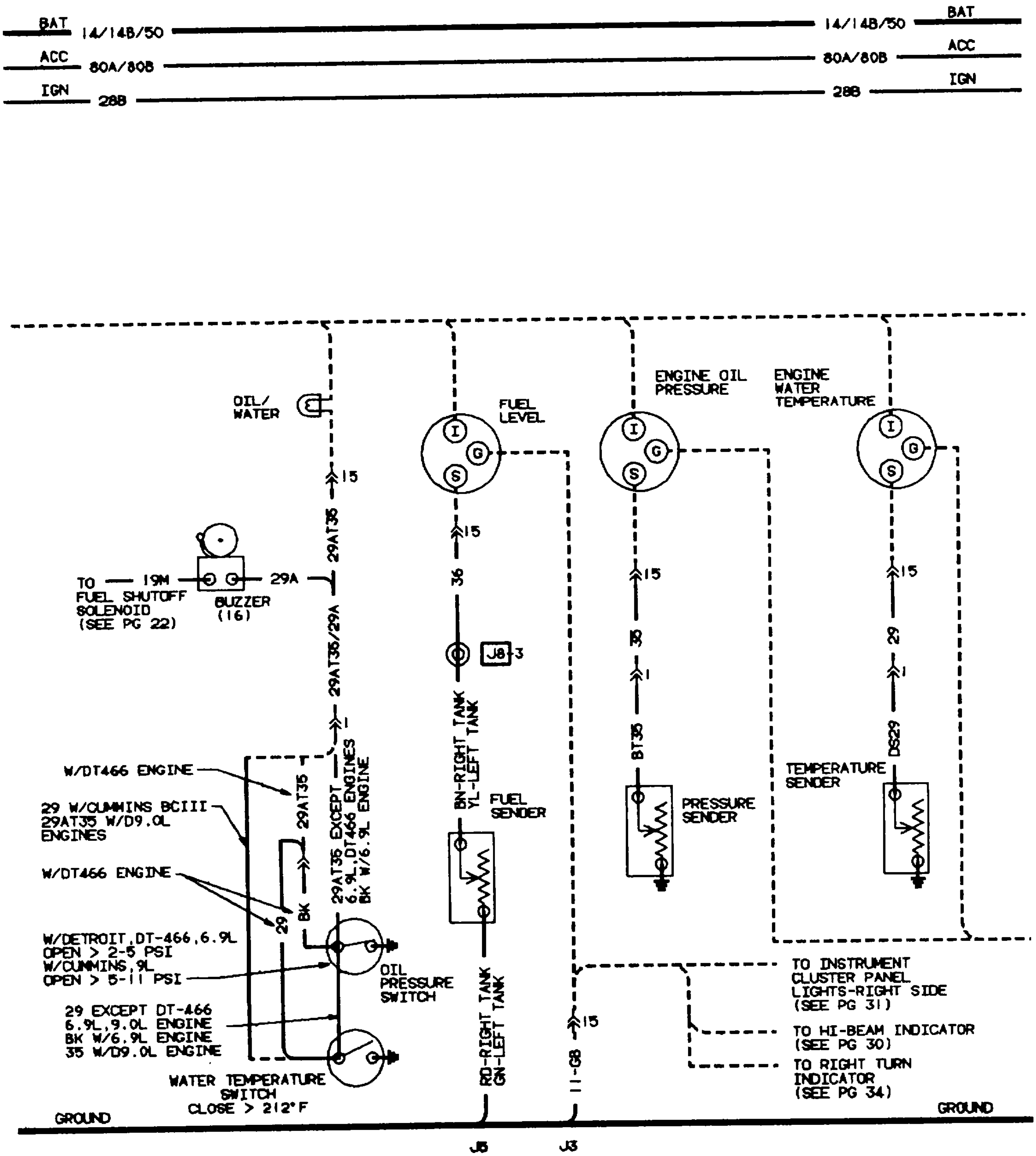


OIL PRESS/WATER TEMPERATURE LIGHT

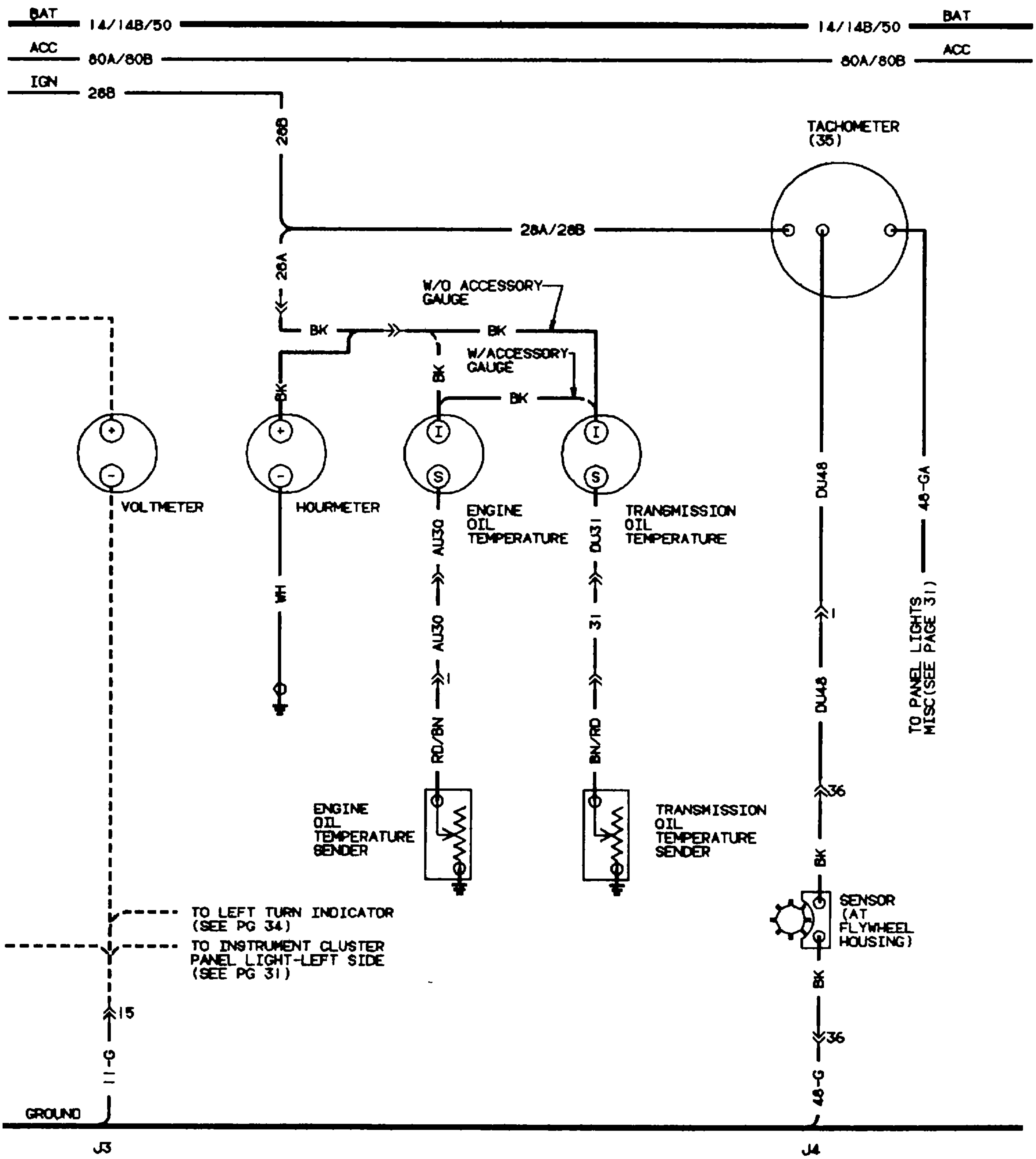
FUEL LEVEL GAUGE

ENGINE OIL PRESSURE GAUGE

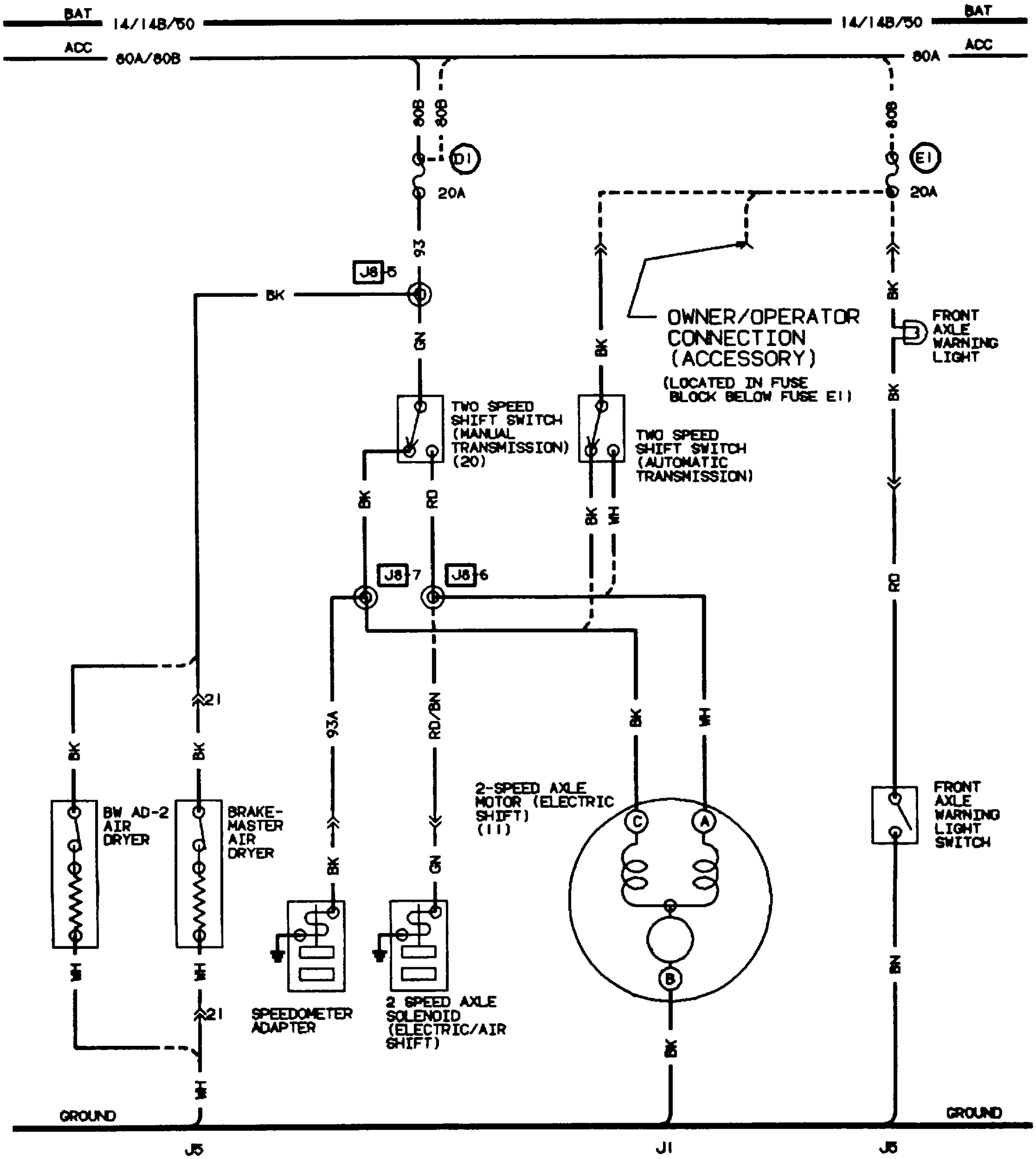
ENGINE WATER TEMPERATURE GAUGE



VOLTMETER **HOURMETER** **ENGINE OIL TEMPERATURE GAUGE** **TRANSMISSION TEMPERATURE GAUGE** **TACHOMETER**



AIR DRYER | TWO SPEED AXLE (ELECTRIC/AIR) | TWO SPEED AXLE (ELECTRIC) | OWNER/OPERATOR CONNECTION (ACCESSORY) | FRONT AXLE WARNING LIGHT



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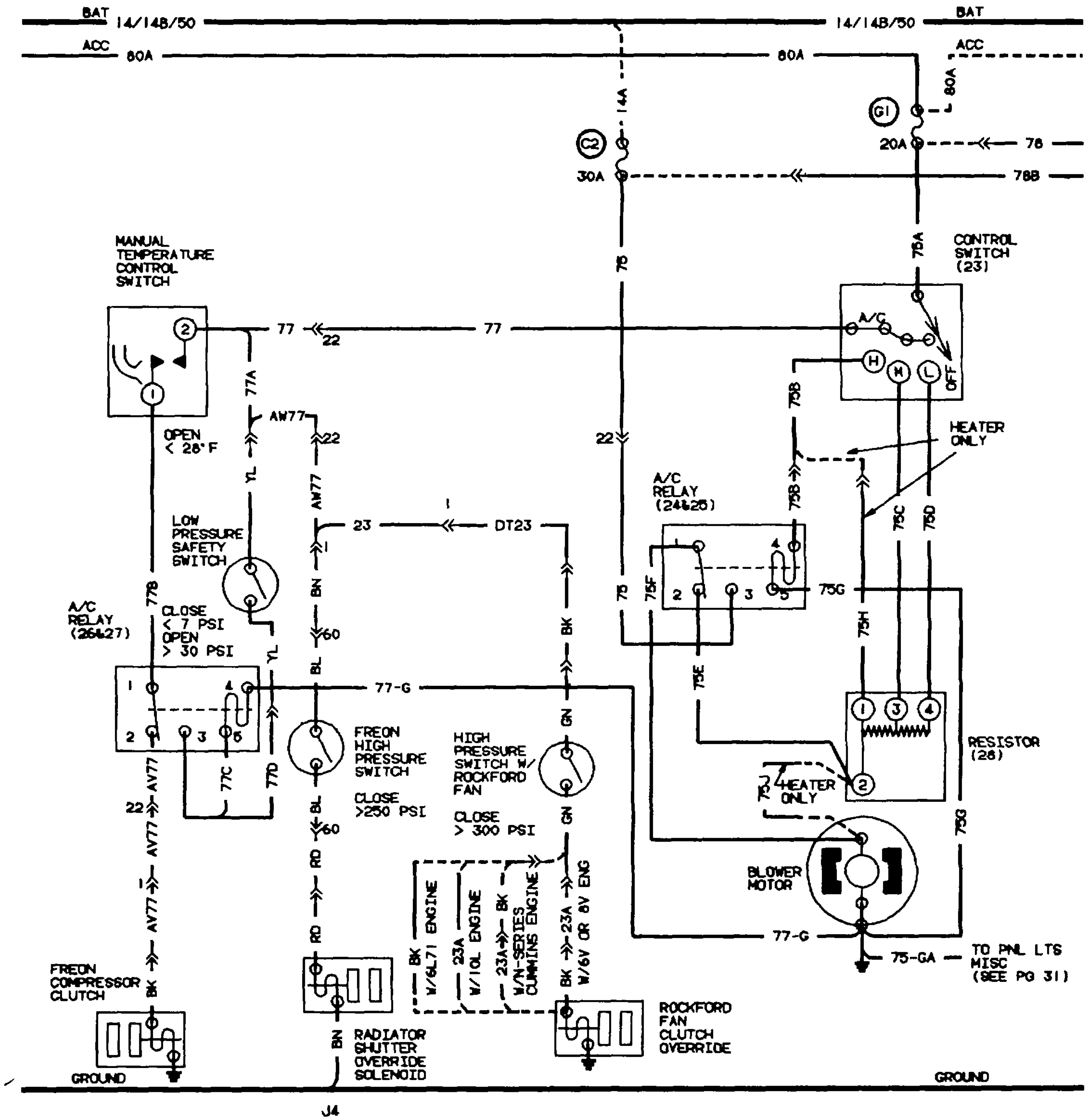
AIR CONDITIONER OVERRIDE FAN | **SHUTTER ENGINE** | **ROCKFORD** | **HEATER**



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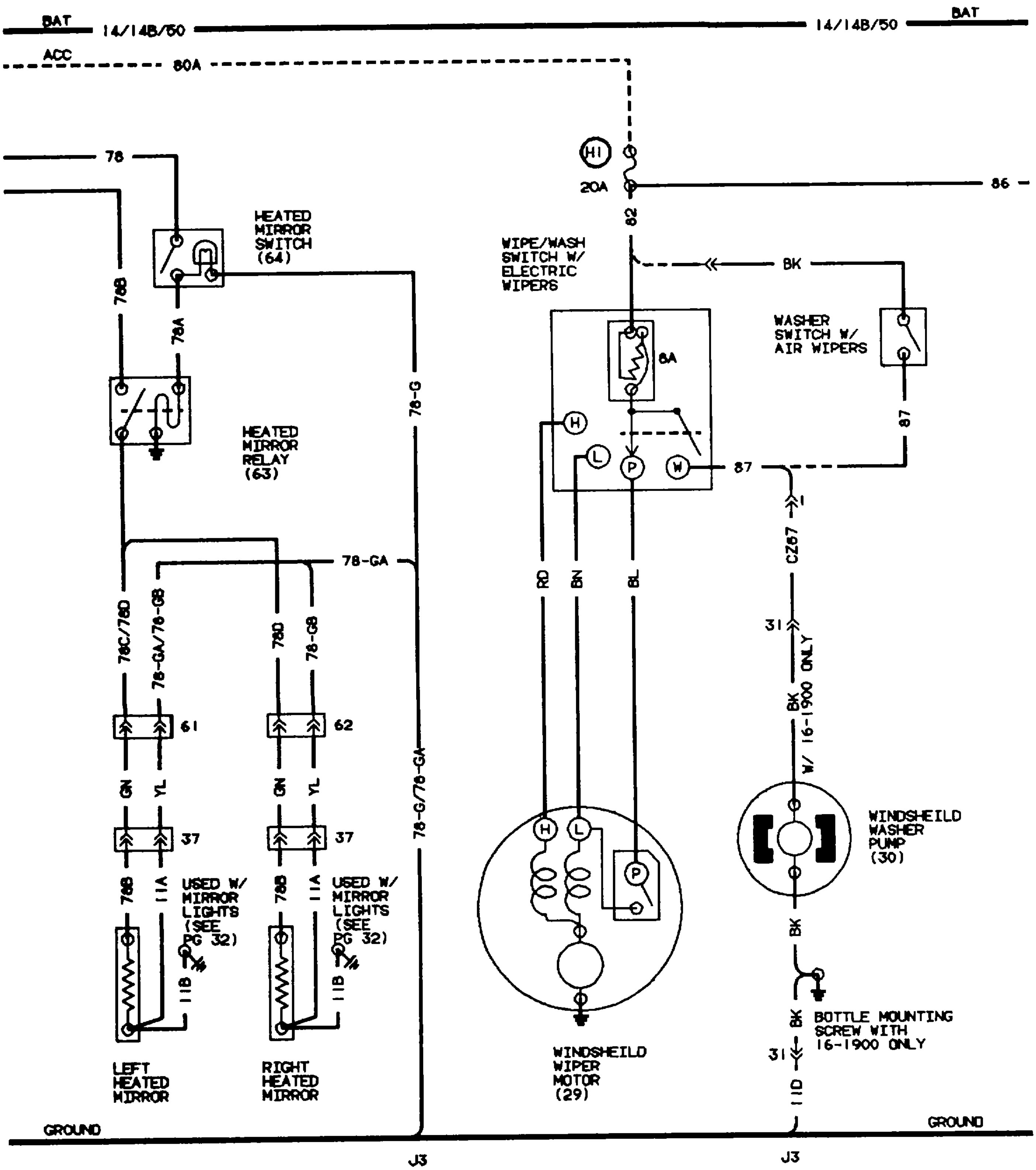
HEATED MIRRORS

WINDSHIELD WIPER

WINDSHIELD WASHER



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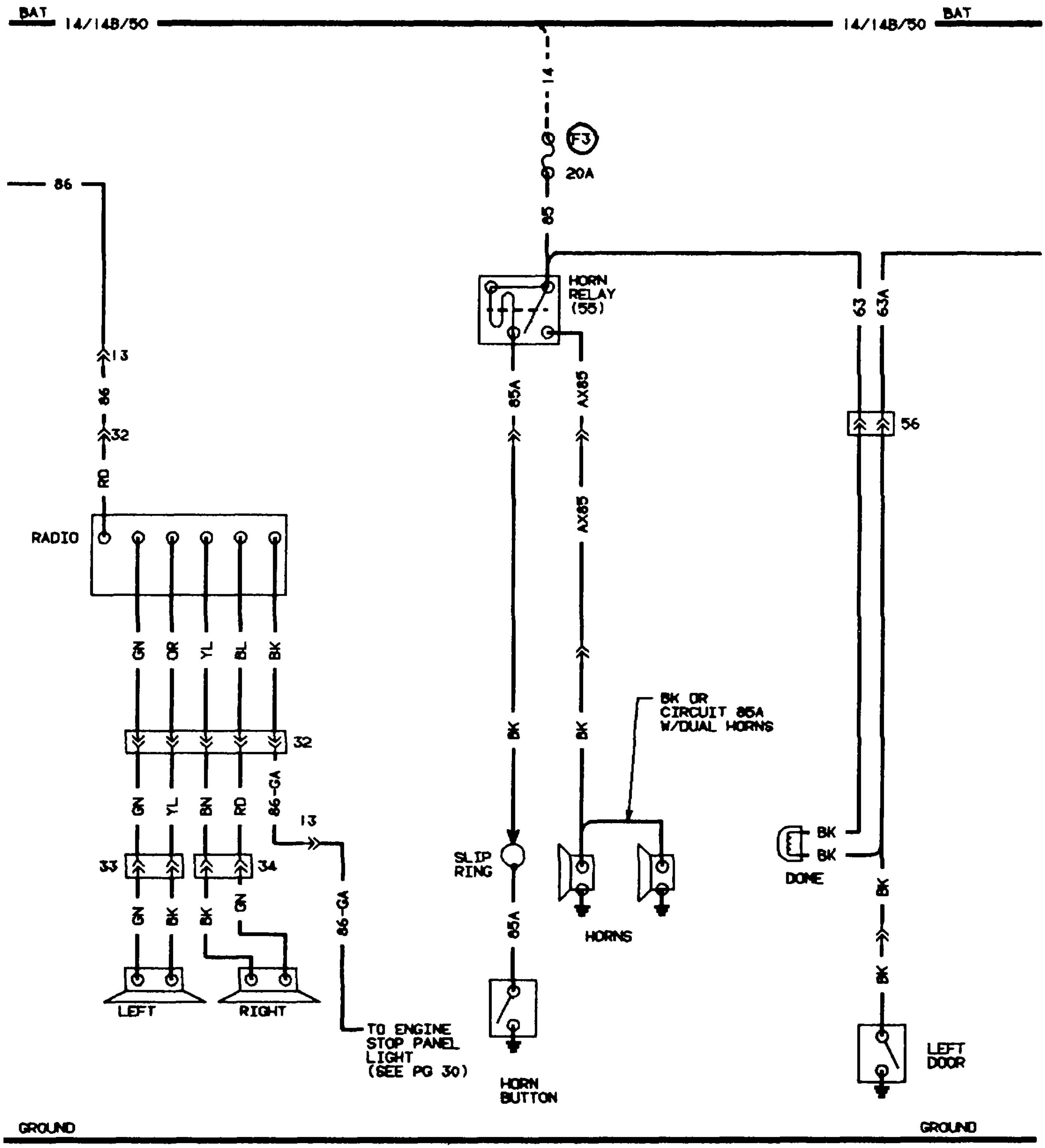
RADIO **HORN** **DOME LIGHT**



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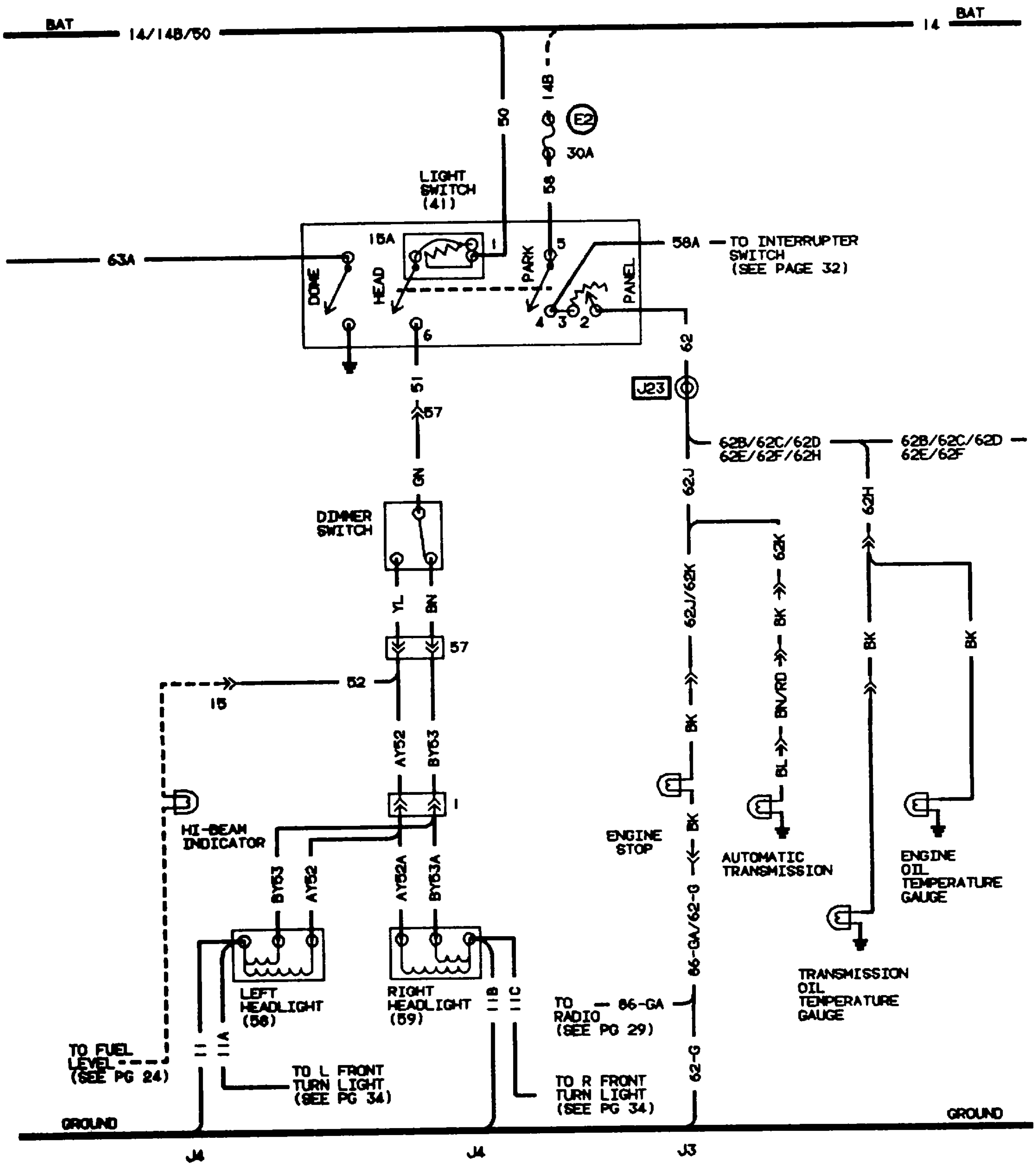
HEADLIGHTS

PANEL LIGHTS-
GAUGES



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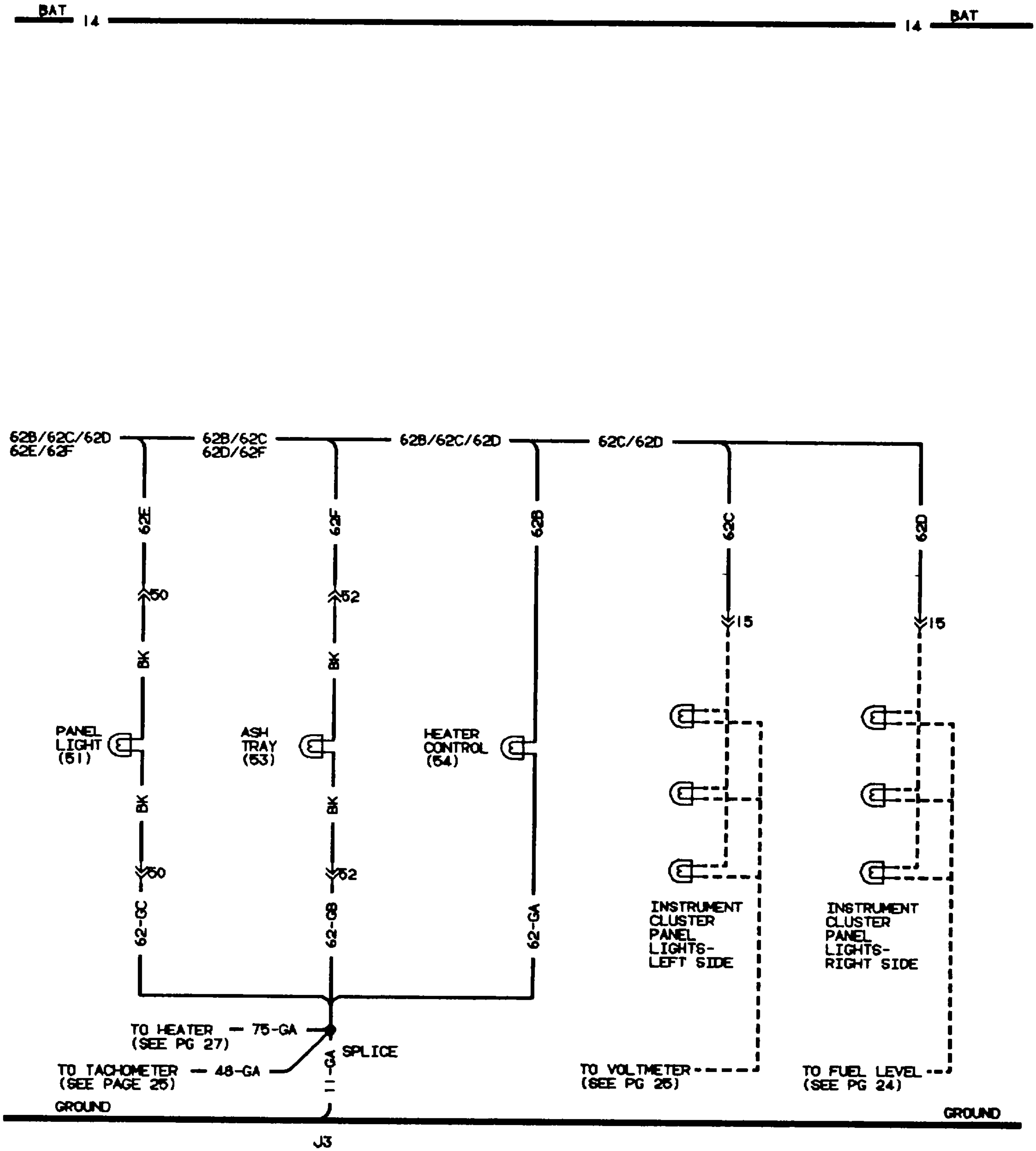
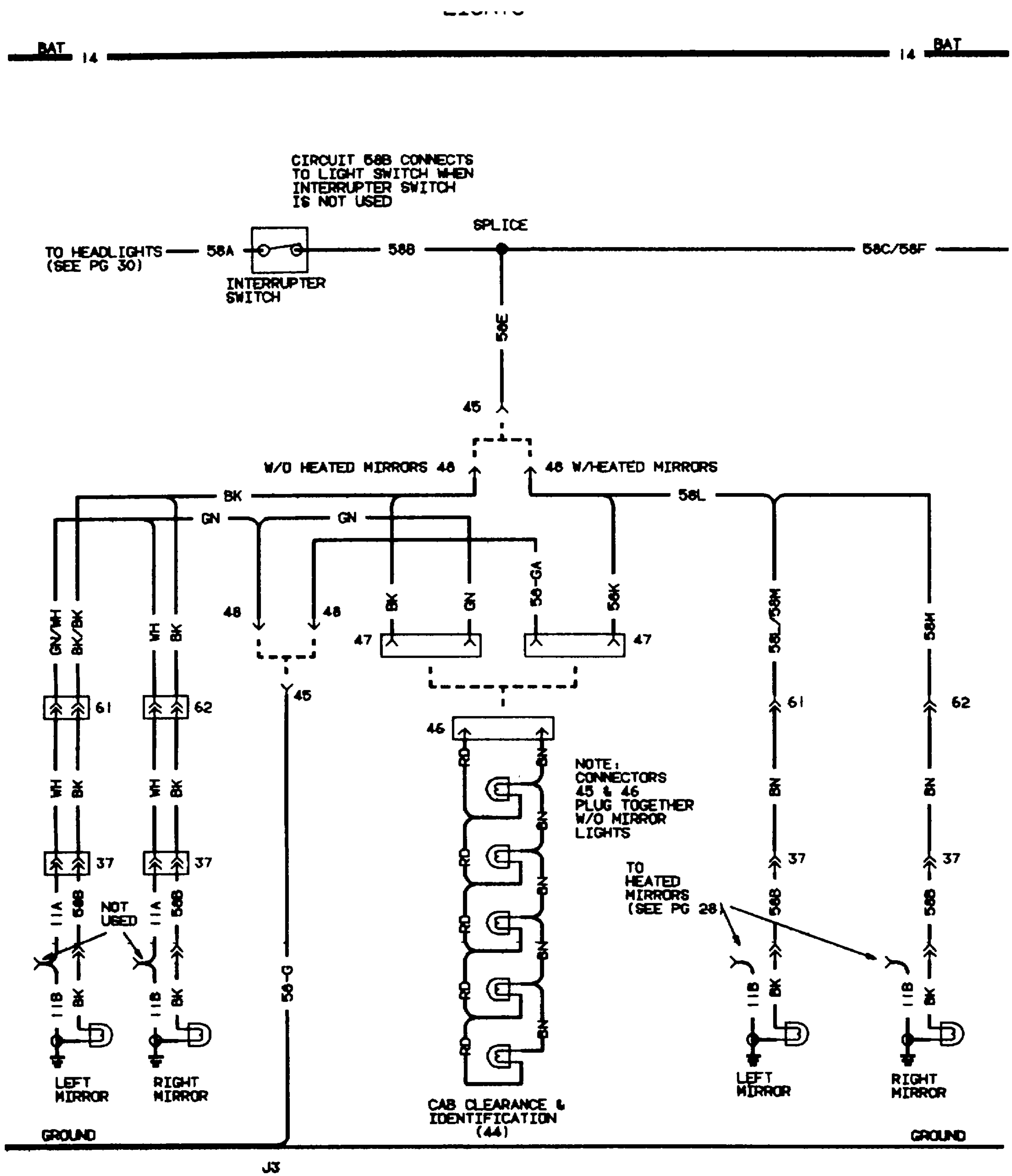
PANEL LIGHTS-MISCELLANEOUS

PANEL LIGHTS-INSTRUMENT CLUSTER



MIRROR LIGHTS	INTERRUPTER SWITCH	CLEARANCE & IDENTIFICATION LIGHTS	MIRROR LIGHTS W/HEATED MIRRORS



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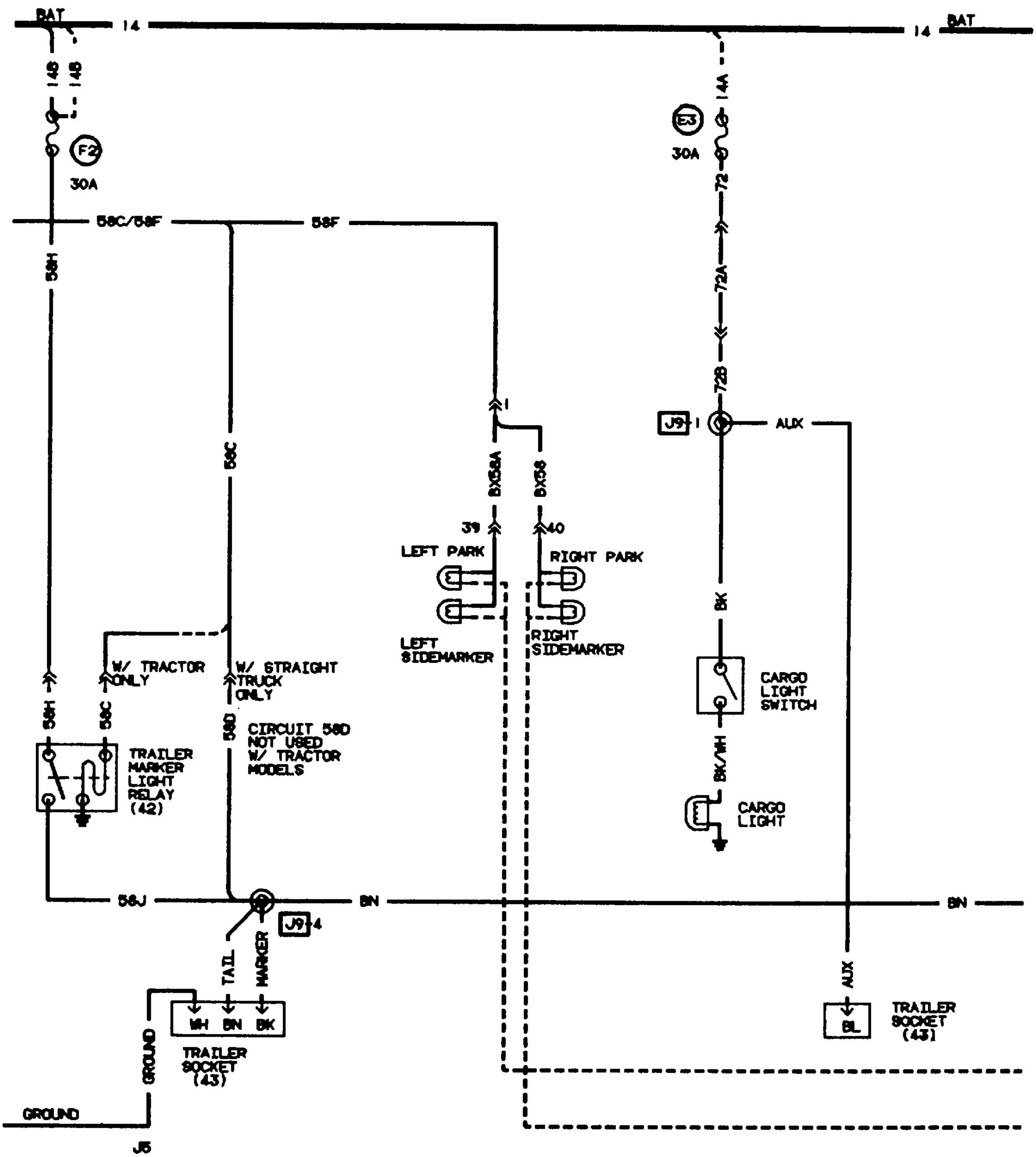
TRAILER MARKER LIGHT RELAY

PARK/SIDEMARKER LIGHTS

CARGO LIGHT



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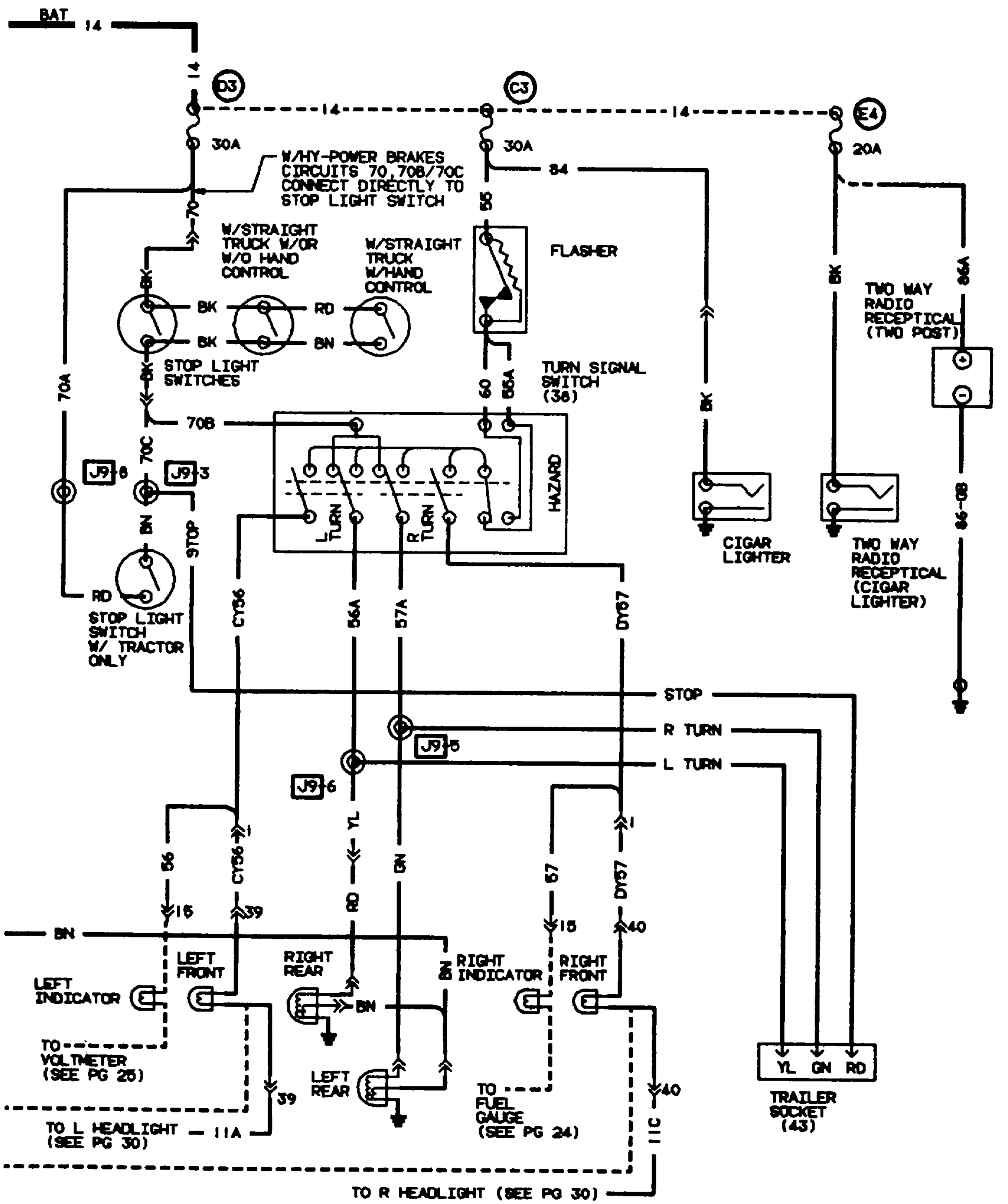
STOP,TAIL,TURN & HAZARD LIGHTS

CIGAR LIGHTER

TRAILER CONNECTIONS

TWO WAY RADIO RECEPTICAL



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NOTES

SERVICE MANUAL

Replace old Section with this revised Section In your CTS-4001 Manual.

ELECTRICAL

LIGHTS

S-SERIES VEHICLES

CONTENTS

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INTRODUCTION

Outlined below are service procedures covering lights used on typical S-Series vehicles. Some vehicles may be equipped with additional accessory lights which are not covered herein.

When diagnosing light failure, first check for a "blown" fuse or tripped circuit breaker. Fuse sizes and locations are listed in the circuit diagram section of the Truck Service Manual Refer to the appropriate section covering the model year of the vehicle being serviced. If a "blown" fuse or tripped circuit breaker is found, inspect wiring circuit for cause of overload and make necessary repairs.

If fuse or circuit breaker is satisfactory, check for "burned out" light bulb and replace if necessary, Light bulb types used in various lights are listed in the LIGHT BULB CHART in this section.

If light bulb is good, check wiring and connectors for an "open" circuit. A 12-volt test light can be used to check circuit continuity. Refer to the appropriate wiring circuit diagram.

HEADLIGHTS

HEADLIGHT AIMING

Various types of headlight aiming equipment are available commercially. When using aiming equipment, follow instructions provided by the equipment manufacturer.

Where headlight aiming equipment is not available, headlight aiming can be checked by projecting the upper beam of each light upon a screen or chart at a distance of about 25 feet ahead of the headlights. The truck should be exactly perpendicular to the chart.

The vertical lines on the chart (Figure 1) mark the distance between the vertical center lines of the headlights and are equally spaced from the center line of the chart.

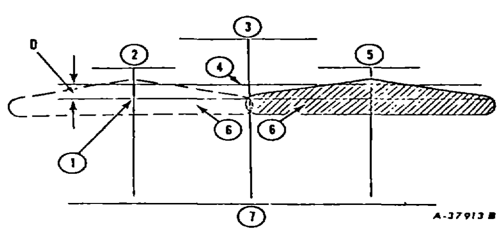


Fig. 1 Headlight Aiming Pattern

1. Projected Beam Center Height
2. Left Light
3. Center of Truck
4. Headlamp Center Height
5. Right Light
6. Projected Beam Pattern (Upper Beam)
7. Floor Line

A horizontal line should be placed on the chart at a level of two (2) inches below the height of the headlight centers above the floor.

With headlights on "HIGH" beam, the "hot spot" of each projected beam pattern should be centered over the point of intersection of the vertical and horizontal lines on the chart, as shown in Figure 1.

If necessary, adjust headlights vertically and/or laterally to obtain proper aim. (See HEADLIGHT ADJUSTMENT).

IMPORTANT

Headlight aim should always be checked on a level floor with the vehicle unloaded,

In some states, the above instructions may conflict with existing laws and regulations. Where this is the case, legal requirements must be met,

Modify the instructions accordingly.

HEADLIGHT ADJUSTMENT

Adjusting screws are provided to move the headlight assembly in relation to the hood (fender) to obtain correct headlight aim.

Lateral or side-to-side adjustment is accomplished by turning adjusting screw at side of headlight (Figure 2).

Vertical or up-and-down adjustment is accomplished by turning adjusting screw at top of headlight (Figure 2).

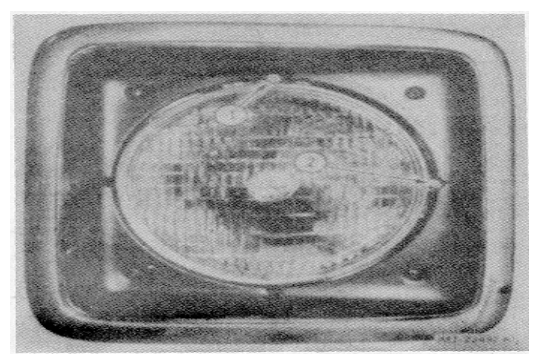


Fig. 2 Headlight Adjusting Screws

1. Vertical Adjustment
2. Lateral Adjustment

To adjust headlight aim, turn adjusting screws as required to position headlight beam pattern as shown under HEADLIGHT AIMING. Adjustments can be made without removing headlight bezels.

SEALED BEAM UNIT REPLACEMENT

1. Remove four (4) retaining screws (Figure 3) and remove headlight bezel.

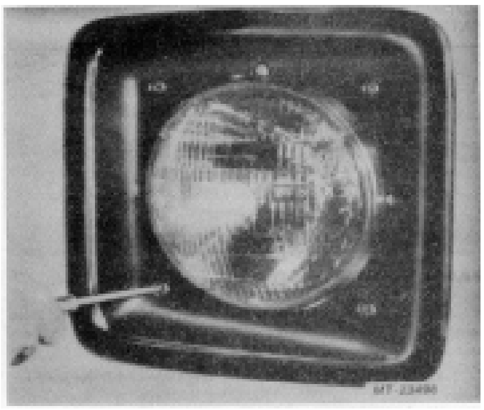


Fig. 3 Removing Headlight Bezel

2. Remove three (3) retaining screws and remove sealed beam unit retaining ring (Figure 4).

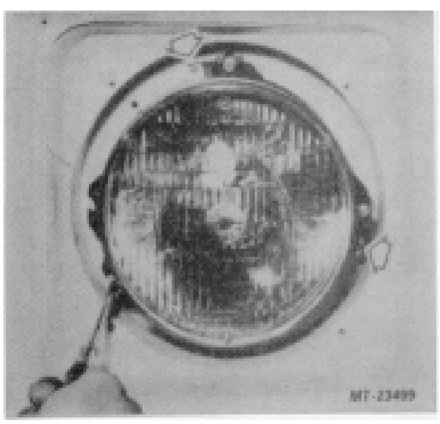


Fig. 4 Removing Sealed Beam Unit Retaining Ring

3. Pull sealed beam unit from headlight assembly. Disconnect three-way wiring connector from rear of sealed beam unit (Figure 5) and remove sealed beam unit.

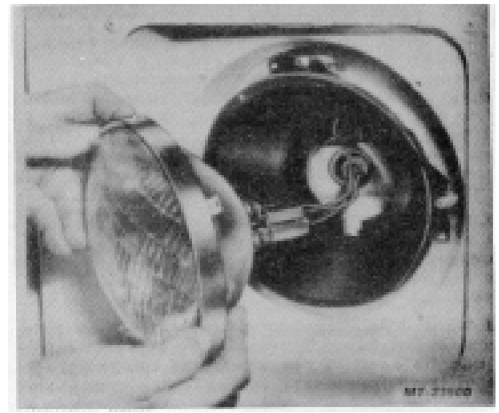


Fig. 5 Removing Sealed Beam Unit

4. Connect three-way wiring connector to new sealed beam unit.

5. Position sealed beam unit in mounting ring.

Install retaining ring and secure with screws.

6. Install headlight bezel and secure with screws.

CAUTION
DO NOT overtighten bezel retaining screws. Overtightening could cause damage (stripping) of threads in hood

7. Check light operation.

HEADLIGHT ASSEMBLY REPLACEMENT

1. Remove four (4) retaining screws and remove headlight bezel (Figure 3).

2. Disconnect headlight retaining spring from headlight assembly (Figure 6).

3. Disengage headlight assembly from adjustment screws. DO NOT turn adjustment screws.

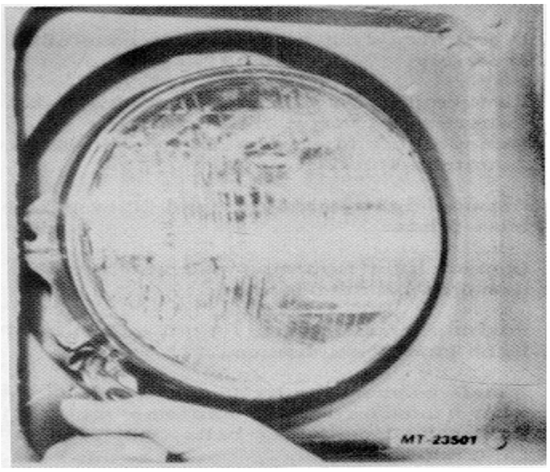


Fig. 6 Disconnecting Headlight Retainer Sprlng

4. Disconnect three-way wiring connector from rear of sealed beam unit and remove headlight assembly (Figure 7).

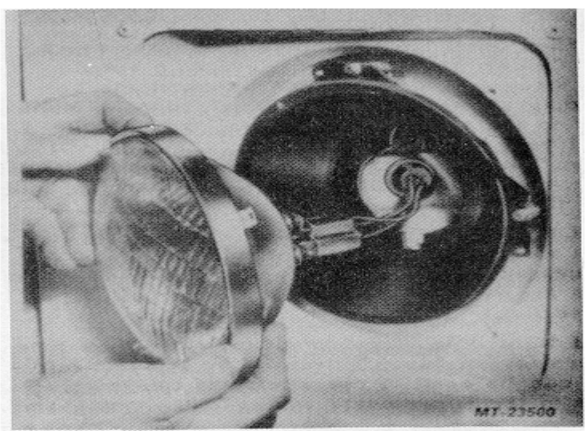


Fig. 7 Removing Headlight Assembly

5. To remove sealed beam assembly from mounting ring (if necessary): a. Remove three (3) retaining screws and remove sealed beam retaining ring (Figure 4).

   b. Remove sealed beam unit from mounting ring.

6. if replacement of headlight retaining spring is required:

   a. Remove spring retaining screw and remove spring from hood (fender).

   b. Position new spring on hood (fender) and secure with retaining screw.

7. If required, replace headlight adjusting screw(s) as follows: (Refer to Fig. 8).

   a. While pushing screw inward (toward rear of vehicle) rotate grommet (nut) ninety degrees (900) clockwise until front tangs of grommet align with slot in hood (fender).

   b. Extract screw (with grommet) working from wheel side of hood (fender).

   c. Position new screw and grommet assembly in hood (fender). Align front retaining tangs on grommet with slot in hood and push screw assembly forward as far as possible.

   d. Rotate grommet ninety degrees (900) counterclockwise until retainer tabs on rear tangs engage with slot in hood (fender) and front tangs are perpendicular to slot.

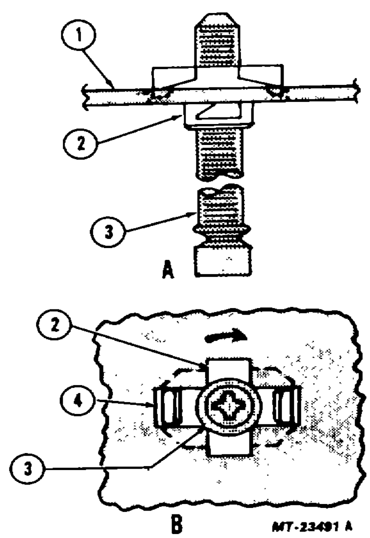


Fig.8 Adjusting Screw Mounting Details

A	Top View	2	Grommet
B	Front View	3	Screw
1	Hood (Fender)	4	Slot in Hood

8. If necessary, position sealed beam unit in headlight mounting ring and secure with retaining ring and screws.
9. Connect three-way wiring connector to rear of sealed beam unit.
10. Engage mounting slots in headlight mounting ring into collar grooves of adjustment screws. Connect headlight retaining spring to headlight mounting ring.
11. Install headlight bezel and secure with screws.

CAUTION
DO NOT overtighten bezel retaining screws. Overtightening could cause damage (stripping) of threads in hood (fender).

12. Check light operation.
13. Check headlight aim. (See HEADLIGHT AIMING).

FRONT TURN SIGNAL/MARKER LIGHTS
BULB REPLACEMENT

Procedure applies to either turn signal or side marker bulbs. Refer to Figure 9.

1. Remove lens mounting screws and remove lens.
2. Press bulb inward and turn counterclockwise to remove bulb from socket.
3. Inspect bulb socket. If rusty or corroded, replace place light assembly. Inspect lens gasket and replace if damaged.
4. Insert new bulb in socket, press inward and turn clockwise to lock in place.
5. Position lens and gasket on light body and install lens mounting screws.
6. Check light operation.

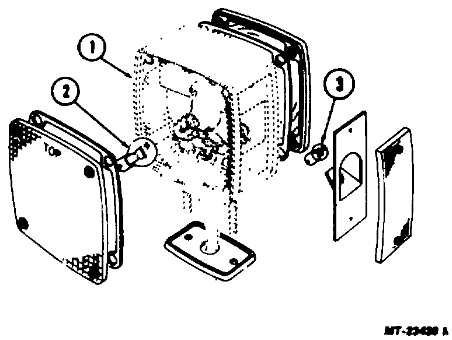


Fig. 9 Front Turn Signal/Marker Light
1. Light Assembly
2. Bulb (Turn Signal)
3. Bulb (Marker)

LIGHT ASSEMBLY REPLACEMENT
1. Disconnect wiring cable from base of light assembly.
2. Remove nuts, washers and wiring cable clip (where used) from light mounting studs. Remove nuts and washers from light guard mounting bolts (if equipped).
3. Remove light assembly (and light guard) from fender.
4. Inspect light mounting pad and replace if damaged or deteriorated.
5. Position mounting pad, light assembly (and light guard) on fender.
6. Install washers and nuts (and cable clip, where used) on light mounting studs. Install light guard mounting bolts, washers and nuts (if equipped).
7. Plug wiring cable connector into light assembly.
8. Tighten light (and light guard) mounting nuts.
9. Check light operation.

CLEARANCE AND IDENTIFICATION
LIGHTS (CAB)
BULB OR LIGHT ASSEMBLY REPLACEMENT
(Refer to Figure 10).
1. Remove light mounting screws. Remove trim bezel and seal (where used).
2. Pry light assembly from mounting recess in cab.
3. Turn bulb socket about one-eighth turn counterclockwise and remove socket (with bulb) from light assembly.

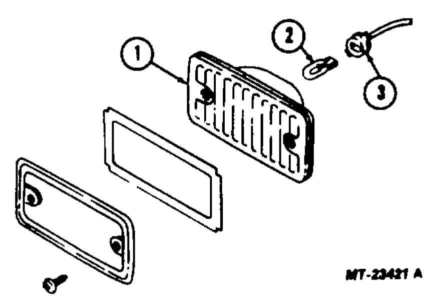


Fig. 10 Clearance Light
1. Light Assembly
2. Bulb
3. Socket

4. Grasp bulb and pull straight out to remove plug-in type bulb from socket.

5. Inspect light assembly and gasket and replace if damaged.

6. Push new bulb into socket.

7. Position socket (with bulb) into light assembly and turn socket one-eighth turn clockwise to secure.

8. Position light assembly (with seal and trim bezel where used) into mounting recess in cab. Secure with mounting screws.

9. Check light operation.

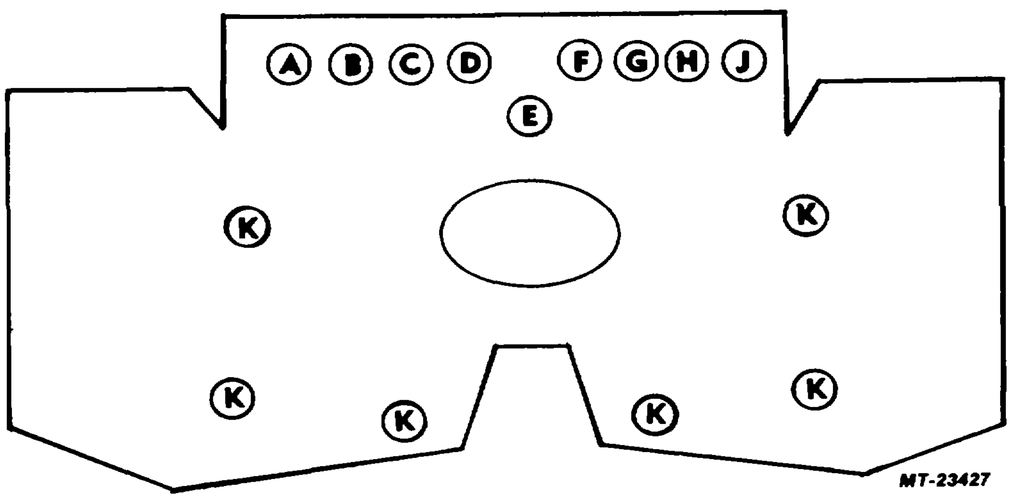


Fig. 11 Instrument Cluster Light Locations (As viewed from front of vehicle)

Legend

A Right Turn Indicator(Antilock Warning--Some Models)
B Low Air
C Glow Plug Indicator (Antilock Warning--Some Models)
D Park/Hydr. Brake Warning
E High Beam Indicator
F Power Divider Lock Warning (Service EGR--Some Models)
G Service EGR Indicator Pressure Warning
H Low Oil Pressure/High Water Temperature Warning
J Left Turn Indicator
K Panel Illumination

INSTRUMENT CLUSTER LIGHTS

Locations of instrument cluster illumination, indicator and warning lights are shown in Figure 11.

BULB REPLACEMENT

Procedures for replacing bulbs in instrument cluster lights are as follows:

Indicator and Warning Lights: (A thru J, Figure 11)

1. Remove instrument cluster cover screws (5) and remove cover to expose warning and indicator lights.

2. Grasp bulb and pull straight outward to remove plug-in type bulb from socket (Figure 12).

   In some cases it may be necessary to remove socket from instrument cluster to remove bulb. See "Cluster Illumination Lights" below.

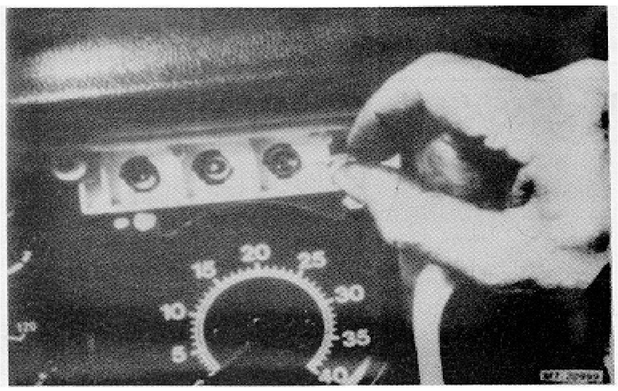


Fig. 12 Removing Bulb from face of Cluster

3. Insert new bulb into socket.
4. Install instrument cluster cover and screws.
5. Check light operation.

Cluster Illumination Lights:
(K, Figure 11)

1. Reaching up in front of instrument cluster, grasp light socket.
2. Turn bulb socket about one-eighth turn clockwise (as viewed from front of vehicle). Pull socket (with bulb) from instrument cluster (Figure 13).

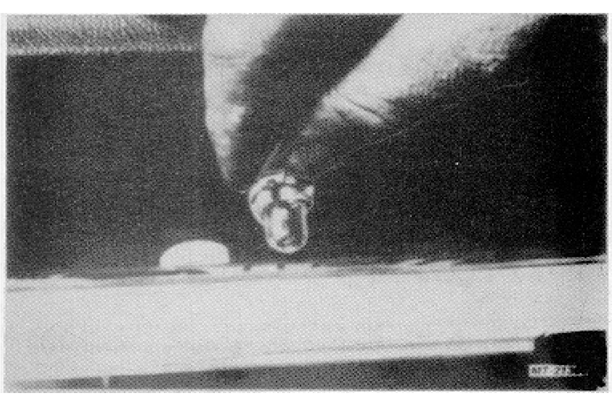


Fig. 13 Removing Bulb and Bulb Socket from Cluster

3. Grasp bulb and pull straight out to remove bulb from socket.
4. Install new bulb in socket.
5. Position socket (with bulb) into instrument cluster and turn socket one-eighth turn counterclockwise (as viewed from front of vehicle) to secure.
6. Check light operation.

DOME LIGHT

BULB REPLACEMENT

(Refer to Figure 14).

1. Pry edge of lens inward to disengage retaining clips. Remove lens.
2. Disengage bulb from terminals.
3. Position new bulb in terminals.
4. Position lens in light assembly and engage retaining clips.
5. Check light operation.

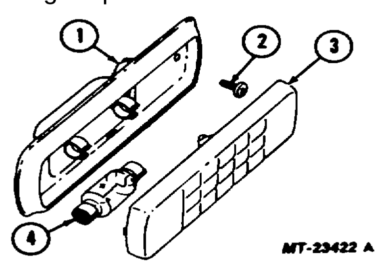


Fig. 14 Dome Light

1. Light Assembly 3. Lens
2. Screw (2) 4. Bulb

LIGHT ASSEMBLY REPLACEMENT

1. Pry edge of lens inward to disengage retaining clips. Remove lens.
2. Remove light mounting screws.
3. Pull light assembly away from cab panel to expose wiring cable connector.
4. Disconnect wiring cable from light assembly. Remove light assembly.

5. Connect wiring cable to new light assembly.

6. Position light assembly on cab panel and secure with mounting screws.

7. Check light operation.

TAIL, STOP, REAR TURN SIGNAL, BACK-UP LIGHTS

BULB REPLACEMENT

(Refer to Figure 16)

1. Remove lens mounting screws (4).

2. Pry lens from light assembly.

3. Press bulb in lightly and turn counterclockwise to disengage retaining pins.

4. Pull bulb from socket.

5. Inspect lens and gasket and replace if damaged.

6. Install new bulb as follows:

    a. Align retaining pins with slots in socket.

    Stop, tail, turn signal bulb has staggered retaining pins to assure correct positioning in socket.

    b. Push bulb into socket and turn clockwise to secure retaining pins.

7. Position gasket and lens in light assembly and secure with screws.

8. Check light operation.

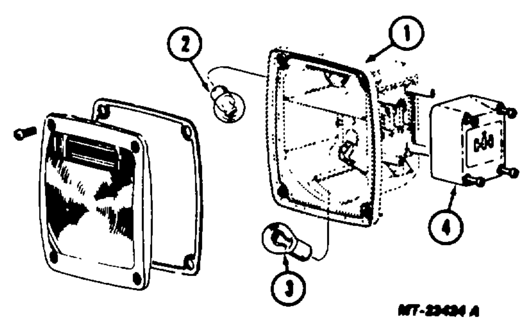


Fig. 16 Tall, Stop. Rear Turn Signal, Back-Up Light

1 Light Assembly
2 Bulb (Back-up)
3Bulb (Tail, Stop, T-Sig.)
4Terminal Cover CTS-

LIGHT ASSEMBLY REPLACEMENT

1. If necessary, clean dirt from threads of light assembly mounting studs.
2. Remove nuts and washers (3 each) securing light assembly to mounting bracket.
3. Remove mounting screws (4) securing terminal cover to light assembly.
4. Disconnect wiring harness connector from light assembly.
5. Inspect and clean wiring harness connector terminals. If terminals are badly corroded or damaged, replace connector.
6. To retard corrosion, coat terminals of new lamp assembly and wiring harness with grease.
7. Connect wiring harness terminal connector to light assembly.
8. Install terminal cover on light assembly and secure with mounting screws.
9. Position light assembly on mounting bracket and secure with lock washers and nuts.
10. Check light operation.

INSTRUMENT PANEL CONTROL LIGHT

(Located above headlight switch)

If bulb fails, it will be necessary to replace the light assembly as follows:

1. Remove nine (9) screws and remove instrument panel top cover.
2. If necessary pull light wiring up through hole in top of instrument panel to expose wiring connector.
3. Disconnect light assembly wiring connector from wiring harness connector (Figure 17).
4. Disengage slot of light assembly from lens to remove light assembly (Figure 17).
   Do not lose lens which can fall out of instrument panel when light is removed.
5. Discard old light assembly.
6. Hold lens into hole in instrument panel and snap new light assembly over lens to retain lens and light assembly.

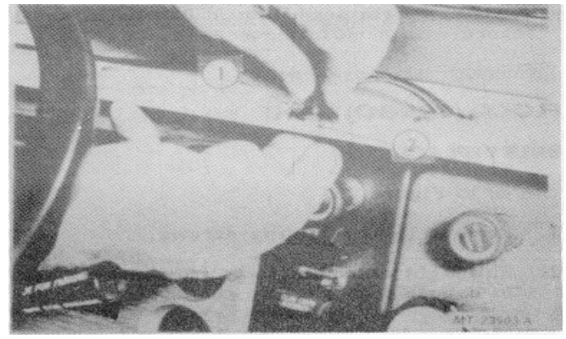


Fig. 17 Instrument Panel Control Light

1 Light Assembly
2 Lens

7. Connect light assembly wiring connector to wiring harness connector.
8. Check light operation.
9. Install instrument panel top cover and retaining screws.

ASHTRAY LIGHT

If bulb fails, it will be necessary to replace the light assembly as follows:

1. Remove ashtray from ashtray housing.
2. Remove mounting screws* from cluster panel holding ashtray (plus radio and auxiliary gauges, where equipped).

* 6 without radio; 8 with radio. On 2200 series vehicles, 8 without radio, 10 with radio.

3. Tip panel outward to gain access to ashtray light (Figure 18).
4. Disconnect light assembly wiring connector from wiring harness connector.
5. Disengage slot of light assembly from lens to remove light assembly.
   Do not lose lens which can fall out of ashtray housing when light is removed.
   For light assembly and lens relationship, see Figure 17.

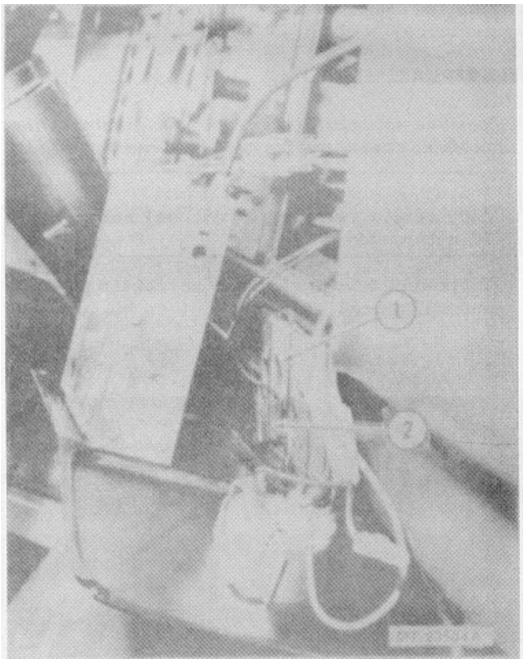


Fig. 18 Ashtray Light

1 Ashtray Housing
2 Light Assembly

6. Discard old light assembly.

7. Hold lens in hole in ashtray housing and snap new light assembly over lens to retain lens and light assembly.

8. Connect light assembly wiring connector to wiring harness connector.

9. Position cluster panel (with ashtray housing, radio, etc.) on instrument panel and secure with screws.

10. Position ashtray in ashtray housing.

11. Check light operation.

HEATER/AIR CONDITIONING CONTROL LIGHT

BULB REPLACEMENT

1. Remove control assembly mounting screws. Remove trim plate. Pull control assembly outward. It may be necessary to remove ashtray to allow movement of control assembly.

2. Rotate light socket (Figure 19) clockwise (as viewed from rear of vehicle). Pull light socket (with bulb) from control assembly.

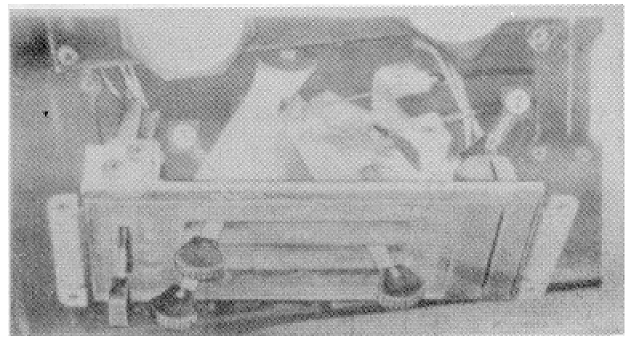


Fig. 19 Heater/Air Conditioning Control Light

1. Control Assembly
2. Light Socket

3. Grasp bulb and pull straight outward to remove plug-in type bulb from socket.

4. Insert new bulb into socket.

5. Insert light socket into control assembly. Turn light socket to secure in position.

6. Position control assembly in instrument panel and install trim plate and mounting screws.

7. Check light operation.

CONTROL IDENTIFICATION OR WARNING LIGHTS

(Engine Stop, Front Axle)

If bulb fails, it will be necessary to replace the light assembly as follows:

1. Pry old light assembly out of slot in instrument panel. Be careful not to scratch finish of instrument panel.
2. Disconnect light assembly from wiring harness.
3. Discard old light assembly.
4. Connect new light assembly to wiring harness.
5. Position light assembly into slot in instrument panel. Push light assembly inward until retaining tangs "snap" into position securing light to instrument panel.
6. Check light operation.

AUXILIARY GAUGE ILLUMINATION LIGHT

(Engine Oil Temperature, Transmission Oil Temperature)

BULB REPLACEMENT

1. Remove mounting screws* from cluster panel holding radio, ashtray and auxiliary gauge(s).

* 6 without radio; 8 with radio. On 2200 series vehicles, 8 without radio; 10 with radio.

2. Tip panel outward to gain access to instrument (Figure 21).

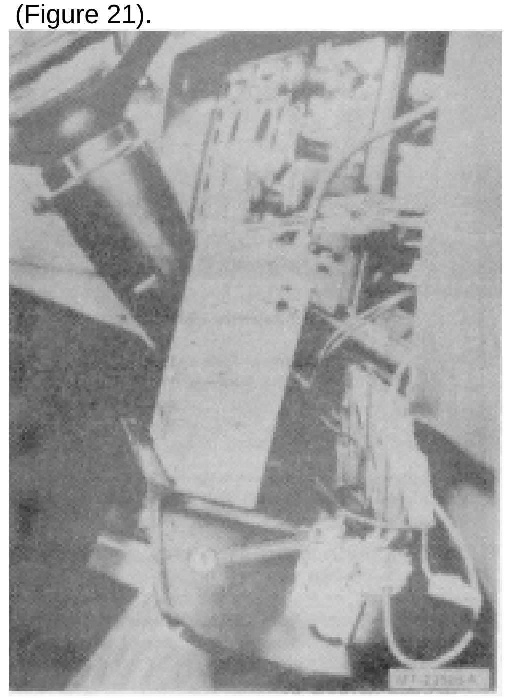


Fig. 21 Auxiliary Gauge Illumination Light (Typical)

1 Light Socket

3. Disconnect light socket from instrument.
4. Press bulb in lightly and turn counterclockwise to disengage retaining pins.

5. Pull bulb from socket.

6. Install new bulb as follows:

   a. Align retaining pins with slots in socket
   b. Push bulb into socket and turn clockwise to secure retaining pins.

7. Insert light socket (with bulb) into instrument.

8. Position cluster panel, with radio, ashtray and gauge(s), on instrument panel and secure with screws.

LIGHT BULB CHART

APPLICATION	CANDLE POWER	TRADE NO.
Headlight	60 Watt (Upper Beam)	6014 (L.H. Dr.) 7002 (R.H. Dr.)
Front Turn Signal	32	1156
Side Marker	2	1895
Park	3	181
Clearance/Identification	3	168
Instrument Cluster: Illumination	3	168
Indicator	2	194
Warning	2	194
Information	2	194
Heater/A.C. Control	3	168
Dome	12	211-2
Tail-Stop-Turn-License	32/3	1157
Back-up	32	1156
Control Identification or * Warning Light (Engine Stop, Front Axle)	0.5	
Auxiliary Gauge Illumination (Engine Oil Temp., Trans	1 Oil Temp.)	53
Instrument Panel Controls	0.5	

* Replace light assembly.

ELECTRICAL

Replace old Section with this
Section in your CTS-4001 ,Service Manual,

INSTRUMENTS

S-SERIES

CONTENTS

INTRODUCTION

Instruments used on S-Series trucks include voltmeter, fuel gauge, oil pressure gauge, water temperature gauge, speedometer, tachometer and air or vacuum gauges, plus oil, water, brake and power divider lock warning lights.

All of these instruments are located on the instrument panel in a demountable instrument cluster (Figure 1) directly in front of the driver. Gauges and panel lights of the cluster are connected to the vehicle electrical system by a flexible printed circuit.

Optional gauges for such other items as engine oil temperature, transmission oil temperature, hour meter, etc. are located to the right of heater controls in a separate panel. Optional gauges are wired independent of the printed circuit.

INSTRUMENT CLUSTER

The instrument cluster is a reliable, quick-disconnect package for the most commonly used instruments. Should the need arise, cluster body can be quickly detached from the instrument panel for quick access to any of its components. Either the complete cluster assembly or its components can be replaced.

CAUTION - ALWAYS DISCONNECT BATTERY NEGATIVE (GROUND) CABLE BEFORE SERVICING INSTRUMENT CLUSTER OR ITS COMPONENTS.

REMOVAL OF COMPLETE CLUSTER

1. Unscrew the four cluster mounting Screws.
2. Tilt or lift out cluster assembly from instrument panel (Figure 2).

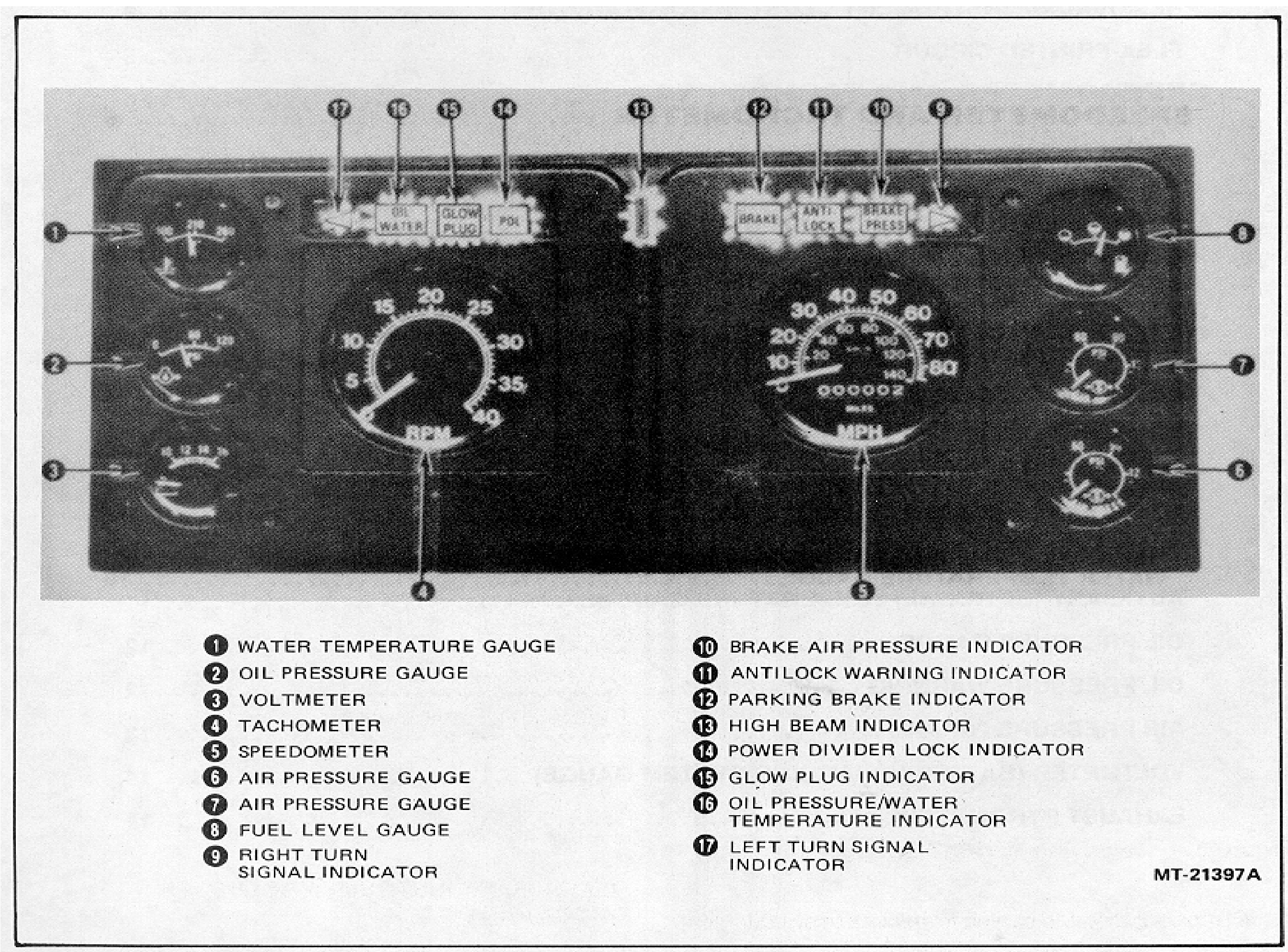


Figure 1 S-Series Instruments (Typical)
Gauges which read totally metric are also available.

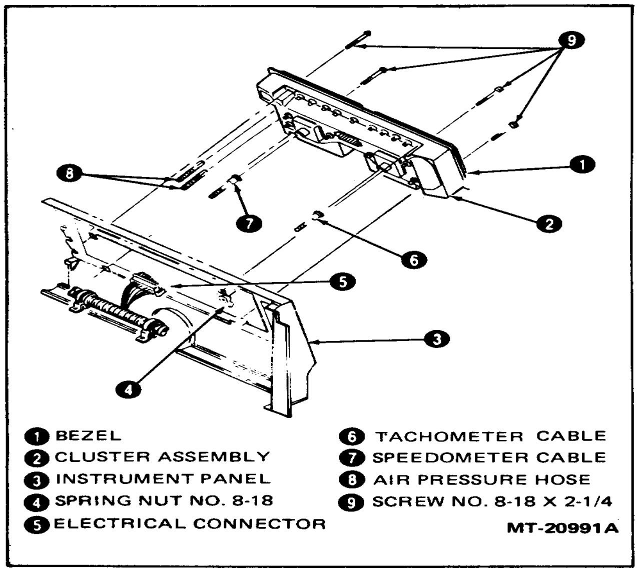


Figure 2-Removing Instrument Cluster

3. Disconnect wiring harness connector from printed circuit on back of cluster assembly (Figure 3).

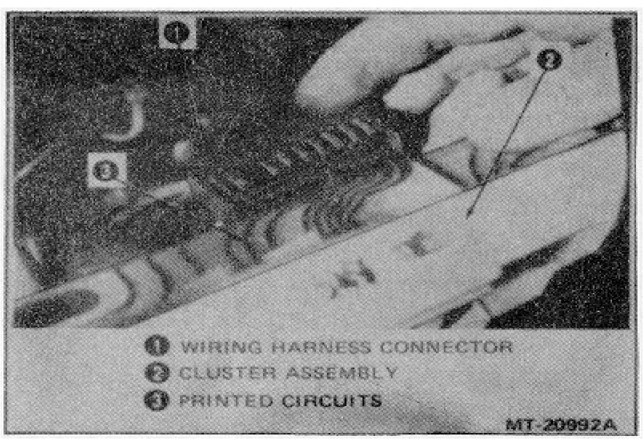


Figure 3 -Removing Wiring Harness Connector

4. Disconnect flexible cables from back of speedometer and tachometer by pressing down on quickconnect spring clasp (Figure 4).

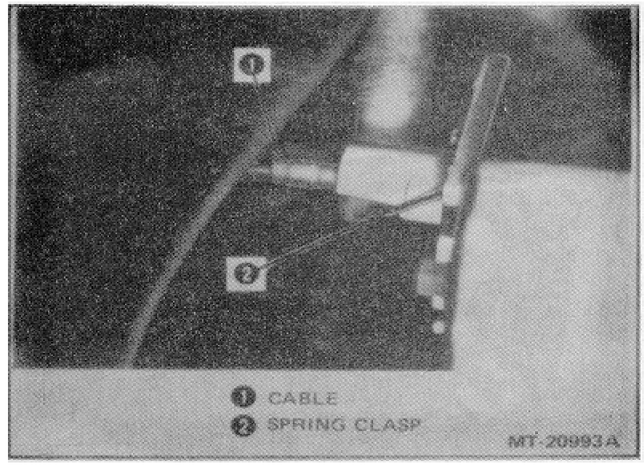


Figure 4- Releasing Speedometer or Tachometer Cable

5. Disconnect air or vacuum lines from fittings (Figure 5) on back of air or vacuum gauges. Two air pressure gauges are used on vehicles with air brakes. One vacuum gauge is used on vehicles with vacuum boosted hydraulic brakes.

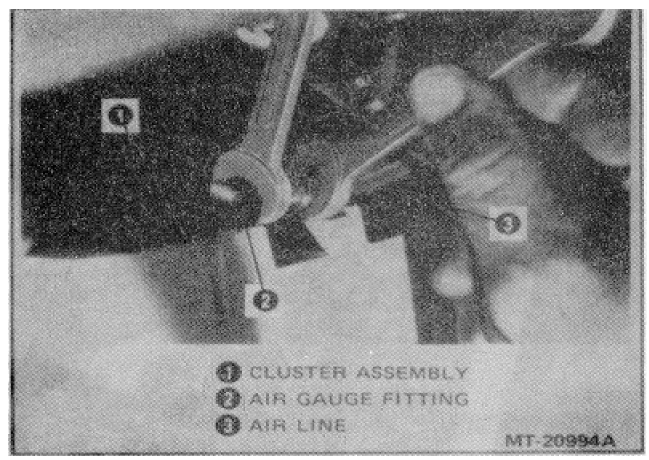


Figure 5 -Removing Air or Vacuum Lines

6. Instrument cluster assembly is now free to be removed from instrument panel.

REMOVAL OF INSTRUMENT CLUSTER COMPONENTS

If it is desired that individual components are to be removed, procedure is as follows:

1. With the four cluster mounting screws removed, remove a fifth mounting screw from center of cluster bezel and detach bezel (Figure 6).

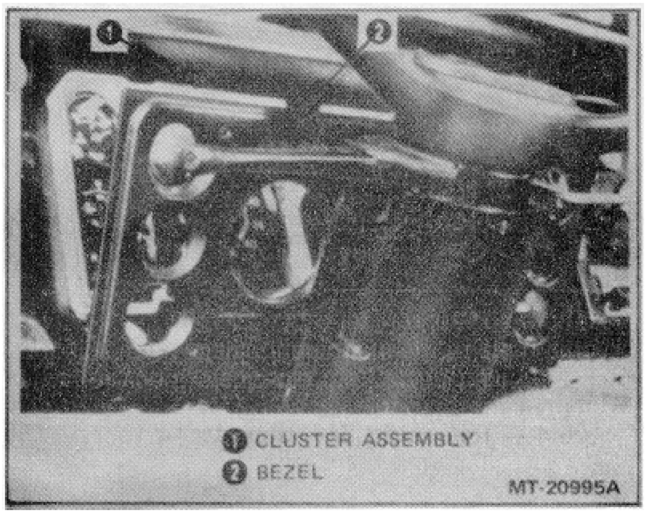


Figure 6 Removing Instrument Cluster Bezel

2. Individual gauges can now be removed by loosening gauge mounting screws as required. All electrically actuated gauges (Figure 7) are removed from front and have plug-in spring loaded connections.

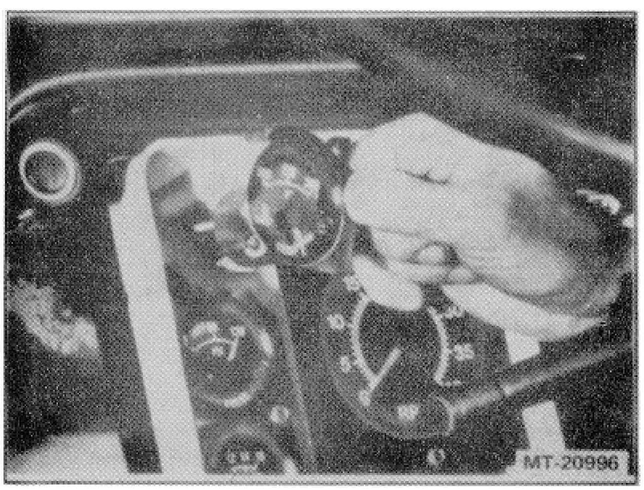


Figure 7 Removing Electrically Actuated Water Temperature Gauge

3. Speedometer and tachometer (Figure 8) are also front serviceable and can be removed from cluster without disconnecting cables. (If cables are to be removed, these are quick-disconnect from rear of cluster, Figure 4.)

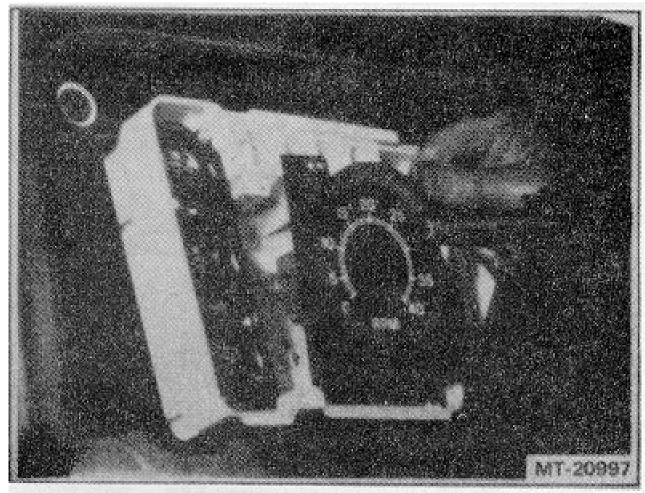


Figure 8 Removing Tachometer

4. Mechanical type air gauges (Figure 9) are front serviceable after removing air line fittings from rear of cluster (Figure 5).

NOTE - Air gauges are mounted to a common bracket and are Installed or removed as a pair from the cluster body. Also, when reinstalling air lines and fittings, use a non-hardening type sealant on fitting threads.

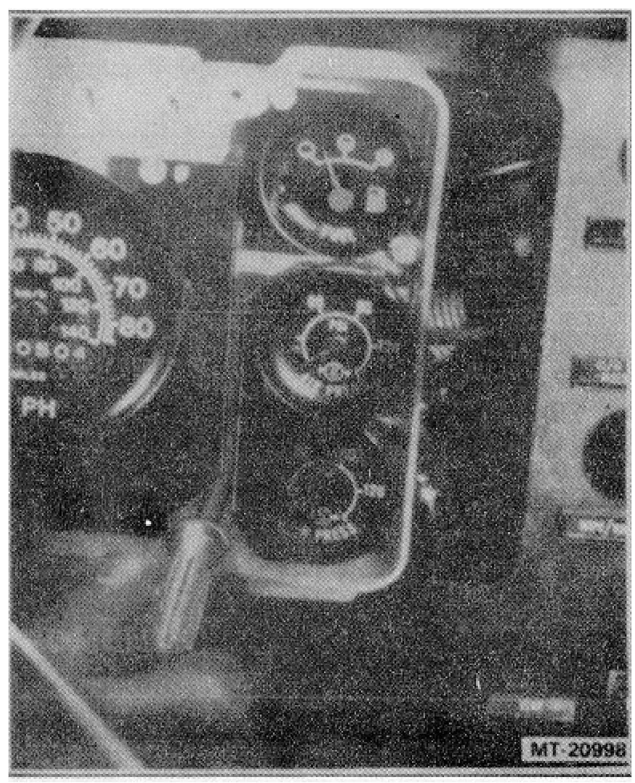


Figure 9 Removing Air Gauges

5. Light bulbs are plug-in type and are serviceable from either front or rear of instrument cluster (Figures 10 and 11).

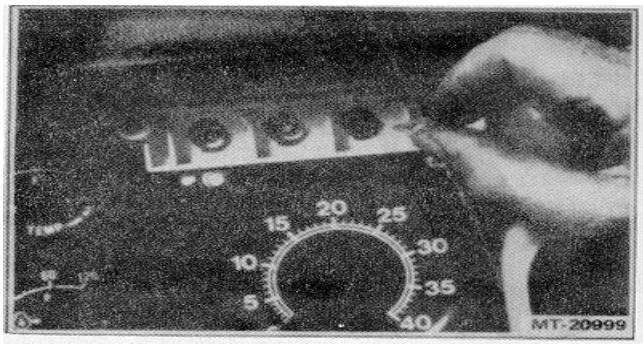


Figure 10 Removing Bulb From Front of liter

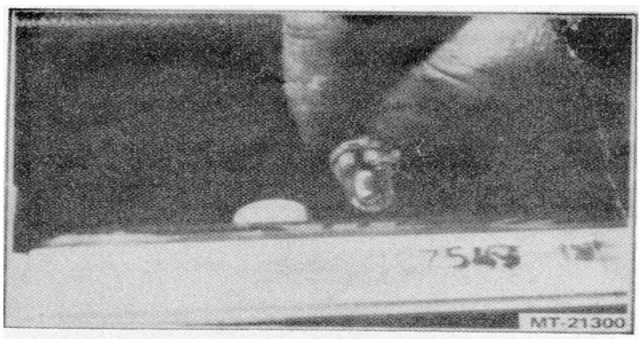


Figure 11 Removing Bulb and Bulb Socket From Rear of Cluster

FLEX-PRINTED CIRCUIT

One component of instrument cluster which is integral with cluster body itself is the flex-printed circuit. This tough flexible plastic film is cemented to cluster body to simplify instrument wiring (25 electrical connections are replaced by one). However, if the need should arise for electrical troubleshooting, individual circuits on the printed circuit are easily checked. This is accomplished with cluster removed (Figure 12).

Circuit Testing

Obtain low voltage (battery powered) test light or circuit tester. Position test probes on a selected circuit in a manner similar to that shown in Figure 12. If test light illuminates, circuit is unbroken, or if test light fails to illuminate circuit is broken. Check each circuit in turn and if a broken circuit is found, instrument cluster body must be replaced.

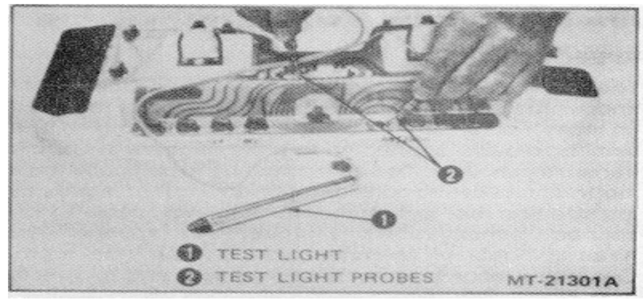


Figure 12 Checked Printed Circuit Continuity

Replacement

Since printed circuit is cemented to and integral with instrument cluster body, the printed circuit and cluster body are available for replacement as a complete assembly only. Where replacement is required, obtain new instrument cluster body assembly and transfer all gauges and light bulbs from old cluster body to new. Individual parts of the instrument cluster, available for service, are shown in

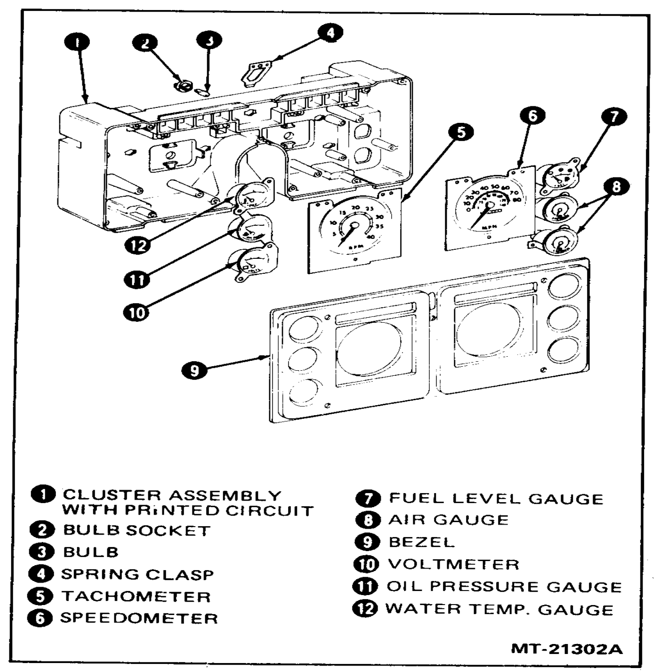


Figure 13 - Component of Instrument Cluster

SPEEDOMETER AND TACHOMETER

SPEEDOMETER

The speedometer used on this vehicle indicates miles and kilometers per hour. Distance traveled is recorded (in miles*) on an odometer. Speedometer is driven by a semi-rigid cable connected to a set of gears in vehicle transmission. Specified gears match the particular truck model and take into consideration such other factors as tire size and rear axle ratio. The semi-rigid cable which connects transmission driven gear to the speedometer head consists of an outer case and an inner core. Odometer records up to 999,999 miles* and returns to zero. School bus models record 99,999.9 miles.* (*Total metric speedometers record kilometers.)

Speedometer Adapter

Should the need arise for changing a truck axle ratio or tire size, a corresponding change must also be made to the speedometer drive. This is accomplished by changing the speedometer adapter and in some instances the driven gear in the truck transmission. Information for finding the correct adapter and driven gear can be found in the Speedometer Section of the Parts Catalog.

TACHOMETER

An electrical or mechanical tachometer (not standard for all vehicles) is also located in the instrument cluster to record engine RPM (Revolutions Per Minute). This instrument enables driver to keep engine speed within an efficient operating range.

The **mechanical tachometer** is driven by a flexible shaft connected to an adapter or driving unit located on engine (distributor shaft for gasoline engines or air compressor injection pump, auxiliary shaft, etc. for diesel engines).

The **electric tachometer** reads the same as the mechanical unit but receives electrical impulses by wire instead of rotating cable. These impulses are received from a sender unit mounted on the engine and using the mechanical tachometer drive take off.

SPEEDOMETER AND TACHOMETER CABLES

A semi-rigid type cable is used for both speedometer and mechanical tachometer on S-Series trucks.

This cable consists of two segments:

(1) An outer case assembly with nut and ferrule at lower end and a quick-disconnect ferrule at upper end.

(2) A wire-wound flexible inner core assembly with squared drive at upper end and floating tip (Figure 14) at lower end.

The floating tip which is detachable from cable allows core to float and thereby minimize thrust on speedometer or tachometer head. (Speedometer cable assemblies are sometimes made in two sections for assembly purposes.)

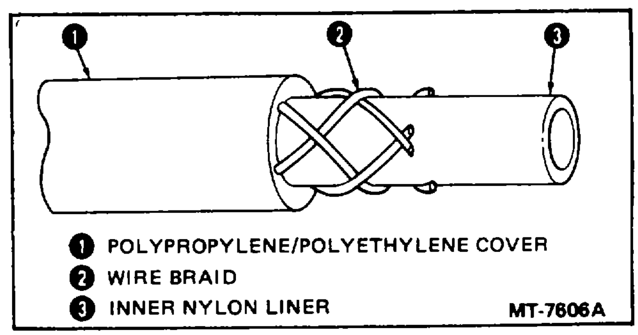


Figure 15 - Semi - Rigid Cable Outer Case

The cable outer case is formed from an inner nylon liner, an intermediate ply of wire braid and an outer polypropylene or polyethylene case (Figure 15).

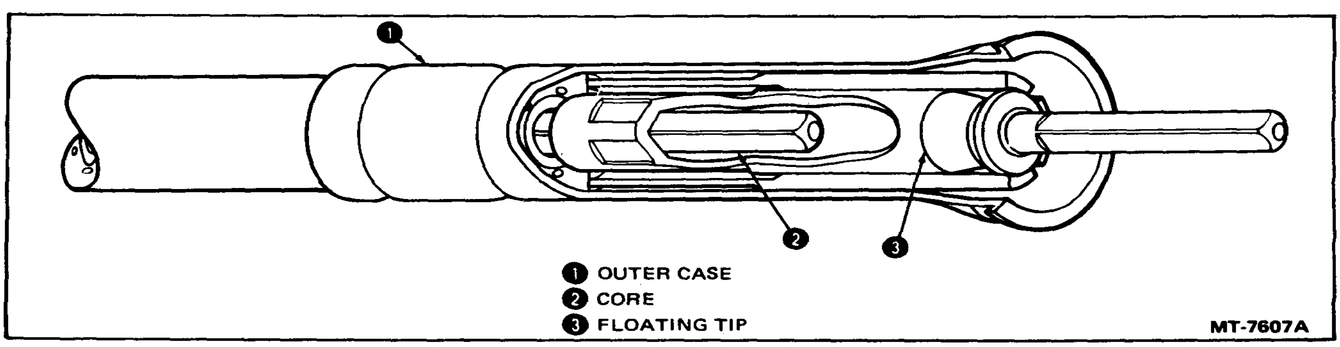


Figure 14 Semi-Rigid Cable End Details

CABLE SERVICE

Removal

1. Disconnect upper end of speedometer or tachometer cable by removing four mounting screws from instrument cluster and detaching cluster enough to expose back of cluster.

2. Depress spring clasp on back of speedometer or tachometer and release cable (Figure 4).

3. Unscrew cable lower or drive end from adapter at either transmission or engine component.

4. Unfasten cable from any ties or slips and remove complete cable assembly from chassis.

Inspection 1.Pull the flexible core out of case.

2. Check for kinks by rolling core on a flat surface. A core kink will show up as a hop at kinked point.

3. Check for frayed spots by running core loosely through fingers.

Core Replacement

Never reuse a kinked or frayed core. A kinked core will cause a fluctuation of speedometer or tachometer reading and a frayed core will fail completely a short time after being returned to service.

NOTE - When replacing core, be sure core Is not too long. A long core will cause a damaging thrust to head of speedometer or tachometer when Installed.

Installation

Apply a thin coat of lubricant (IH #251 H EP) to core at reassembly as follows:

1. Place approximately 1 teaspoon of lube in one hand.

2. Feed the core (lower end first) through the lube and into casing.

3. Keep last four inches of cable free of lube to prevent lube from entering the instrument head.

4. Install complete cable assembly in chassis and connect in reverse order of "Removal" procedure.

IMPORTANT - Avoid sharp bends when installing speedometer or tachometer cables. Under no circumstances should a casing have less than a six inch radius bend. Route tachometer cable away from compressor discharge line and strap to stay rod to avoid cable damage.

SPEEDOMETER, TACHOMETER AND CABLE TROUBLESHOOTING GUIDE

PROBLEM	PROBABLE CAUSE	SOLUTION
Inoperative	1 Cable disconnected 2 Broken core 3 Damaged speedometer or tachometer.	1 Connect cable. 2 Repair or replace. 3 Replace.
Indicator pointer fluctuates	1 Kinked core 2 Cable improperly routed 3 Cable improperly installed in speedometer or tachometer head.	1 Repair or replace. 2 Route cable correctly. 3 Install cable correctly.
Noisy, clicking or squealing	1 Damaged or worn parts in speedometer or tachometer. 2 Damaged core 3 Cable improperly routed	1 Replace. 2 Repair or replace. 3 Route cable correctly.
Reads incorrectly	1 Wrong adapter 2 Cable improperly installed 3 Speedometer or tachometer not calibrated.	1 Install correct adapter. 2 Install cable correctly. 3 Replace.

GAUGES

Except for air pressure, air restriction, and other optional gauges which are mechanical Bourdon tube or diaphragm-type all gauges are of the electromagnetic air core-type. In each system to be monitored (Fuel Level, Oil Pressure, Water Temperature, etc.), a sender uses a variable resistance to control current from the battery through a coil or coils in the gauge.

GAUGE TESTER

To assist in checking the electrical indicating-type gauges, use of a universal-type Gauge Tester SE-2781 (Figure 16) is suggested. This test eliminates time-consuming trial and error methods of checking out the gauges.

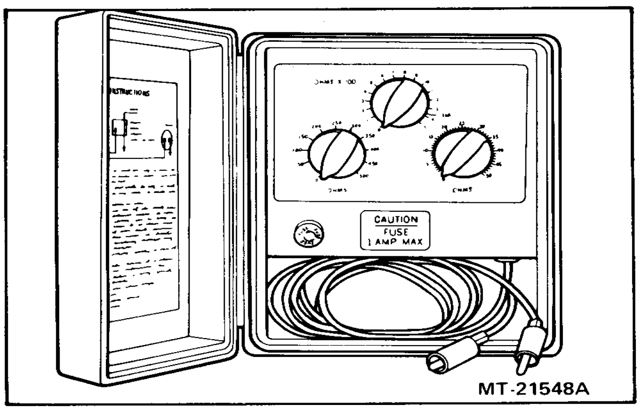


Figure 16 Gauge Tester (SE-2781)

To test gauge operation, the sender wire is disconnected from the sender unit and the tester is connected between the sender wire and ground. The tester substitutes for the sender unit as shown in Figure 17.

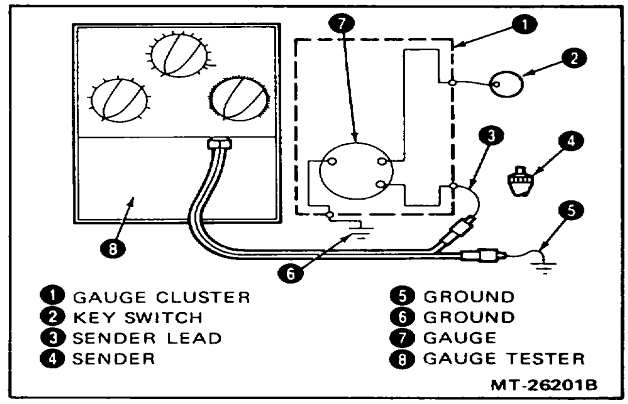


Figure 17 Gauge Tester Connections

Procedures for testing temperature, fuel level, and oil pressure gauges with the gauge tester are given later in this section. Tester setting and gauge reading specifications are shown in Table 1.

NOTE - To ensure full power to all Instruments In cluster, connector lock tabs on both sides of harness connector must be solidly engaged with cluster socket.

TABLE 1

GAUGE TESTER RESISTANCE SETTINGS (Ohms)
(For Use With SE-2781 Gauge Tester)

Type of Gauge	Gauge Reading: Low Scale	Half Scale	Full Scale
Water Temperature:			
With 260° Gauge	1365	113	55
With 220 Gauge	1365	212	99
Fuel Level	1	44	88
Oil Pressure	1	47	88
Oil Temperature:			
Engine	1365	63	28
Transmission	1365	63	28
Rear Axle	1365	63	28

Proper connector insertion and power to cluster is assured if the following Indicators react when key switch is turned on:

1. **Voltmeter pointer moves up scale.**
2. **Some warning lights come on (depends on installation).**
3. **Electric gauges Indicate zero.**

With power to cluster off, electric gauge pointers may move to any point on gauge scale. This is a characteristic of this type of gauge and does not indicate a faulty part.

GAUGE QUICK CHECKS

If a universal gauge tester is not available, electrical gauges can also be "quick-checked" to determine if they are functioning by a simple "Sender Disconnect and Ground Test" (Table 2). While this a quick test, it does have two disadvantages.

1.The test tells only that gauge Is functioning. It does not determine if gauge is accurate.
2.The grounding of sender wire test for a temperature gauge will damage that unit.

FUEL LEVEL GAUGE
Operation

The electric fuel gauge system consists of two basic components - the instrument cluster mounted gauge and the fuel tank sending unit. The tank unit controls the gauge and the gauge registers the quantity of fuel in the tank. The two units are connected electrically as shown in Figure 18.

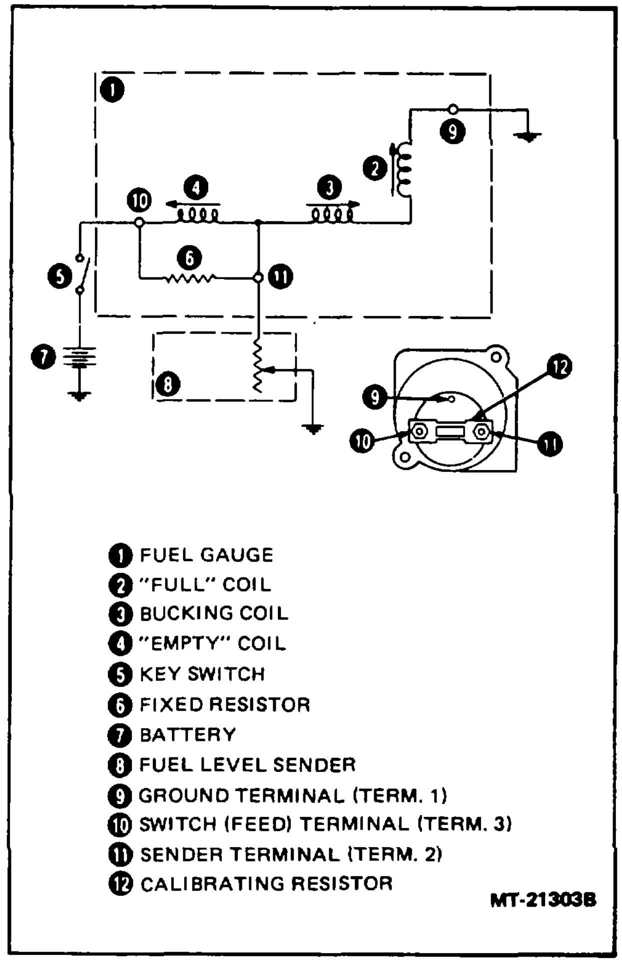


Figure 18 - Fuel Gauge Circuit Diagram

TABLE 2

GAUGE QUICK CHECK (Sender Wire Disconnect and Ground Test)		
	Gauge Reading (With Key Switch "ON")	
Type of Gauge	**With Sender Wire Disconnected**	**With Sender Wire Grounded**
Fuel Level	Above Full Scale	Below Low Scale
Oil Pressure	Above Full Scale	Below Low **Scale**
Water Temperature	Below Low Scale	**Do Not Ground***
Oil Temperature:		
Engine	Below Low Scale	**Do Not Ground***
Transmission	Below Low Scale	**Do Not Ground***
Rear Axle	Below Low Scale	**Do Not Ground***
*Grounding temperature sender wire will burn out gauge.		

This air core type fuel gauge consists of three (3) copper wire coils wound around a plastic bobbin containing a magnet and spindle assembly. Attached to the magnet and spindle assembly is a pointer which indicates fuel level. The fuel gauge requires a 0 to 90 ohm resistance sender to operate. The sender is the tank unit and consists of a float and arm assembly and a variable resistor. The sender's resistance is controlled by the position of float and arm assembly. A full fuel tank raises float to its highest position. At this position the variable resistor has a resistance of 88 ohms. With an empty fuel tank the float assumes its lowest position, creating a sender resistance of less than 1 ohm.

The fuel gauge circuit diagram (Figure 18) shows that with key switch "ON," current flows from the battery through a parallel circuit consisting of the empty coil and the fixed resistor and thence through another circuit composed of:

- The variable resistance fuel level sender, and the bucking coil and the full coil.
- The fuel sender only when in its empty position.

Variations in the position of the fuel level sender contact will vary the active portion of resistance element and thus control the amount of current flowing in the bucking and full coils Maximum current in the bucking and full coils occurs with the tank unit in the full "F" position. Under this condition, the magnetic field of the bucking and full coils is at maximum and the pointer and armature assembly will align itself with the resultant magnetic field of the three coils - the "Full" position. As the fuel is used, the fuel level sender contact position changes to reduce the current in the bucking and full coils and increases the current in the empty coil. This variation in current reduces the magnetic field strength of the bucking and full coils from a maximum at "full" to zero at the empty or "E" position at which time the armature and pointer assembly is aligned with the magnetic field of the empty coil. Thus, the interaction of the magnetic field of the three coils produces a resultant magnetic field which controls the rotation and position of the armature and pointer assembly.

The sender and key switch terminals are connected by a calibrating resistor (Figure 18). The other terminal is the ground terminal.

The sender terminal is the first terminal clockwise from ground terminal when viewed from back side of gauge.

NOTE -The gauge Is grounded to chassis through the ground terminal when plugged Into Instrument cluster printed circuit.

When the key switch is turned off, pointer will not necessarily return to the empty position. This is inherent in the instrument and does not indicate a faulty part.

Testing

1. Disconnect wire at fuel tank sender unit.
2. Connect one lead of Gauge Tester to end of sender wire. Connect second lead to ground. (Gauge tester now substitutes for sender unit.
3. Turn key switch "ON" (Be sure there is power to cluster.
4. Set tester for 88 ohms. Fuel gauge should read at full. (Pointer within boundaries of ball.
5. Set tester for 44 ohms. Fuel gauge should read at half scale. (Pointer within boundaries of ball.
6. Set tester at 1 ohm. Fuel gauge should read at empty. (Pointer within boundaries of ball. If fuel gauge responds correctly to various tester settings, gauge and wiring between gauge and sender unit are OK. Trouble is in sender unit or sender unit is not grounded.

    a. Check sender unit ground circuit. Make sure circuit is grounded.

    b. If ground circuit is OK, replace sender unit If gauge does not respond to tester:

    a. Check continuity of gauge wiring circuits. Make sure connector terminals are clean and tight.

    b. Check gauge cluster ground circuit. Make sure circuit is grounded.

    c. If wiring is OK, replace gauge.

WATER TEMPERATURE GAUGE
Operation
The water temperature gauge circuit consists of two basic components - the cluster-mounted gauge and the thermistor sending unit. The sender controls the gauge reading which indicates the water temperature. The two units are connected electrically as shown in

The operating principle of the temperature indicating system can be understood by reference to the temperature gauge circuit diagram (Figure 19). With the ignition switch closed, current will flow from the battery through the bucking and "cold" coils and the fixed resistor to ground, and through the "Hot" coil and the variable resistance temperature sender to ground. The temperature sender consists of a thermistor en-closed in a sealed threaded shell containing a heat transfer medium and equipped with an insulated terminal. With the temperature sender immersed in a cold liquid (1000F), its resistance is high and the current flowing through the "hot" coil is small; therefore, the magnetic field produced by the "hot" coil is negligible. At this time the pointer and armature assembly will align itself with the resultant magnetic field produced by the "cold" and bucking coils at the 1 00°F position. The mag-netic field of the "cold" and bucking coils is always a constant and serves as a reference. As the temperature of the liquid increases, the resistance of the sender decreases since the thermistor has a negative tempera-ture coefficient. The decrease in sender resistance in-creases the current flowing in the "hot" coil, reaching a maximum at the full-scale position. Thus, the interaction of the magnetic fields of the three coils produces a resultant magnetic field which controls the rotation and position of the armature and pointer assembly.

NOTE - The gauge is grounded to chassis through the ground terminal when plugged into the Instrument cluster printed circuit.

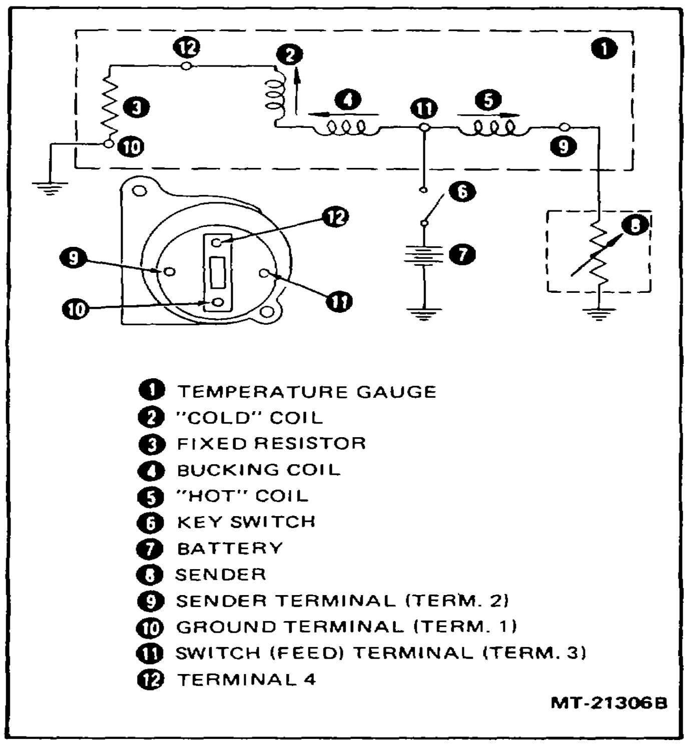


Figure 19 - Water Temperature Gauge Circuit Diagram

The sender terminal is the first terminal clockwise from ground terminal (when viewed from back side). The ignition terminal is directly opposite from sender terminal.

Testing

1. Disconnect sender wire from water temperature sender unit.
2. Connect one lead of gauge tester to sender wire. Connect other lead of tester to a good vehicle ground. (Gauge tester now substitutes for sender unit.
3. Turn key switch "ON" (Be sure there is power to cluster.
4. Set tester: For 260° gauges, use 55 ohms. For 2200 gauges, use 99 ohms. Temperature gauge should read at full scale (HOT). (Pointer within 2 pointer widths of hash mark.
5. Set tester: For 2600 gauges, use 113 ohms. For 2200 gauges, use 212 ohms. Gauge should read at half scale. (Pointer within 2 pointer widths of hash mark.
6. Set tester to 1365 ohms Gauge should read at low scale (COLD). (Pointer within 2 pointer widths of hash mark.

If temperature gauge responds correctly to various tester settings, gauge and wiring between gauge and sender unit are OK.. Trouble is in sender unit or sender unit is not grounded.

NOTE - Sealant or dirt on threads of sender unit or engine cylinder head may prevent a good electrical ground Check for this condition before replacing sender unit.

If gauge does not respond to tester:

a. Check continuity of gauge wiring circuits. Make sure connectors' terminals are clean and tight.
b. Check gauge cluster ground circuit. Make sure circuit is grounded.
c. If wiring is OK, replace gauge.

A similar procedure is used to test engine, transmission and rear axle oil temperature gauges. Refer to Table 1 for tester settings.

AUXILIARY TEMPERATURE GAUGES

The auxiliary (optional) temperature gauges are also electromagnetic type and are actuated by sending units (variable resistance thermistors). Sending units are located in the component on which temperature monitoring is desired (engine oil, transmission, rear axles, etc. Operating principles and testing of auxiliary tempera-ture gauges are similar to the water temperature gauge previously described. Refer to Table 1 for tester settings for checking these gauges.

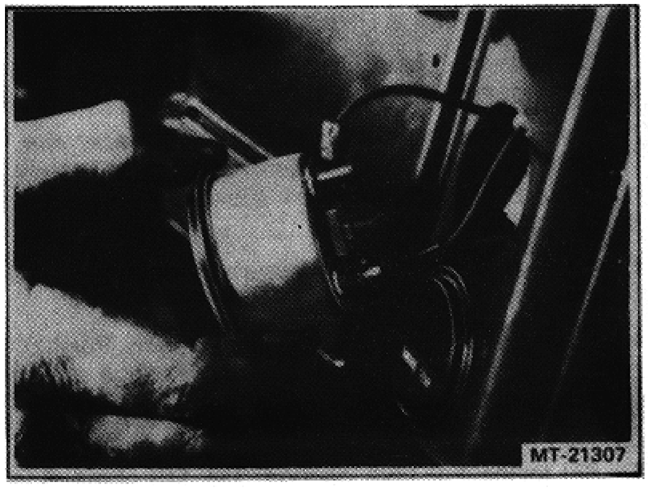


Figure 20 - Servicing Auxiliary Gauge

OIL PRESSURE GAUGE

Operation

The oil pressure gauge circuit (Figure 21) consists of two basic components - the cluster-mounted gauge and the sending unit. The sending unit senses the pressure of oil in the oil gallery during engine operation and registers the pressure on the gauge. Operation of the oil pressure gauge system is similar to the fuel level gauge except that the sending unit re-sistance is controlled by a diaphragm instead of a float.

Testing

1. Disconnect wire at oil pressure sender unit (located under cab floor on driver's side).
2. Connect one lead of gauge tester to end of sender wire. Connect second lead to ground. (Gauge tester now substitutes for sender unit.
3. Turn key switch "ON" (Be sure there is power to cluster.
4. Set tester for 88 ohms. (Oil pressure gauge should read at full scale.
5. Set tester for 47 ohms. Oil pressure gauge should read at half scale. (Pointer within 2 pointer widths of hash mark.
6. Set tester at 1 ohm. Oil pressure gauge should read at low scale. (Pointer within 2 pointer widths of hash mark.

If oil pressure gauge responds correctly to various tester settings, gauge and wiring between gauge and sender unit are OK. Trouble is in the sender unit or the sender unit is not grounded.

NOTE - Sealant or dirt on threads of sender unit or engine oil gallery may prevent a good electrical ground. Check for this condition before replacing sender unit.

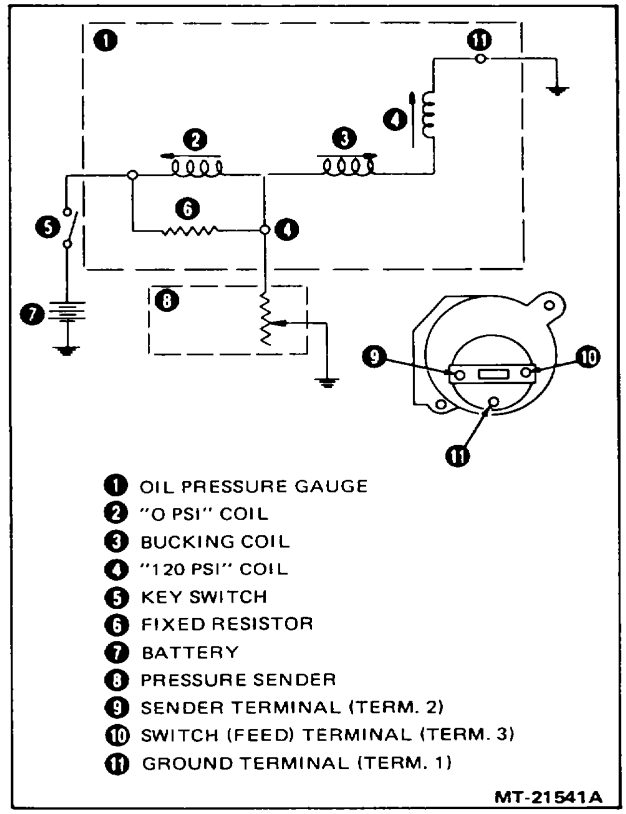


Figure 21 - Oil Pressure Gauge Circuit Diagram

If gauge does not respond to tester:

a. Check continuity of gauge wiring circuit. Make sure connector terminals are clean and tight.

b. Check gauge cluster ground circuit. Make sure circuit is grounded.

c. If wiring is OK, replace gauge.

OIL PRESSURE WARNING LAMP

A second or back-up oil pressure warning system is also used. This system uses a second oil pressure warning switch mounted on the engine.

When engine oil pressure is in its normal operating range (high) the pressure switch is held in its off position and no current is sent to warning light in the instrument cluster.

When engine oil pressure is below its normal operating range (low) the pressure switch will close to its "on" position and deliver current to warning light in instrument cluster and cause warning lamp to light.

AIR PRESSURE GAUGE

Operation

The air pressure gauges are the mechanical type and operate on the Bourdon tube principle.

When air system is pressurized, air enters the air pressure gauge and exerts pressure on the Bourdon tube. As pressure increases, the Bourdon tube tends to straighten out and thus actuate the sector and pinion gear (Figure 22) to which it is attached. This causes indicator to move across dial in an upscale direction. When pressure decreases, the Bourdon tube relaxes and pointer moves in a downscale direction. A steadily applied air pressure holds the Bourdon tube and pointer at a fixed scale reading corresponding to applied pressure.

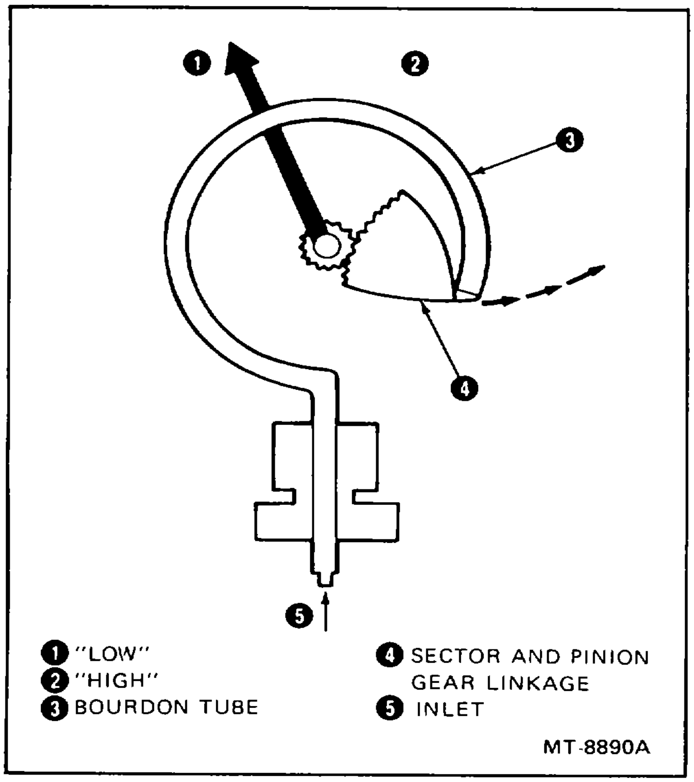


Figure 22 - Air Pressure Gauge Details

Removal

1. Detach instrument cluster and cluster bezel.
2. Unscrew air lines from fittings on rear of the two air gauge inlets on back of instrument cluster.
3. Remove gauge mounting screws and demount gauges from instrument cluster (Figure 23).
4. Separate individual gauges from bracket.

Figure 23 - Removing Air Pressure Gauges

Testing

1. If a suspected gauge has been reading high and does not return to zero when disconnected, Bourdon tube has been damaged. Service by replacing with a new gauge.

2. If gauge has been reading low or does not read at all, examine the inlet connection for dirt which might restrict air from entering gauge. Make a trial connection and if gauge still does not register correctly, replace gauge.

NOTE - Always make a comparison test with a gauge known to be reading correctly before discarding a questionable gauge.

Installation

Installation of air gauges is the reverse of removal procedure. Be sure to use non-hardening sealing compound on fitting threads to prevent leaks. Check installation so as to prevent kinks in air lines.

VOLTMETER (BATTERY/CHARGING SYSTEM GAUGE)

Operation

The voltmeter or battery/charging system gauge (Figure 24) indicates the condition of battery and charging system. This gauge will monitor a voltage range between 10 and 16 volts. Color segments of this range also indicate system condition as follows:

GREEN - A well-charged battery.
FIRE ORANGE - Either a too high or too low charged battery.

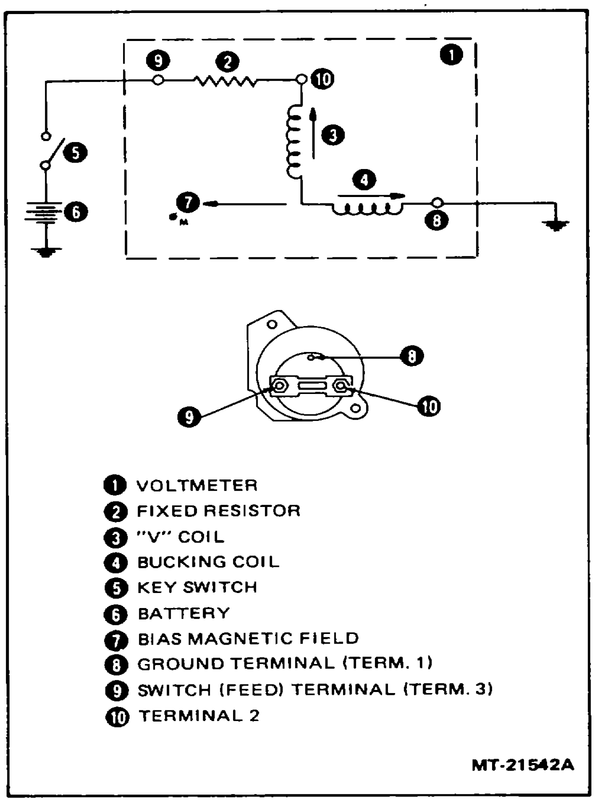


Figure 24 - Voltmeter Circuit Diagram

With key switch "on" but before starting engine, the voltmeter will show condition of battery. While starting engine, indicator will temporarily descend to "Fire Orange" segment but immediately return to "Green" segment when engine is operating. With engine running at operating speeds, the voltmeter indicator should remain in the "Green" segment. This is charging system's nor-mal operating range and indicates alternator is charging.

If indicator ascends to "Fire Orange" segment, alternator voltage output is too high.

Constant reading in either high or low "Fire Orange" segments of the voltmeter indicates a complete check of battery and charging system is required. See appropriate alternator section of the Service Manual.

Testing

Operation of voltmeter can be checked by removing voltmeter from cluster and connecting voltmeter terminals to an independent voltage source (12 V battery). The voltmeter should indicate battery voltage 0 ± 5 volt.

If voltmeter **reads properly,** voltmeter is OK and problem is in vehicle wiring. Check continuity with test light.

If voltmeter **does not read properly,** replace voltmeter.

EXHAUST PYROMETER

Description

The exhaust pyrometer indicates the temperature of exhaust gases leaving the engine.

The exhaust pyrometer system (Figure 25) consists of the dash unit (gauge) mounted on the instrument panel, the sender unit (thermocouple) mounted in the engine's exhaust outlet and the connecting wiring circuits.

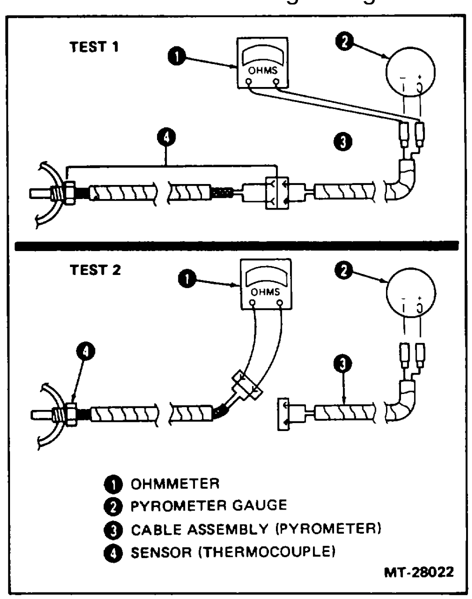


Figure 25 - Pyrometer Tests

Testing

The diagnostic procedure outlined below can be followed to help determine the cause for an inoperative pyrometer.

The component units (gauge and sender unit) are not repairable. If tests indicate that a unit is faulty, replace it.

Before making diagnostic tests, inspect pyrometer wiring circuits for damaged wires or loose or corroded terminals. (Refer to vehicle wiring circuit diagrams in the Service Manual.) Make any necessary repairs.

The pyrometer system can be checked with a volt-ohmmeter (Simpson Model 260 or equivalent). Perform tests in the following sequence to locate the problem.

1. Disconnect leads from pyrometer gauge.
2. Test sensor and cable assembly as follows:
    a. Set ohmmeter on Rx1 scale.
    b. Connect ohmmeter leads to sensor cable terminals (Test 1, Figure 25).
    c. Ohmmeter should read 4 $\pm$ 2 ohms (2-6 ohms).
    d. If specified ohmmeter reading is obtained, sensor and cable are OK. Trouble is in pyrometer gauge. Replace gauge.
    e. If ohmmeter reading is low (no resistance), check for short in cable assembly.
    f. If ohmmeter reading is high (high resistance), proceed to Step 3.
3. Test sensor (thermocouple) as follows:
    a. Disconnect sensor leads from cable assembly.
    b. Connect ohmmeter to sensor lead terminals (Test 2, Figure 25).
    c. Ohmmeter should read 1 ohm or less.
    d. If specified ohmmeter reading is obtained, sensor is OK. Fault is in cable assembly. Replace cable.
    e. If ohmmeter reading is high, sensor is faulty. Replace sensor.

SUPPLEMENT NO. 1333
Replace old section with this Revised Section in your CTS-2001 Manual.

STARTING MOTOR
ENCLOSED SHIFT LEVER TYPE

HEAVY DUTY

CONTENTS

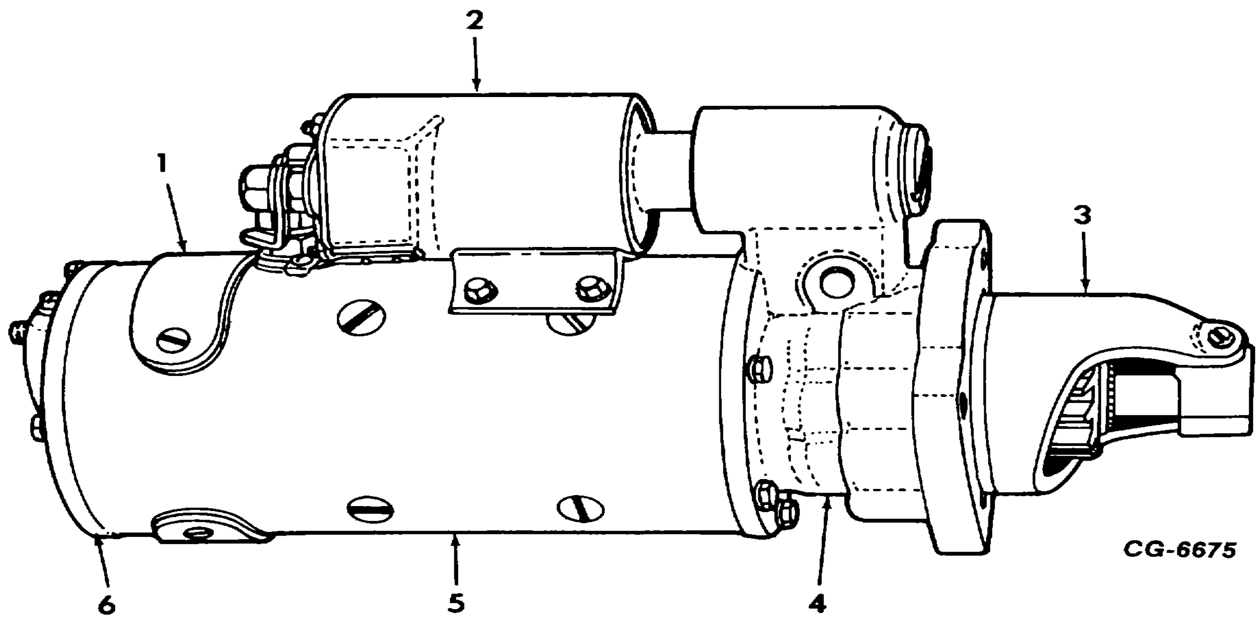


Fig. 1 Heavy Duty Starting Motor with Enclosed Shift

1. **Cover Plate**
2. **Solenoid**
3. **Nose housing**
4. **Lever housing**
5. **Field frame**
6. **Commutator end**

DESCRIPTION

Heavy duty, enclosed shift lever type starting motors-are designed to protect the shift lever and solenoid plunger from dirt, road splash and icing conditions.

The nose housing can be rotated to obtain a number of different solenoid positions with respect to the mounting flange, which permits a variety of mounting applications.

NOTE: Be sure to mark the location of the nose housing in some manner to assure proper location of nose housing-to-lever housing upon reassembly of starting motor.

Either the intermediate duty or the heavy duty overrunning type sprag clutches may be used on the heavy duty starting motors with the enclosed shift lever. Both types of clutches are shifted into mesh with the flywheel ring gear by action of the solenoid. When the drive pinion is engaged with the fly-wheel, the pinion will not be permitted to disengage until the engine has started and the solenoid circuit is interrupted.

Some of the heavy duty starting motors feature a seal between the shaft and lever housing, and all of the heavy duty starting motors with the enclosed shift lever have a rubber boot or linkage seal over the solenoid plunger. These seals prevent the entry of dirt and oil into the motor main frame.

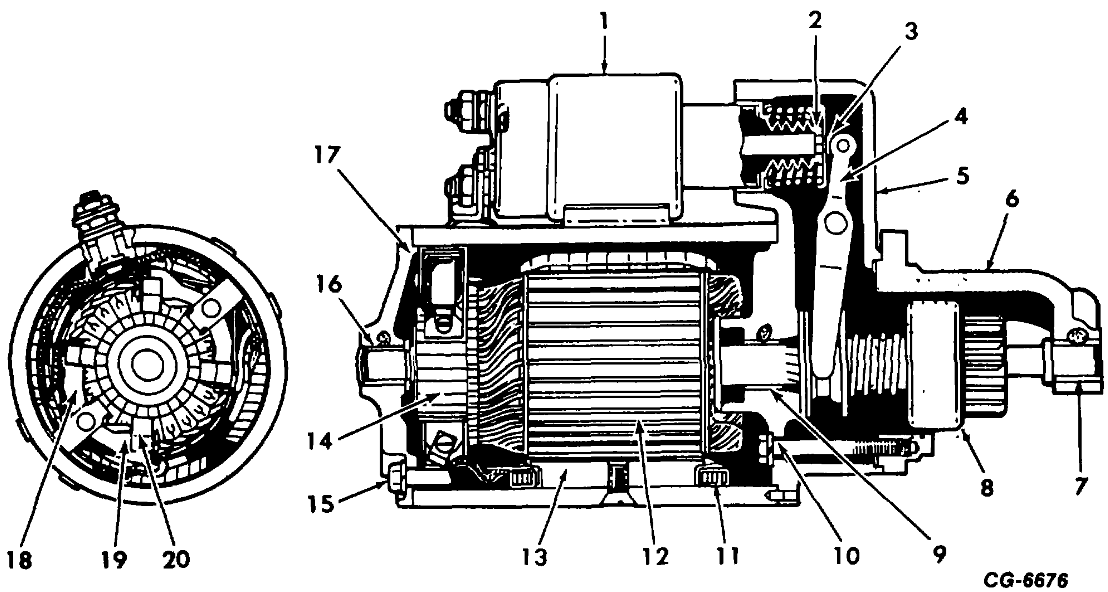


Fig. 2 Sectional View of Starting Motor with International Duty Clutch

1. Solenoid
2. Linkage seal
3. Linkage
4. Shift Lever
5. Lever housing
6. Nose housing
7. Bronze bushing
8. Intermediate duty clutch
9. Bronze bushing
10. Attaching bolt
11. Field coil
12. Armature
13. Pole shoe
14. Commutator
15. Thru bolt
16. Bronze bushing
17. Commutator end frame
18. Grounded brush holder
19. Insulated brush holder
20. Brush

Fig. 2. Sectional View of Starting Motor with International Duty Clutch

LUBRICATION

Lubrication is provided for the bron2 bushings located in the commutator end frame, lever housing and the nose housing, by an oil saturated wick that projects through each bushing and contacts the armature shaft. Oil can be added to the wicks by removing the pipe plugs.

The starting motor should be lubricated whenever it is disassembled with SAE-10 oil. All the wicks should be saturated, reservoirs filled and the splines underneath the clutch should be lubricated with a light coat of oil.

Some of the starting motors are equipped with a large oil reservoir for each wick, also "O" rings are used at various locations to resist entry of dirt and moisture. The starting motors which utilize the large oil reservoirs and the "O" ring are called "long life motors."

MAINTENANCE

On chassis operating under normal conditions no maintenance to these starting motors will be required. When the engine is overhauled the starting motor should be disassembled, inspected, cleaned, tested and any repairs made.

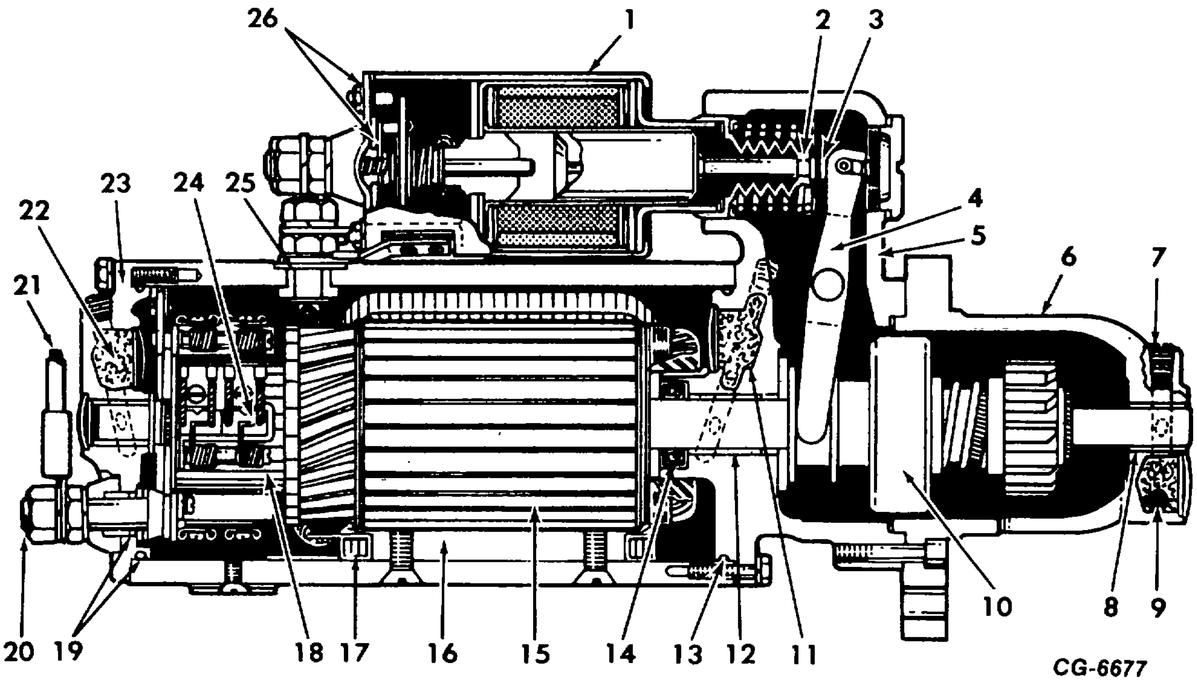


Fig. 3 Sectional View of Starting Motor with Heavy Duty Sprag Clutch

1. Heavy duty solenoid switch
2. Linkage seal
3. Linkage
4. Shift lever
5. Lever housing
6. Nose housing
7. Pipe plug
8. Bronze bushing
9. Oil reservoir
10. Heavy duty clutch
11. Oil reservoir
12. Bronze bushing
13. "O" ring
14. Shaft seal
15. Armature
16. Pole shoe
17. Field coil
18. Commutator
19. "O" rings
20. Terminal
21. Cable
22. Oil reservoir
23. Commutator end frame
24. Brush
25. Gasket
26. Gaskets

Fig. 3. Sectional View of Starting Motor with Heavy Duty Sprag Clutch

TROUBLE SHOOTING THE STARTING CIRCUIT

When trouble develops in the starting motor system, and the starter motor cranks the engine slowly or not at all, several preliminary checks can be made to determine whether the trouble is in the battery, starting motor, wiring circuit between them, or elsewhere. Many conditions besides defects in the motor can result in poor cranking performance.

To obtain full performance from a starting motor or to determine the cause of abnormal operation, the motor should be subjected to one or more of the following tests. These tests are performed with the starter motor removed from the engine. Failure of the motor to perform according to the specifications will require disassembly and further checks or adjustments to be made.

NOTE: All starting motor tests should be made with engine and battery at room temperature (not cold).

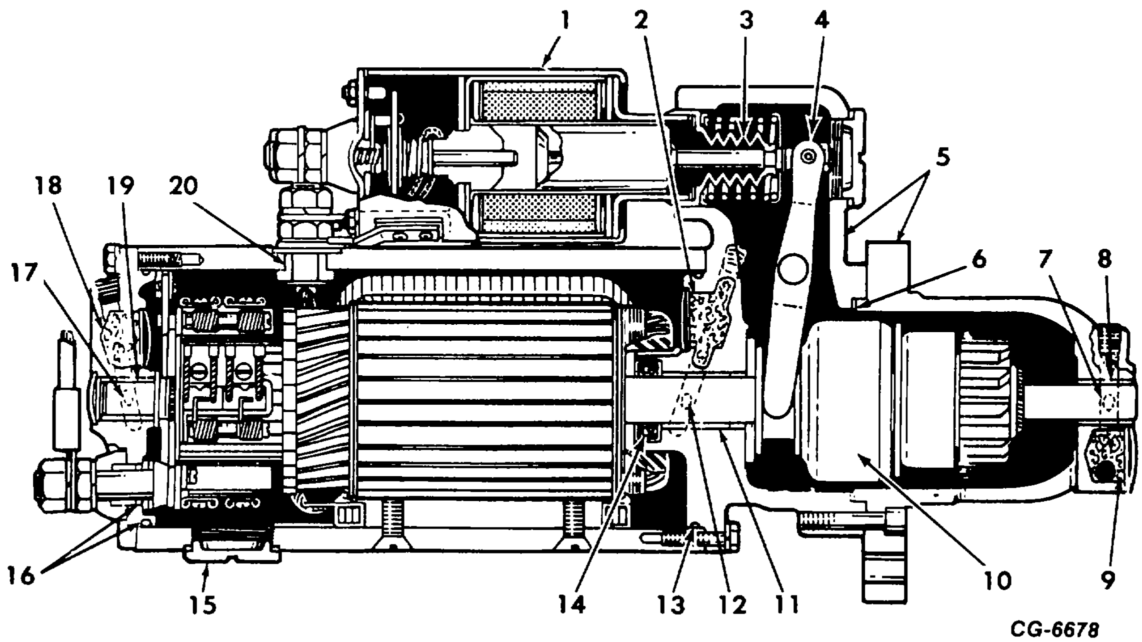


Fig. 4 Sectional View of Starting Motor with DR-250 Heavy Duty Drive

1. Heavy duty solenoid switch
2. Oil reservoir
3. Sealing boat
4. Totally enclosed shift mechanism
5. Two-piece housing
6. Gasket
7. Oil wick
8. Bronze bearing
9. Oil reservoir
10. DR-250 drive
11. Bronze bearing
12. Oil wick
13. "O" ring
14. Shaft seal
15. Brush inspection plug
16. "O" rings
17. Oil wick
18. Oil reservoir
19. Bronze bearing
20. Gasket

Fig. 4. Sectional View of Starting Motor with DR-250 Heavy Duty Drive

Regardless of the construction, never operate the starting motor more than 3(seconds at a time without pausing to allow it to cool for at least 2 minutes Overheating caused by excessive cranking will seriously damage the motor.

For the most part a volt-ampere test (SE-2283) will be used in performing the starter tests and the instruction manual supplied with the tester will pro-vide the detailed instructions using the volt-ampere tester.

NOTE: All illustrations of starting motor and circuit tests show leads connected for NEGATIVE grounded system. Reverse the positions of the leads when testing a POSITIVE grounded system. Make sure the volt se-lector switch on the volt-ampere tester is positioned properly for the voltage system being inspected.

.

Test No 1 - Cranking Voltage Test

This test tells us the overall condition of battery, starter, cables or switches to determine if sufficient volt-age is available to operate ignition sys-tem when starter is in operation.

Connect voltmeter leads at the starter observing the polarity, Fig. 5. Disconnect secondary coil lead to prevent engine from starting. Crank engine noting voltmeter reading (should be 9.6 volts or better with 12-volt electrical system).

If a reading of less than 9.6 volts is found, proceed to the next test.

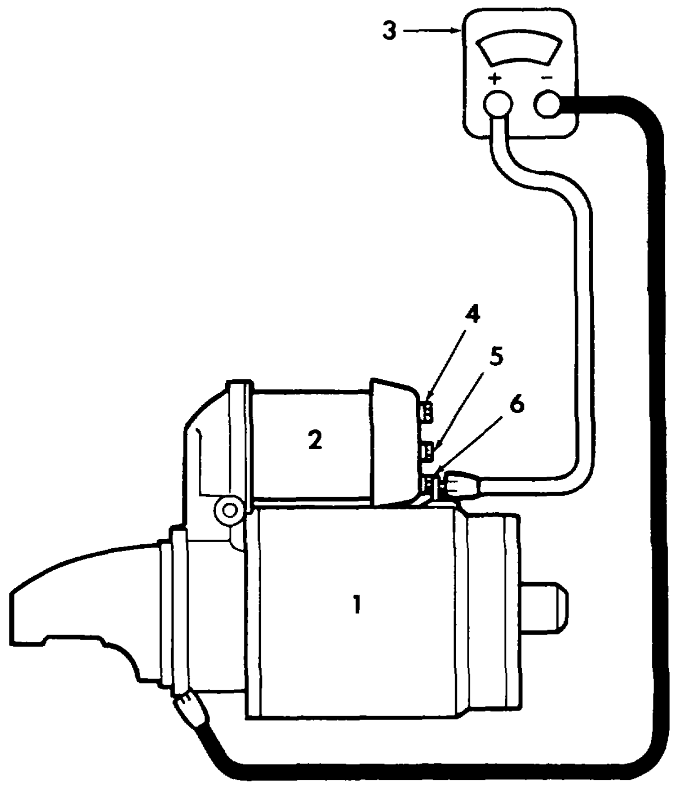


Fig. 5 Cranking Voltage Test

1. Starting motor
2. Solenoid
3. Voltmeter
4. Battery Terminal (Batt.)
5. Solenoid Terminal (S)
6. Motor Terminal (M)

Fig. 5. Cranking Voltage test

Test No 2 - Battery Capacity Test

The battery capacity test is per-formed to determine if the battery is in satisfactory condition. See "Battery" Section B. If the battery passes this test, continue the next test.

Test No 3 - Voltage Drop Test

Generally, the starting or cranking circuit is a series circuit from the battery insulated post to the starting motor solenoid, to the motor, to ground (chassis) and return to the battery ground post, Fig. 6.

In the cranking circuit we also have a cranking control circuit, Fig. 6. In this circuit the solenoid is controlled or operated by closing an ignition switch or push button starting switch at the instrument panel. In this cranking control circuit there are frequently some safety switches such as transmission "neutral safety switch" and/or vacuum-operated cutout switch.

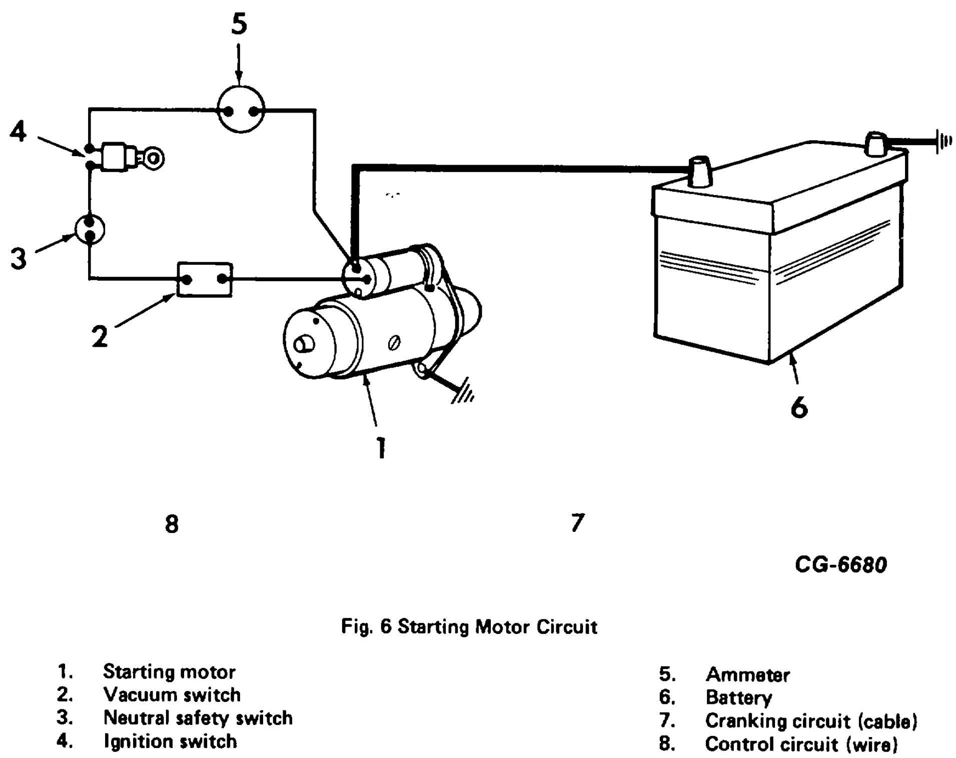


Fig. 6. Starting Motor Circuit

Excessive resistance in the starting or cranking system circuit will cause slow cranking speeds and hard starting. The starting system will function properly only when the "cranking circuit" and "control circuit" with the components are in satisfactory condition.

Corrosion, loose terminal, damaged or undersized cables (wires) will cause cranking problems. In addition, the switches involved must make good electrical connections when closed. The voltage drop test will be performed in three steps: cranking circuit, control circuit and grounded side.

<u>Cranking Circuit</u>: Voltage drops are measured by connecting a voltmeter in parallel across the circuit or section of a circuit being inspected, then reading the voltmeter while circuit is in operation. To test voltage drop in the cranking circuit from battery to starter, connect the voltmeter (observing the polarity and voltage rating of meter) to battery post (not clamp) to starter motor terminal as shown in Fig. 7. Prevent engine from starting during test. Crank engine and observe voltmeter reading.

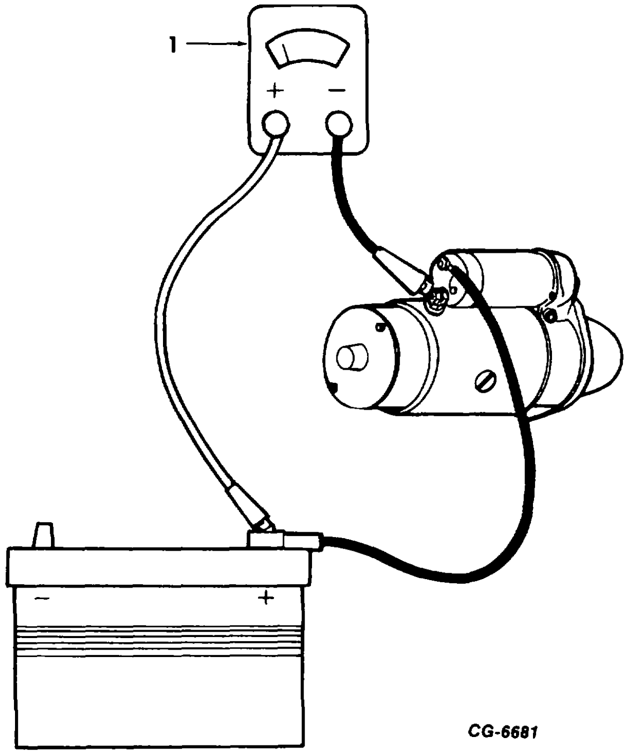


Fig. 7. Cranking Circuit Test

1. Voltmeter

Values of maximum voltage drops for a standard 12-volt cranking circuit are as follows:

	Volt
Cable Under Three (3) Feet	.1
Cable Over Three (3) to Six (6) Feet	.2
Mechanical Switch	.1
Solenoid Switch	.2
Magnetic Switch	.3
Each Connection	.0

Add these values together. For ex-ample, you have a total of .5 volt and you have less than .5 volt drop, continue to grounded side test.

However, if you have more than .5 volt drop, you have an excessive voltage drop. This must be located by moving test lead from starting motor and working toward the battery. Crank engine and each move. When a noticeable decrease in the voltage reading is obtained, the trouble will be located between that point and the preceding point checked.

Items which could be at fault can either be a damaged cable or poor connection, an undersized wire or possibly a bad solenoid (contact within the solenoid). Repair the fault.

Grounded Size: High resistance in ground circuit of starting motor system will result in hard starting and may affect the charging circuit as well.

Connect voltmeter leads to ground on starting motor and to ground post of battery. The allowable voltage drop of .2 volt is permissible. If more than .2 volt is obtained, a poor ground is pre-sent, such as a loose starting motor mounting bolt, bad battery ground connector or ground connection to engine or frame, depending upon the battery installation. The excessive voltage drop is located in much the same manner as in the preceding test working toward the battery.

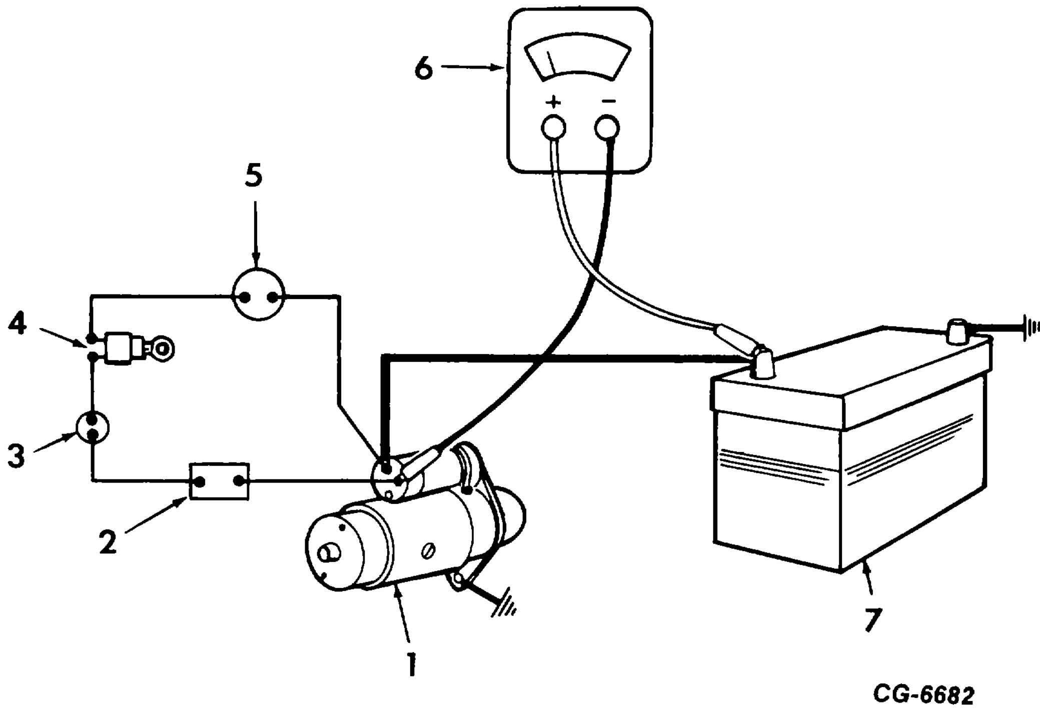


Fig. 8 Control Circuit Test

1. Starting motor
2. Vacuum switch
3. Neutral safety switch
4. Ignition switch
5. Ammeter
6. Voltmeter
7. Battery

Fig. 8. Control Circuit Test

Control Circuit: High resistance in the control circuit will reduce the cur-rent flow through the solenoid windings, which can cause improper function of solenoid or not at all. Improper functioning of the solenoid could result in burning of contacts in the solenoid causing high resistance in the starting motor circuit.

To complete control circuit test, check the vehicle circuit diagram to assist in locating the wires and particular switches involved in the chassis. Observe polarity of voltmeter and connect leads to battery post and solenoid switch terminal as shown in Fig. 8. Crank engine using the vehicle ignition switch or push button if equipped, observing the voltmeter reading. If the voltmeter shows less than .5 volt, the circuit is in good condition. If more than .5 volt, this is an indication of excessive resistance. Note: Occasionally a slightly higher voltage will be found in the circuit and the circuit still be normal.

Isolate the point of high resistance by placing the voltmeter leads across each component in the circuit in turn. A reading of more than .1 volt across any one wire or switch is usually an indication of the trouble.

After completing the cranking volt-age test, battery capacity test and the voltage drop tests, and the starting motor still fails to function, remove the motor and make the no load test as follows.

Note that the preceding tests were made in the particular order to make certain the starting motor circuit is in good condition before needless starter motor removal.

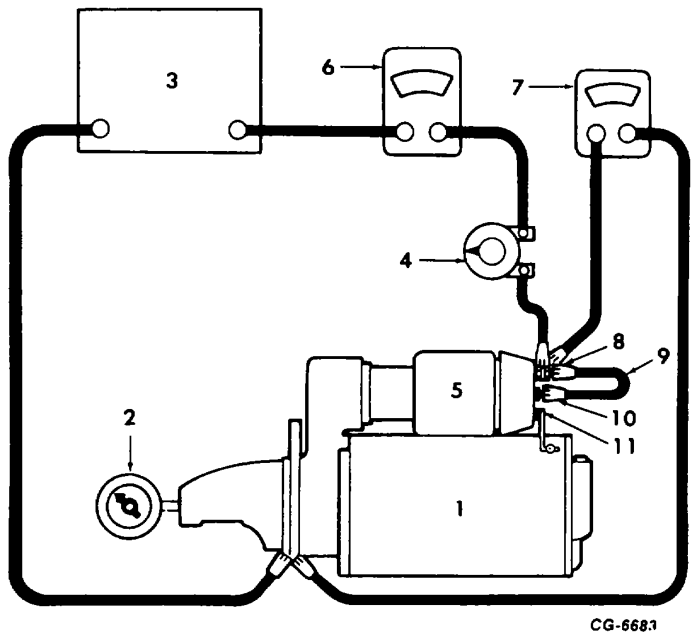


Fig. 9 No Load Test Hookup

1. Starting motor
2. RPM indicator
3. Battery
4. Variable resistance
5. Solenoid
6. Ammeter
7. Voltmeter
8. Battery Terminal (Batt.)
9. Jumper lead
10. Solenoid Terminal (S)
11. Motor Terminal (M)

Fig. 9. No Load Test Hookup

<u>Test No 4 - No Load Test</u>

Before performing the "No Load Test" look the motor over. The pinion should be checked to be sure it is free by turning it on the screw shaft. The armature should be checked so that it is free to rotate by prying the pinion with a screw driver. Tight bearing, bent armature shaft or loose pole shoe

screws could cause the armature not to turn freely. The motor should be disassembled if the armature does not turn freely. However, if the armature will rotate freely, the next step is to give the motor a no load test before disassembly.

Connect the starting motor in series with a fully charged battery of the specified voltage, an ammeter capable of reading several hundred amperes, and a variable resistance. Also connect a voltmeter as illustrated in Fig. 9 from the motor terminal to the motor frame. An R.P.M. indicator is necessary to measure armature speed. Obtain the specified voltage by varying the re-sistance unit, then read the current draw and the armature speed and com-pare these readings with the values listed in the specifications.

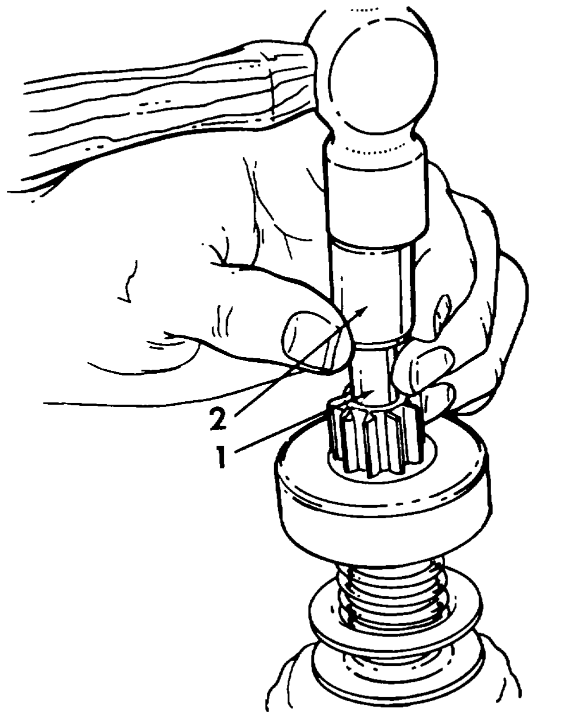


Fig. 10 Removing Retainer from Snap Ring

1. Retainer
2. Cylinder

Fig. 10. Removing retainer from Snap Ring

DISASSEMBLY

If the starting motor does not perform according to the specifications it will be necessary to disassemble it for further tests of the components.

NOTE: Before starting to disassemble the starting motor etch mark the field frame, lever housing and the nose housing so they may be reassembled in the same position.

Intermediate Duty Drive Clutch Motor

1 Disconnect field coil connector from solenoid motor terminal and remove solenoid mounting screws.

2 Remove the through bolts.

3 Remove commutator end frame from field frame and frame from lever housing.

4 Remove the nose housing bolts and separate the lever housing and nose housing.

5 Remove the pinion from the armature by sliding a metal cylinder onto the shaft. With a hammer strike the metal cylinder against the retainer, drive the retainer towards the armature core and off the snap ring, Fig. 10.

6 Remove the snap ring from the groove in the armature shaft. If snap ring is too badly distorted during removal, it must be replaced.

7 Remove the armature and clutch assemblies from the lever housing.

8 Separate the solenoid from the lever housing.

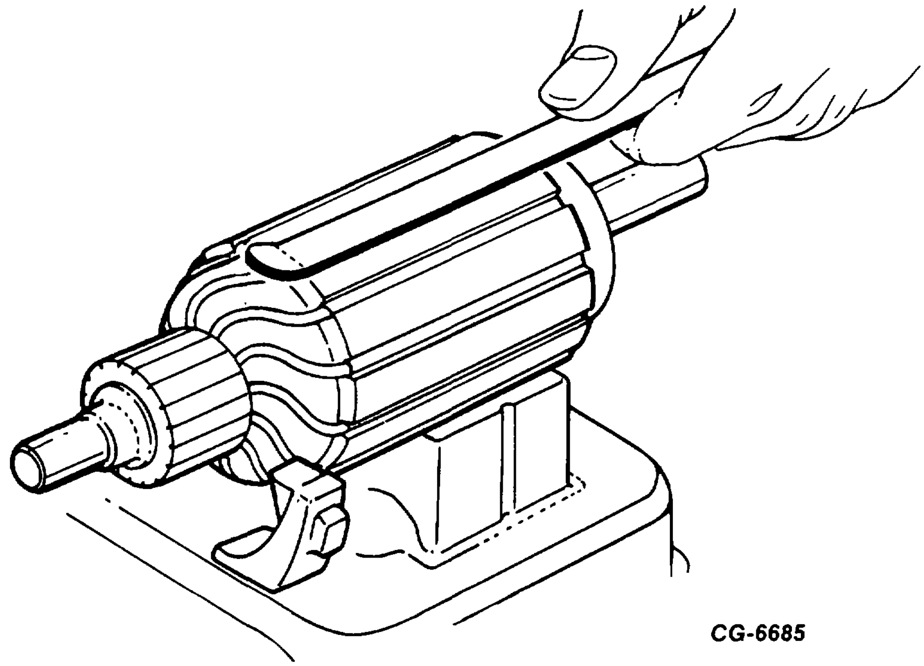


Fig. 11. Testing Armature for CG-6685 Short Circuits

Heavy Duty Drive Clutch Motor

1. Disconnect field coil connector from solenoid motor terminal and lead from solenoid ground terminal.
2. Motors which have brush inspection plates, remove the plates, then remove the brush lead screws which disconnect the field leads from the brush holders.
3. Separate the commutator end frame from the field frame.
4. Separate the nose housing and field frame from the lever housing.
5. Remove the armature and clutch assembly from lever housing.
6. Separate solenoid from lever housing by pulling apart.

INSPECTION AND REPAIR

1. Brushes and Brush Holders - Inspect the brushes for wear. If they are worn down to one-half their original length, when compared with a new brush, they should be replaced. Clean brush holders and be sure that the brushes will not bind in the holders. The full length of the brush surface should ride on the commutator with spring tension to provide a good contact. Inspect the brush leads and screws to be sure they are tight and clean.

2. Armature - Inspect the armature to be sure there are no short circuits, open or grounds.

   a. Short circuits are located by turning the armature in a growler while holding a steel strip on the armature. The steel strip will vibrate on the area of the short circuit, see Fig. 11.

   b. Opens are usually found where the conductors are joined to the commutator. Loose or poor connections will cause arcing and burning of the commutator. If the bars are not burned too bad, resolder the leads in the riser bars and turn the commutator down in a lathe. Then under cut the insulation between the commutator bars 1/32".

   c. Grounds in the armature can be found using a test lamp and prods, see Fig. 12. If the lamp lights when one prod is positioned on the commutator and the other prod on the armature core or shaft the armature is grounded.

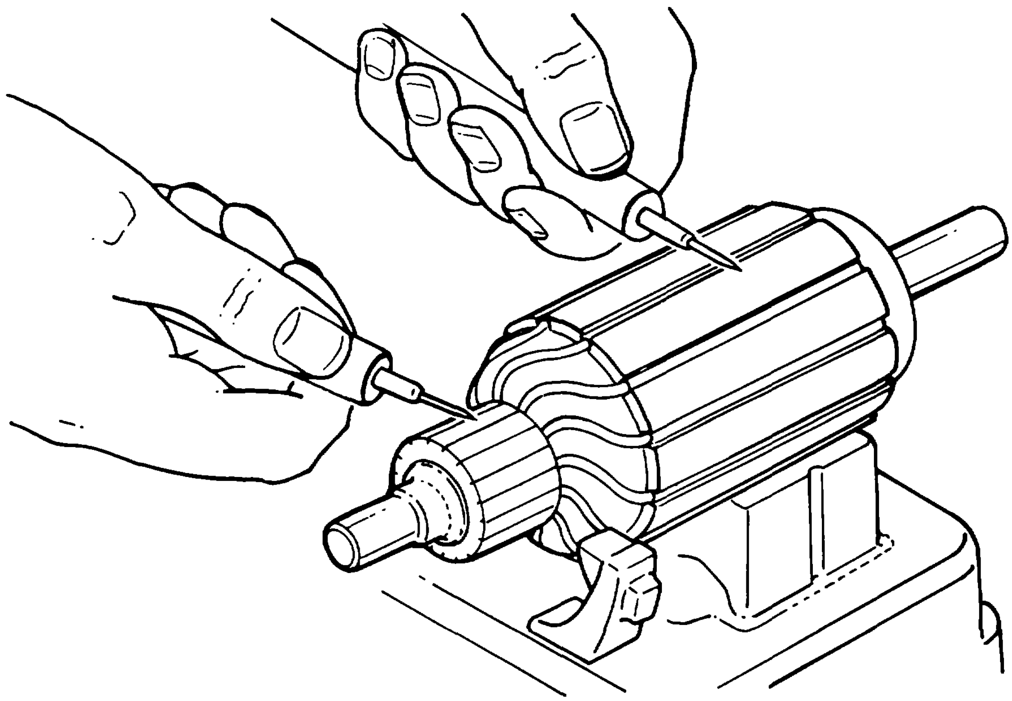


Fig. 12. Testing Armature for Grounds

If the commutator is worn, dirty or out-of-round or the insulation is high, the commutator should be turned down and under cut.

3. Field Coils - Check field coils for ground and opens with a test lamp.

   a. Grounds - With the field coil ground disconnected, position one test prod on the field frame and the other to the field connector. If the lamp lights the field coils are grounded and must either be replaced or repaired.
   b. Opens - If the test lamp does not light when the prods are connected to the ends of coil leads, the field coils are open.

A pole shoe spreader and pole shoe screw driver should be used if the field coils are to be removed. Extra caution should be taken in replacing the field coils to prevent grounding or shorting when they are tightened in place. If the pole shoe has a long lip on one side, it should be assembled in the direction of armature rotation.

CLUTCH ASSEMBLIES

Four kinds of clutches or motor drives (a heavy duty sprag, a Positork drive, an intermediate duty type and a splined drive) may be used on the enclosed shift lever heavy duty motors.

The intermediate clutch may be either the sprag type or the four roll type. All four types are moved into mesh with the flywheel ring gear by action of the solenoid. The pinion will remain engaged until starting is assured and the solenoid is interrupted.

Intermediate Duty Sprag Clutch

1. Remove the lock wire, collar and spring from sleeve assembly. Early design type cluthes are equipped with a spring stop and a second lock wire which must be removed after removing the spring.
2. Remove the retainer ring and large washers. DO NOT remove sleeve assembly or sprags from shell assembly.
3. Lubricate the sprags and saturate the felt washer with No. 5W-20 oil. Heavier oil must not be used.
4. Reassembly is the reverse of the disassembly.

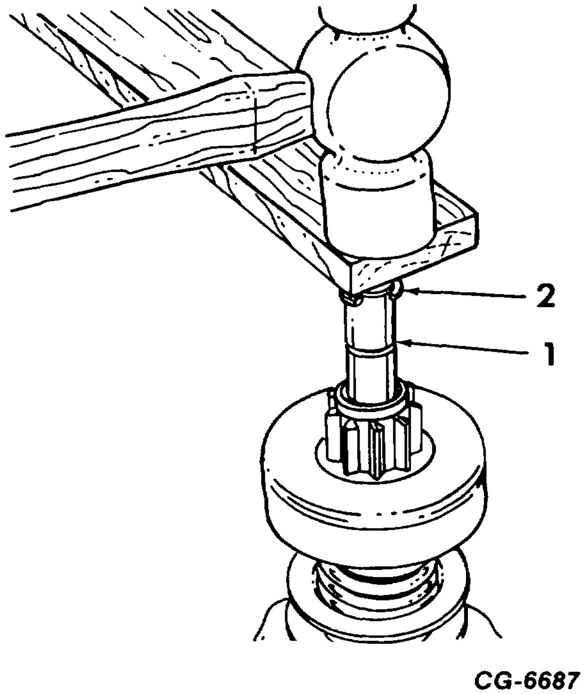


Fig. 13. Installing Snap Ring

1. Groove **2. Snap ring**

<u>Heavy Duty Sprag Clutch and DR-250 Drive</u>

1. Remove the cupped pinion stop and split washer. When removing the cupped pinion stop it will probably be damaged. A new one will be required at time of reassembly.
2. Remove remaining parts such as pinion washer or retainer cups and baffle if equipped. The splined drive will have a spring cup (spring inside cup).
3. DO NOT lubricate the sprags on heavy duty clutches as they are lubricated for life with a special lubricant.
4. Reassembly is the reverse of the disassembly.

<u>Spline Drive and Positork Drive</u>

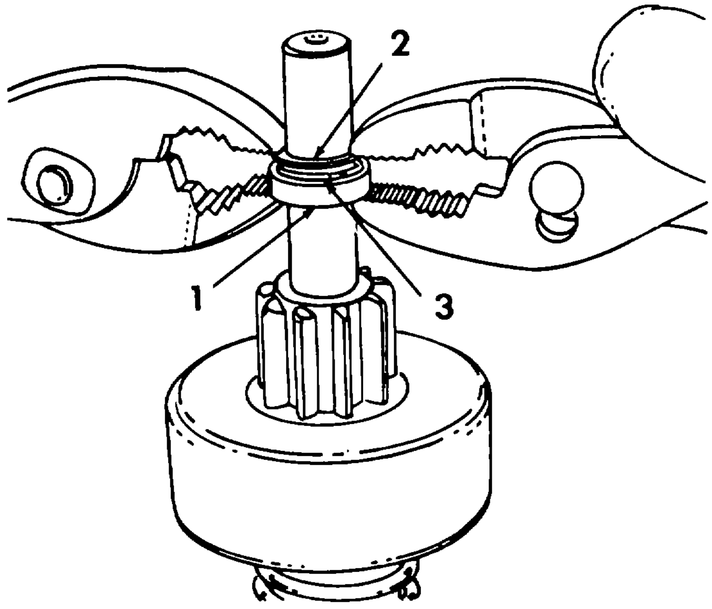
These types of drives are serviced by complete replacement only.

REASSEMBLY

The reassembly procedure for the most part is the reverse of the disassembly.

Motors using the snap ring and retainer on the armature shaft as the pinion stop are re-assembled as follows:

1. Place the clutch assembly on the armature shaft.
2. To aid in reinstalling the snap ring and retainer on the armature shaft observe the following:
   a. Place the retainer on the armature shaft with the cupped surface facing the snap ring groove.
   b. Place the snap ring on the end of the shaft. With a piece of wood on top of ring, force the ring over the shaft with a light hammer blow, Fig. 13. Then slide the ring down into the groove.
   c. To force the retainer over the snap ring, place a suitable washer over the shaft and squeeze the retainer and washer together with pliers, Fig. 14.
   d. Remove the washer.



CG-6688

Fig. 14. Installation of Retainer

1. Retainer **2. Washer** **3. Snap Ring**

3. When reinstalling the field frame lever housing and nose housing align the etch marks scribed when the motor was disassembled.

4. Starting motors with the end frame which utilize eight brushes --

   a. Pull the armature out of the field frame just enough to permit the brushes to be positioned over
the commutator.

   b. Push the commutator end frame and armature back against the field frame.

5. On intermediate duty clutch motors, be sure to assemble all brushes to the brush arms so the long side of the brush is toward the commutator end frame (the brush holes are off-set). Otherwise, the brushes may contact the riser bars.

6. Be sure all wicks and oil reservoirs are saturated with SAE-10 oil and the splines were coated with a light coat of SAE-10 oil also. Lever housings having a bearing and seal should have the grease cavity be-tween the bearing and seal. filled with Delco-Remy Lubricant No. 1960954 or equivalent (Fig. 3 and Fig. 4).

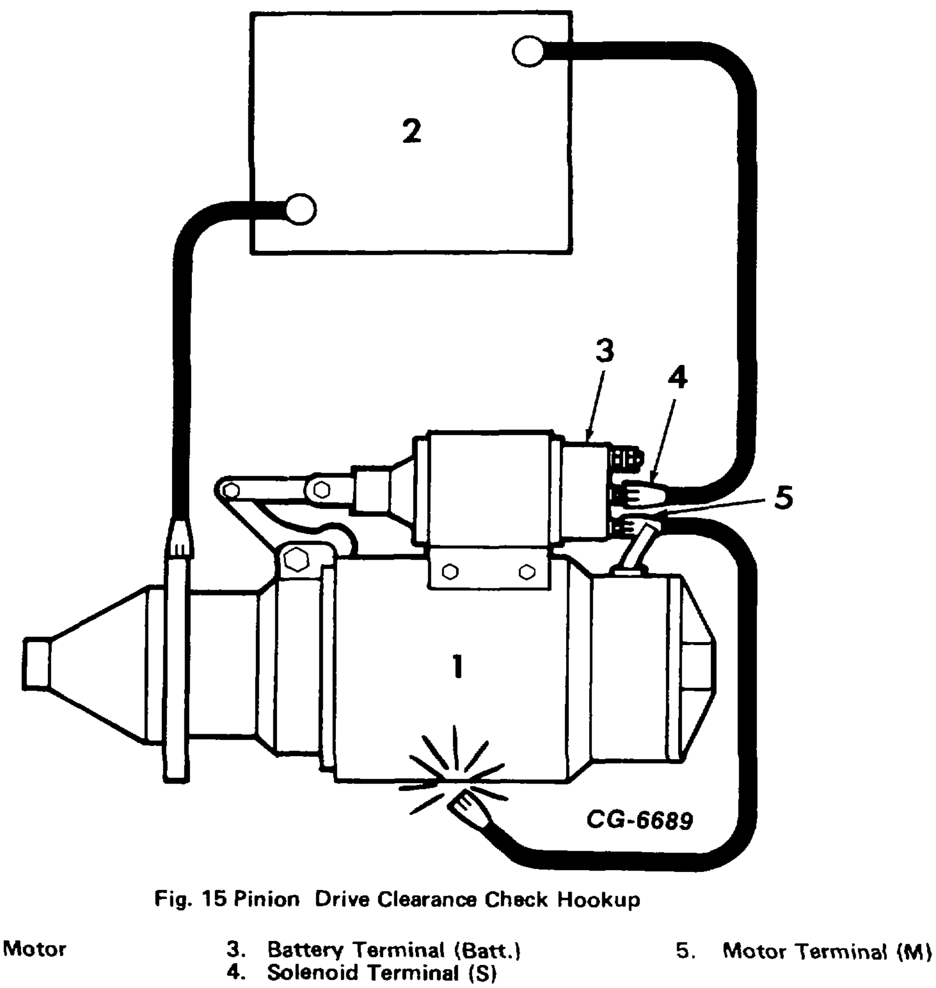


Fig. 15. Pinion Drive Clearance Check Hookup

PINION CLEARANCE

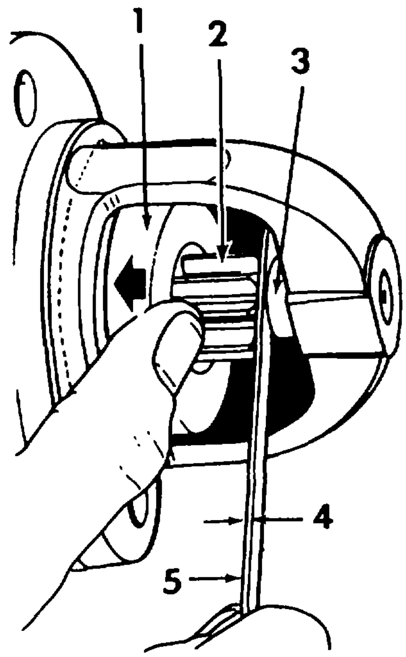
There are no provisions for adjusting the pinion clearance on motors using the intermediate duty clutch, Fig. 2. However, the pinion clearance should be checked on all motors after reassembly to insure proper clearance. Check the pinion clearance as follows:

1. Disconnect the motor field coil connector from the solenoid motor terminal. CAREFULLY INSULATE IT.

2. Connect a battery, of the same voltage as the solenoid, one lead to solenoid switch terminal and the other to the starter or solenoid frame, Fig. 15.

3. Connect a jumper wire to the starting motor terminal on the solenoid, then touch the second end to the motor frame. This will shift the pinion into cranking position and will remain until the battery is disconnected.

CAUTION: Do not keep the jumper wire connected too long as overheating of the solenoid may result.



CG-6690

Fig. 16 Checking Pinion Clearance on Motors with the Intermediate Duty Clutch

1. Press on clutch as shown to take up movement
2. Pinion
3. Retainer
4. .010" to .140" pinion clearance
5. Feeler gauge

Fig. 16. Checking Pinion Clearance on Motors with the Intermediate Duty Clutch

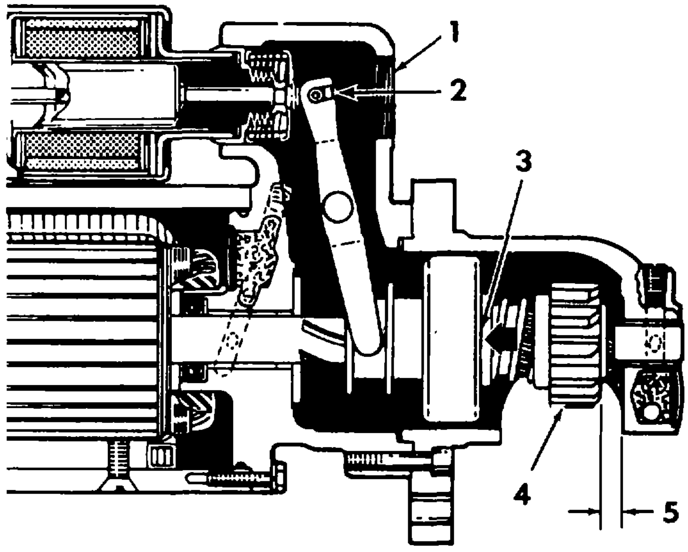
4. Push the pinion back towards the commutator end to eliminate any overtravel. Measure the distance between the pinion stop and pinion. The clearance should be:

   a. Intermediate Duty Clutch -- .010 to .140 inch, Fig. 16.

   b. Heavy Duty Clutch -- 23/64 inch, Fig. 16 and Fig. 17.

   c. Motors with Spline Drive -- .010 to .070 inch between spline and retainer.

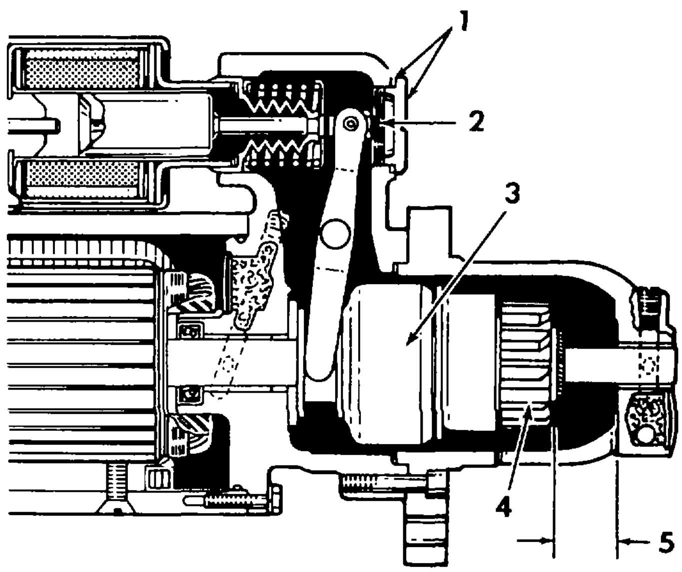
5. Clearance is adjusted by removing plug and gasket on rear housing and turning the adjustment nut, Fig. 17 and Fig. 18.



CG-6691

Fig. 17. Checking Pinion Clearance on Motors with the heavy Duty Sprag Clutch

1. Plug removed
2. Shaft nut (turn to adjust pinion clearance)
3. Press on clutch to take up movement
4. Pinion
5. Pinion clearance 23/64"



CG-6692

Fig. 18 Checking Pinion Clearance on Motors with DR-250 Drive

1. Remove plug & gasket
2. Shaft nut (turn to adjust pinion clearance)
3. Press on clutch to take up movement.
4. Pinion
5. Pinion clearance 23/64"

Fig. 18. Checking Pinion Clearance on Motors with DR-250 Drive

SPECIFICATIONS

Model Numbers	System Voltage	NO LOAD TEST				
		Volts	Amperes *		RPM	
			Minimum	Maximum	Minimum	Maximum
11109630 11109646 11109989	24	20	95	120	5500	7500
1113167 1113172 1113183 1113217 1113218 1113245	12	9	50	70	3500	5500
1113491 1113626 1113644 1113650 1113655	12	9	75	105	5000	7000
1113820 1113846 1113887 1113914 1113969	24	20	75	95	5500	7500
1114052	12	9	120	150	3000	4500
1114058	12	9	140	190	4000	7000
1114064 1114066	12	9	120	150	3000	4500
1114070	12	9	140	190	4000	7000
1114071	12	9	120	150	3000	4500
1114074 1114076	12	9	140	190	4000	7000
1114085	12	9	120	150	3000	4500
1114088	12	9	140	190	4000	7000
1114089	12	9	105	135	3000	4500
1114098	12	9	140	190	4000	7000
1114101	12	9	120	150	3000	4500
1114102	12	9	140	190	4000	7000
1114107 1114112	12	9	120	150	3000	4500
1114113	12	9	140	190	4000	7000

* Includes Solenoid

Model Numbers	System Voltage	NO LOAD TEST				
		Volts	Amperes* Minimum	Amperes* Maximum	RPM Minimum	RPM Maximum
1114116	12	9	120	150	3000	4500
1114120	12	9	140	190	4000	7000
1114122	12	9	120	150	3000	4500
1114127 1114128 1114134 1114145 1114161 1114165	12	9	140	190	4000	7000
1114168	12	9	120	150	3000	4500
1114171 1114176	12	9	140	190	4000	7000
1114180 1114187 1114189 1114196	12	9	120	150	3000	4500
1114194 1114197 1114734	12	9	140	190	4000	7000
508702C91	12	9	130	160	5000	7000

FRONT END SHEET METAL

CONTENTS

Subject	CTS No.

NOTE: Refer to Group 16 for Front End Sheet Metal.

SERVICE MANUAL

LUBRICATION

CONTENTS

LUBRICATION

Replace old Section with this revised Section in your CTS-4001 Manual

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

GENERAL

New vehicles are lubricated before they are delivered. After the vehicle is placed in operation, regular lubrication intervals, based on the type of service and road conditions, should be established. Thorough lubrication at definite intervals will add to the Low Cost of Ownership (LCO) and will reduce the overall operating expense.

The interval between lubrication periods, oil changes, etc., depends entirely upon operating conditions. The loads carried, speed, road and weather conditions all contribute to the frequency of lubrication periods. In some types of operation, and where operating conditions are extremely severe (such as in deep water, mud, or unusually dusty conditions), the vehicle may require lubrication after every twenty-four (24) hours of operation.

Only lubricants of the best quality ., having proper body or viscosity, should be use, The use of inferior products will reduce the service life of the vehicle or result in failure of its components.

The lubrication specifications refer only to the viscosity (SAE) and type to be applied. The viscosity numbers have been adopted by the Society of Automotive Engineers to classify lubricants according to "body" or 'thickness" and do not cover any other properties.

Unless otherwise specified, never add lubricant unless it is the same grade as that which is already in use. If the grade is unknown or not available, drain flush and refill with new lubricant.

The Lubrication Intervals specified should be performed at whatever interval occurs first, whether it is months or miles (kilometers).

ENGINE OIL

Keep oil level as near the high level mark as possible.
Never operate an engine with oil level below low level mark.

When checking the oil level, the dipstick must be withdrawn and wiped clean, then inserted all the way and withdrawn again for a true reading.

Never check the oil level with the engine running or immediately after engine shutdown as an inaccurate reading will be obtained.

ENGINE OIL SPECIFICATIONS

OIL QUALITY

Oil quality is described by API (American Petroleum Institute) engine service categories. API categories are defined by oil performance (deposits and wear) measured in standardized engine tests. API "S" categories (SC, SE, SF) describe oils for spark ignition (gasoline) engines, while "C" categories (CC, CD) describe oils for diesel engines. Oils with both "S" and "C" categories (such as SF/CD) are suitable for both spark ignition and diesel engines. Sometimes, the "S" and "C" categories are reversed (such as CD/SF).

Oil quality is also described by two current U.S. Military Specifications, MIL-L-46152B and MIL-L-2104D. (MILL-2104D recently superseded MIL-L-2104C, which is now obsolete but which may still be widely used.)

The oil quality recommended depends upon engine type (diesel or spark ignition) and engine design. There are many supplementary fuel and oil additives for sale. If you follow the lubricant and oil-change interval recommendations, your engine will not require these additives.

NOTE

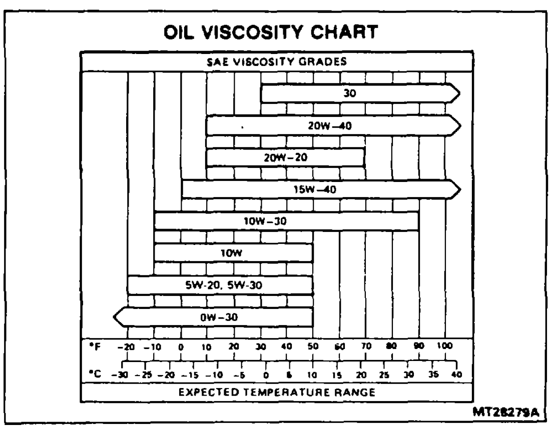
: Do NOT use oils specifically marketed by suppliers for stationary, marine, or railroad diesel engines, or for stationary natural gas engines, even though they are marked API category CD. Such oils can cause excessive valve train wear and combustion chamber deposits. (These oils are sold only In drums or bulk.)

DT/DTI-466C DIESEL ENGINES

Use oils meeting API categories CD, SC/CD, SE/CD, or SF/CD, or Military Specifications MIL-L-2104D or MILL-2104C. IH No. 1 Enqine Oil meets these requirements.

OIL VISCOSITY

Oil viscosity (thickness) is described by SAE (Society of Automotive Engineers) Viscosity Grade. Colder temperatures require lower viscosity oils to ensure good flow during starting, while hotter temperatures require higher viscosity oils for satisfactory lubrication. Based upon the temperature range you expect before your next oil change, use oil viscosity chart and the notes below to choose the proper viscosity grade. Using other viscosity grades, or using viscosity grades at temperatures outside the recommended ranges could result in engine damage.



NOTES:

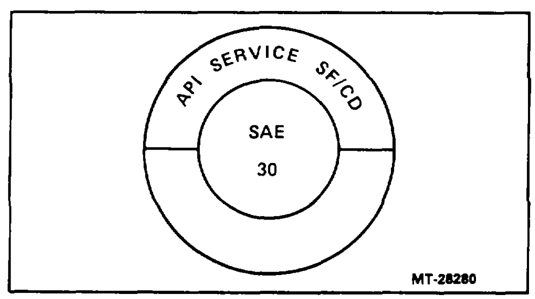
1. SAE 15W-40 IS THE PREFERRED VISCOSITY GRADE FOR 6.9L DIESEL ENGINES FOR ALL OPERATING CONDITIONS WHERE THE TEMPERATURE WILL NOT BE COLDER THAN - 1C (+ 30°F).
2. SOME INCREASE IN OIL CONSUMPTION MAY BE EX- PECTED WHEN SAE OW-30, 5W-20, 5W-30, 10W, 10W-30 AND 1 W-40 OILS ARE USED. CHECK OIL LEVELS MORE FREOUENTLY.
3. SAE 5W-20 OILS ARE NOT RECOMMENDED FOR CONTINUOUS HIGH SPEED OPERATION.

ENERGY CONSERVING OILS

Oils marketed as "Energy Conserving" are intended to improve fuel economy in passenger car engines. Some of these oils contain friction modifier chemical additives. One additive, molybdenum dithiophosphate, has been implicated in copper corrosion problems in some heavy duty diesel engines. Therefore, until further information is available, do not use an "Energy Conserving" oil containing molybdenum dithiophosphate in any IH-built engine. In addition, some "Energy Conserving" oils meet only API category SF for spark ignition engines, and do not meet the oil quality requirements for diesel engines.

OIL IDENTIFICATION SYMBOL

An oil container symbol system has been developed to help you choose the proper oil. The top portion of the symbol shows the oil quality, such as API Service SF/ CD in the example. The symbol may show additional categories, such as API Service SE, SF/CC, CD. The center portion will probably show the SAE viscosity grade, such as SAE 30 in the example. If the lower portion shows "Energy Conserving," be sure the upper and center portions show correct API service category and proper SAE viscosity grade recommended for your engine.



CRANKCASE OIL SPECIFICATIONS

For specific information on most commercial oil brand names, write for the booklet entitled:

"LUBRICATING OIL DATA BOOK FOR HEAVY-DUTY AUTOMOTIVE AND INDUSTRIAL ENGINES"
Engine Manufacturers Association
111 East Wacker Drive
Chicago, Illinois 60601
(312) 644-6610

ENGINE MAINTENANCE SCHEDULE CHARTS
DT/DTI 466 ENGINES

Maintenance Operation①	Inspection Interval						
	Daily	Every 9 600 km, 6,000 Miles, 200 Hours or 3 Months	Every 19 200 km, 12,000 Miles, 400 Hours or 6 Months	Every 48 280 km, 30,000 Miles, 1,000 Hours or 12 Months	Every 144 841 km, 90,000 Miles, 3,000 Hours or 24 Months	Every 241 500 to 322 000 km, 150,000 to 200,000 Miles, or 5000 to 6700 Hours	Annually
Inspect Coolant and Oil Levels	X						
Inspect Low Oil Pressure Alarm②	X						
Inspect for External Leakage	X						
Inspect Air Restriction Indicator③	X						
Drain Water Separator (Fuel System)	X						
Change Engine Oil and Filters⑤		X					
Inspect Throttle Linkage		X					
Measure Low and High Idle⑥		X					
Inspect and Adjust Belts		X					
Inspect Air Intake Piping		X					
Inspect High Temperature Coolant Alarm②							
Measure Air Intake Restriction③⑥			X				
Change Fuel Filters			X				
Inspect Vibration Damper⑦				X			
Measure Crankcase Pressure⑥				X			
Pressurize Induction System⑥				X			
Clean Crankcase Breather				X			
Measure Nozzle Opening Pressure and Spray Pattern⑥						X	
Adjust Valve Lash⑥ or ⑦					X		
Measure Intake Manifold Pressure⑥					X		
Inspect Turbo-Charger						X	
Service Cooling System and Cooling System Filter							X
Inspect Thermostat							X
Inspect Electrical System							X

① Correct if necessary.
② If equipped.
③ Service air cleaner elements as required.
④ Or change according to transfer pump pressure minimum specifications.
⑤ If fuel contains more than 0.5 percent sulfur, reduce oil change intervals as follows:
⑥ Refer to Diesel Engine Diagnostic Manual CGES-240.
⑦ Refer to 400 Series Engine Service Manual CGES-185.
⑧ Refer to DT/DTI 466 Engine Operation Manual (1171585R1).

Sulfur Content, Percent	Oil-Change Interval
Below 0.5	Normal
0.5 to 1.0	1/2 Normal
Above 1.0	1/4 Normal

COOLING SYSTEM

ANTI-FREEZE

The cooling system of your new vehicle is filled at the factory with IH permanent-type anti-freeze. IH permanent-type anti-freeze may be added undiluted if protection below -290C (200F) is required.

CLEANING

Once a year the cooling system should be drained and thoroughly flushed.

Unless the cooling system is treated with a corrosion preventative, rust and scale will eventually clog up passages in the radiator and water jackets. This condition is aggravated in some localities by formation of insoluble salts from the water used.

IH cleaning solutions are available which have proven very successful in removing accumulation of rust, scale, sludge and grease. This solution should be used according to the recommendation on the container.

CAUTION
DO NOT USE CHEMICAL MIXTURES TO STOP RADIATOR LEAKS EXCEPT IN AN EMERGENCY. NEVER USE SUCH SOLUTIONS INSTEAD OF NEEDED RADIATOR REPAIR.

When draining the cooling solution, disconnect the radiator outlet hose, as large particles of sediment will not pass through the drain.

WARNING
USE ONLY THE FOLLOWING PROCEDURE TO REMOVE THE PRESSURE TYPE CAP FROM THE RADIATOR. ALWAYS ALLOW THE ENGINE TO COOL FIRST. WRAP A THICK, HEAVY CLOTH AROUND THE CAP. PUSH DOWN, LOOSEN CAP SLOWLY TO ITS FIRST NOTCH POSITION; THEN PAUSE A MOMENT. THIS WILL AVOID POSSIBLE SCALDING BY HOT WATER OR STEAM. CONTINUE TO TURN CAP TO THE LEFT AND REMOVE.

CAUTION
IF THE COOLANT SHOULD GET EXTREMELY LOW AND THE ENGINE VERY HOT, LET THE ENGINE COOL FOR APPROXIMATELY 15 MINUTES BEFORE ADDING COOLANT; THEN, WITH THE ENGINE RUNNING, ADD COOLANT SLOWLY. ADDING COLD WATER TO A HOT ENGINE MAY CRACK THE CYLINDER HEAD OR CRANKCASE.

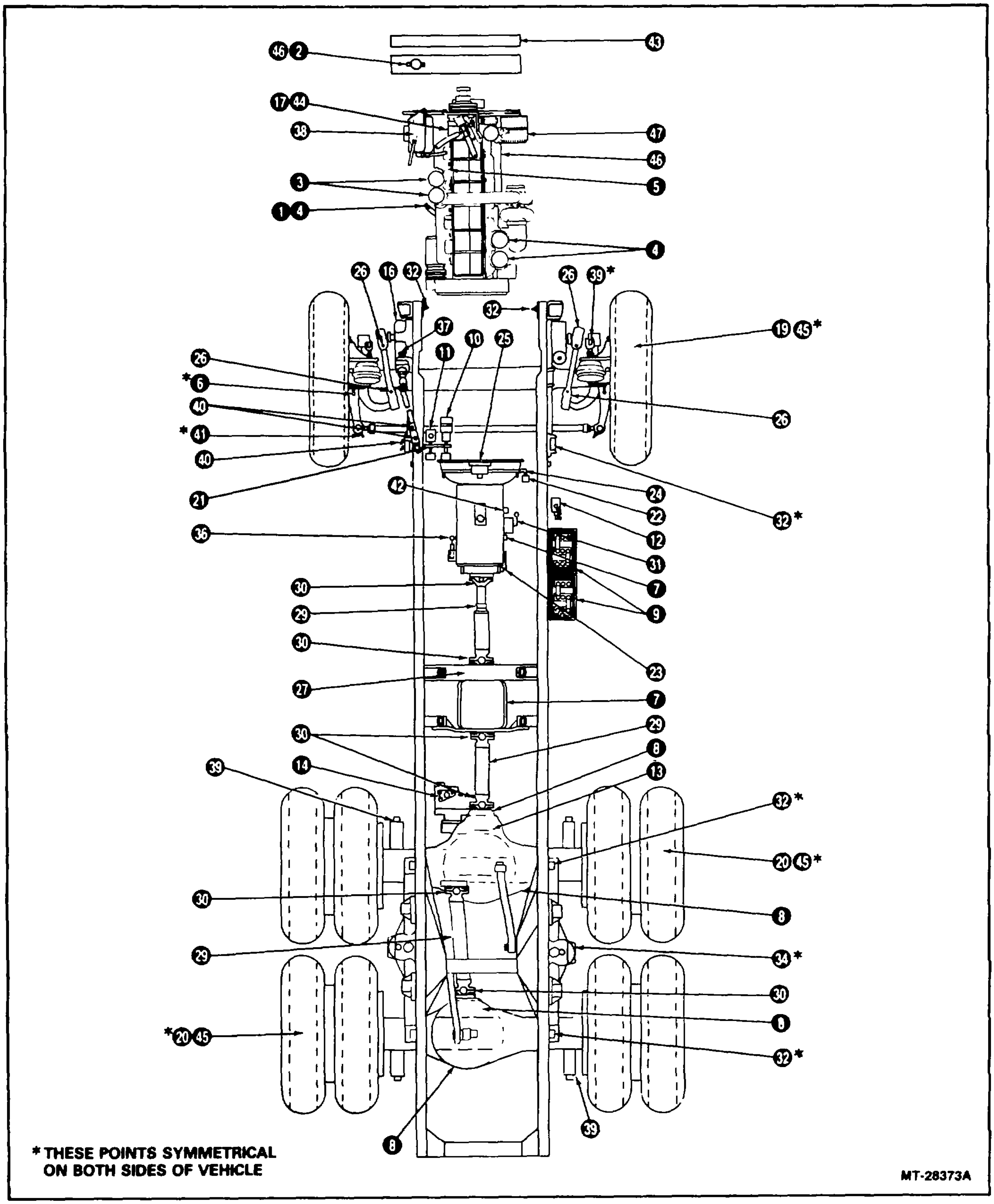


Figure 1 - Lubrication Points - Typical 6x4 Vehicle with Single Rear Axle Options Illustrated

LUBRICATION - MAINTENANCE GUIDE INTERVALS

KEY NO.	DESCRIPTION	OPERATION	USE OR REMARKS①
DAILY INSPECTION			
1	Engine Crankcase Level Change Interval	Check and Correct	A Refer to Engine Oil Specifications and Engine Maintenance Charts
2	Coolant Level	Check and Correct on each Fuel Stop	Refer to Cooling System in this Section
NI	Low Oil Pressure Alarm	Correct as Necessary	Refer to Engine Oil Specifications
NI	External Leakage	Correct as Necessary	
NI	Air Cleaner Restriction Indicator	Correct as Necessary	B
3	Fuel/Water Separator	Drain and Replace Element as Necessary	
AS REQUIRED			
NI	Air Cleaner (Engine)	Clean or Replace	B
NI	Speedometer, Tachometer Cable	Lubricate	IH251 H EP Grease or equivalent NLGI #2 Multi-purpose Lithium Grease. (Electronic Speedometer or Tachometer Not Required)
NI	Speedometer, Tachometer Head	Lubricate	Light Weight Oil (Not Required w/ Electronic Speedometer or Tachometer)
3	Fuel Filters	Replace	Refer to Engine Maintenance Charts found in this Manual or Separate Engine Supplements.
4	Engine Oil Filter	Replace	
5	Throttle Linkage	Lubricate	Light Engine Oil
6	Trunnion Bearing and Axle Shaft U-Joint-Dana Axles	Lubricate	O
10	Brake Pedal Linkage Clevis & Pins (Cargostar)	Lubricate	Mobil SHC32 Lubricant or Equivalent.
14	Two Speed Axle (Electronic)	Lubricate	P Lube at overhaul or Motor Replacement
NI	Seat Adjuster Slides		IH251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease.
NI	Manifold Heat Control Valve	Lubricate	Penetrating Oil
1.000 MILES OR 1600 KILOMETERS			
6	Steering Knuckles and U-Joints FABCO Axles	Lubricate	O
7	Transmission (Clark)	Change Initial Fill Lubricant	I
8	Differential Rockwell	Change Initial Fill Lubricant	C Not to exceed 3,000 miles or 5000 kilometers
4.000 MILES. 6000 KILOMETERS OR MONTHLY			
7	Transmission Main & Aux Fuller Spicer	Change Initial Fill	Mileage Interval Only. J K
8	Differential (Front or Rear Axles) Dana Eaton	Change Initial Fill	Mileage Interval Only. Q C
8	Differential (Front or Rear Axles)	Check Level and Correct as Required	C, Q
9	Battery (With Caps)	Check Water Level	Distilled Water
9	Battery Posts	Clean	Grease After Cleaning
10	Brake Master Cylinder S-Series, Cargostar	Check Level and Correct as Required	Super Heavy Duty "DOT 3" Brake Fluid.
11	Clutch Master Cylinder Cargostar and RH Drive S-Series		

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①Letters indicate additional requirements of Special Instructions following this chart.

LUBRICATION - MAINTENANCE GUIDE INTERVALS

KEY NO.	DESCRIPTION	OPERATION	USE OR REMARKS①
4,000 MILES, 6000 KILOMETERS OR MONTHLY (CONTINUED)			
12	Cab Hydraulic Lift Pump	Check Level and Correct as Required	
	Cargostar		MIL H-5606B Hydraulic Fluid
	CO-9670, CO-5870		Dexron II*
13	Power Divider Shift Motors	Check Level and Correct as Required	E
14	Two Speed Axle Shift Motor Air	Check Level and Correct as Required	E
15	Transmission Remote Control Housing Cargostar	Check Level and Correct as Required	SAE 10W30 Engine Oil
16	Steering Gear (Manual): Ross & Gemmer	Check Level and Correct as Required	SAE 85W-150 Gear Lubricant or SAE-90 SP Type Lubricant Meeting MIL-L-2105C Class
	Saginaw	Check Level and Correct as Required	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
17	Power Steering Pump	Check Level and Correct as Required	F
	Hydraulic Brake Booster Pump (w/o P.S.)		
18	Transfer Case	Check Level and Correct as Required	H
7	Transmissions	Check Level and Correct as Required	
	Automatic		M
	Clark		I
	New Process		H
	Fuller (Main and Aux.)		J
	Spicer (Main and Aux.)		K
19	Wheel Bearings (Oil) Front	Check Level and Correct as Required	C, Q or SAE 30 Engine Oil
20	Wheel Bearings (Oil) Rear	Check Level and Correct as Required	C, Q
NI	Cab Latch Pivot Pins Cargostar, CO9670 & CO5870	Lubricate	Light Weight Engine Oil
21	Clutch Pedal Linkage	Lubricate	Light Weight Engine Oil
22	Clutch Slave Cylinder Yoke Pin Cargostar, RH Drive S-Series	Lubricate	Light Weight Engine Oil
23	Parking Brake Linkage S-Series, Cargostar	Lubricate	Light Weight Engine Oil
NI	Door Check, Hinges, Latches, Strikers, S-Series, Cargostar	Lubricate	Light Weight Engine Oil
NI	Hood Linkage	Lubricate	Light Weight Engine Oil
NI	Cab Latch and Lock Levers, Cargostar, CO9670 & CO5870	Lubricate	Mobil SHC 32 Low Temp Lubricant or Equivalent
24	Clutch Relay and Release Fork Shaft	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
25	Clutch Release Sleeve, Bearing, Fork	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
NI	Clutch Pedal Shoulder Bolt Cargostar	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
NI	Clutch Control Cable	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
26	Drag Link Cargostar S-Series	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
NI	Hood Tilt Linkage	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
NI	Power Divider Lock Yoke Pin	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
27	Prop Shaft Center Bearing	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease

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LUBRICATION - MAINTENANCE GUIDE INTERVALS

KEY NO.	DESCRIPTION	OPERATION	USE OR REMARKS①
4,000 MILES, 6000 KILOMETERS OR MONTHLY (CONTINUED)			
28	Parking Brake Relay Lever	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
29	Prop Shaft Slip Joint	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
30	Prop Shaft U-Joint	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
31	Power Take Off Shift Control	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
32	Spring Pins	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
33	Steering Gear Relay Lever Cargostar	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
34	Suspension Connecting Tube Bearing	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
35	Transfer Case Shift Linkage	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
15	Transmission Control Rods, U-Joint Cargostar	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
NI	Transmission Control Rods CO9670, CO5870	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
36	Transmission Air Cylinder Linkage	Lubricate	E
12,000 MILES, 19 000 KILOMETERS OR 3 MONTHS			
37	Steering Gear Input Shaft Bearing Cap (Sheppard)	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease lubricated with low pressure to flush out any contaminants which may have passed the seals
7	Transmission New Process	Change	H 6 months
	Transmission (Spicer) Main and Aux. (No monthly interval)	Change	K After Initial Lubricant Change
NI	Water Filter (5 months)	Replace	
16,000 MILES, 26 000 KILOMETERS OR 5 MONTHS			
38	Air Cleaner (Air Compressor)	Clean or Replace	
26	Drag Link 9370, CO9670, CO5870, 5000	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
39	Brake Camshafts and Manual Slack Adjusters	Lubricate	
6	Steering Knuckles Non-Drive Axle	Lubricate	G IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
	Steering Knuckle & Bearings, Steering U-Joints & Outer Drive Shaft Seals (Rockwell Driving Axles)	Lubricate	O IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
40	Steering Column U-Joints, Slip Joint	Lubricate	
41	Tie Rod Ends	Lubricate	N IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
NI	Door Check, Hinges, Latches, Strikers 9370, CO9670, CO5870	Lubricate	Light Weight Engine Oil
42	Transmission Air and Oil Filter	Replace	
18	Transfer Case	Change Lubricant	H
7	Transmission (Automatic)	Change Lubricant	M

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LUBRICATION - MAINTENANCE GUIDE INTERVALS

KEY NO.	DESCRIPTION	OPERATION	USE OR REMARKS①
20.000 MILES, 32 000 KILOMETERS OR MONTHLY			
43	Radiator Shutters	Lubricate	Automatic control radiator shutters vane bearings are to be coated with light duty or penetrating oil. Vehicles which have been in storage or out of service for any length of time are to have bearings lubricated prior to going back into service.
20.000 MILES, 32 000 KILOMETERS OR 20 MONTHS			
44	Power Steering Pump Filter Element	Replace	
24.000 MILES, 38 000 KILOMETERS OR 5 MONTHS			
39	Brake Automatic Slack Adjusters	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
40	Steering Column Flexible Coupling Cargostar	Lubricate	
NI	Brake Pedal to Brake Valve Linkage	Lubricate	Light Weight Engine Oil
7	Transmission (Clark)	Change Lubricant	I After Initial Fill Lubricant Change
32.000 MILES OR 51 000 KILOMETERS			
7	Transmission (Fuller) Main & Aux.	Change Lubricant	J After Initial Fill Lubricant Change
32.000 MILES, 51 000 KILOMETERS OR ANNUALLY			
45	Wheel Bearings (Grease)	Repack	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease
52.000 MILES, 84 000 KILOMETERS OR 6 MONTHS			
17	Steering Gear (Power) Sheppard	Change Lubricant	F
ANNUALLY, 96,000 MILES OR 154 000 KILOMETERS			
19	Wheel Bearings (Oil) Front	Change Lubricant	C or SAE 30 Engine Oil
20	Wheel Bearings (Oil) Rear	Change Lubricant	C
ANNUALLY, 100,000 MILES OR 160 000 KILOMETERS			
8	Differential (Front or Rear)	Change Lubricant	
	Dana		Q After Initial Change, Change Annually
	Eaton		C After Initial Change, Change Every 100,000 Miles (160 000 km) for Service on Class A or Better Roads. Changes More Often on Lower Class and Off-Road Service.
	Rockwell		C & D
NI	Door Lock Cylinders	Lubricate	Lock Oil
46	Cooling System and Cooling System Filter	Service Cooling System	Refer to Engine Operation and Maintenance Manual 9.0 Liter Engine 1171584R1 DT/DTI 466 Engine 1171585R1
OVERHAUL			
47	Alternator	Lubricate	Cam and Ball Bearing Lubricant (Delco-Remy #1948791)
NI	Brake Caliper & Anchor Plate	Lubricate	NLGI #1-1/2 (Part No. 990647CI)
NI	Brake Shoe Anchor Pins	Lubricate	IH 251 H EP Grease or Equivalent NLGI #2 Multi-Purpose Lithium Grease

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SPECIAL INSTRUCTIONS

A. For Engine Oil Specifications refer to Engine Oil Specifications in this Section

Recommended Engine Oil and Oil Filter Service Intervals will be located in operator's manual (Maintenance Charts)

B. Diesel Engines: When air restriction reading (in inches of water vacuum) reaches the following, clean or replace engine air cleaner. Refer to Restriction Gauge Instructions in operator's manual.

Engine	Inches of Water Vacuum
DT/DTI-466,	25 in. H20 or 635mm

Due to the many variables associated with element washing, only new air cleaner elements should be used to replace elements that have become restricted beyond the maximum recommended restriction level.

E. SAE-1OW Engine Oil for temperatures - 18°C (0°F) and up. For temperatures below - 18°C (0°F) use three parts SAE-10W engine oil to one part kerosene. The mixture can safely be used in temperatures up to 0°C (32°F).

F.

Ross Gears:

IH Power Steering Fluid (1 Quart Can No. 990625-CI). For S-Series 1600-2100.

G. **Lubrication Procedures:**
With chassis load on axle, force grease through thrust bearings. Then with axle lifted clear of floor, force grease between king pin and bushing surfaces. Use IH 251H EP grease.

Do not raise wheel end off ground when greasing.

H. Use straight mineral oil SAE 90 for temperatures - 18°C (0°F) and up. Use SAE 80 for temperatures below - 18°C (0°F). **Special Recommendations:** Where temperature is consistently below -18°C (0°F) and where parked vehicles are exposed to unusual cold for long periods, use SAE 75. Where temperatures are consistently above 320C (900F) or unusually hot, use SAE 140 straight mineral oil.

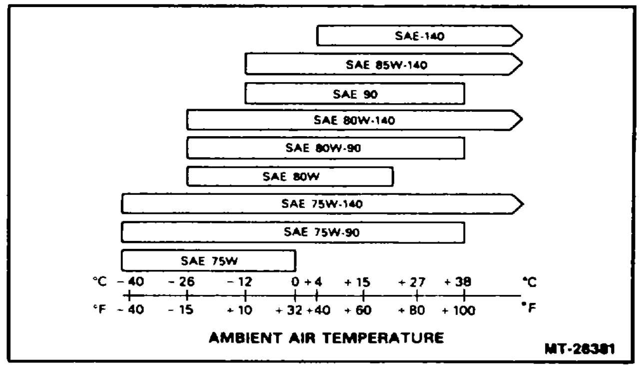
K Spicer

Engine Oil (SF, CC or CD)	SAE 30	Below -18°C (0°F)
	SAE 30, 40, 50	Above -18°C (0°F)
Mineral Oil (Rust and Oxidation Inhibited)	SAE 80	Below - 18°C (0°F)
	SAE 90	Above -18°C (0°F)

O.

FA83 (FABCO) Front Drive Axles Lubricate with IH 251H EP Grease. Lube steering knuckle bearings & steering U-Joints.

Q. Dana-Spicer axles use SP type lubricant of API GL 5 quality inspecting MIL-L-2105B, C or better specifications including synthetic lubricants. For abnormally high temperatures, severe service (hot climate prolonged periods), use SAE 140. Refer to table at right.



CLUTCH

CONTENTS

SERVICE MANUAL

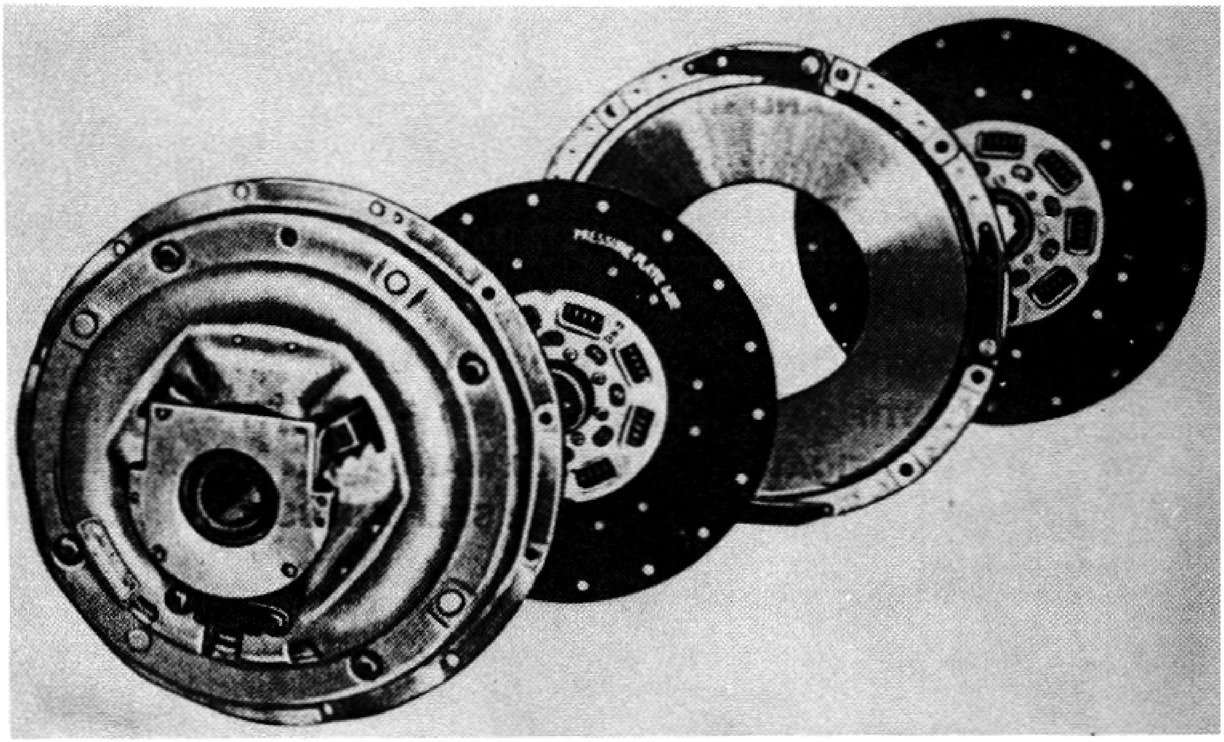
Insert this new Section in our CTS 4001 Service Manual.

CLUTCH

SPICER 14 INCH (355.6mm) STAMPED ANGLE SPRING SINGLE PLATE AND TWO-PLATE PULL TYPE CLUTCH

CODE 11369

CONTENTS



SAS-1402 TWO PLATE

The major components of the Spicer Stamped Angle-Spring Two-Plate Clutch are the cover assembly and two driven discs separated by an adapter ring and an Intermediate plate assembly.

DESCRIPTION

The stamped cover gives the clutch its strength and, combined with a flat flywheel, offers a lightweight package and low inertia. The strap drive concept reduces pounding and excessive wear The 14" stamped steel construction is tailored to mid-range engines having up to

torque capacity 800 lbs. ft.

with the two plate.

The SAS is a dry disc design

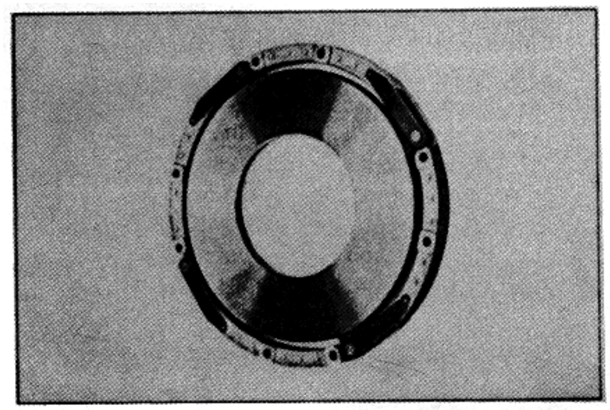
with centrally located springs located away from heat generated by the pressure plate.

In the 14-inch two-plate models the intermediate plate separating the driven discs is mounted on a flat flywheel.

The flywheel ring carries four drive straps to retract the pressure plate when the clutch is disengaged, and to provide quiet operation.

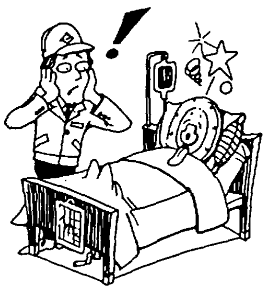
SPACER RING & INTERMEDIATE PLATE ASSEMBLY

The Stamped Angle-Spring two-plate clutch utilizes a unique spacer ring and intermediate plate assembly. The die cast aluminum spacer ring mounts to the flywheel. Four spring steel straps are used to drive the intermediate plate, eliminating drive lug wear and noise.



RECOMMENDED OPERATION AND MAINTENANCE FOR LONG CLUTCH LIFE

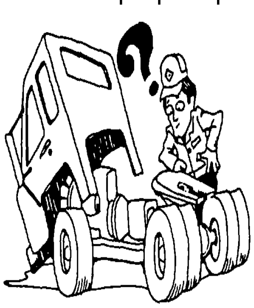
Spicer clutches will last many thousands of miles if properly installed, used and maintained They are designed and built to withstand rugged use But regardless of their strength and quality, their life will be shortened if they are abused. **EXCESS FRICTION HEAT, A CLUTCH'S WORST ENEMY. Almost** every early fairlure of a clutch can be traced to excess friction heat - all of which can be prevented by proper operation and maintenance. Here's how: Do not "ride or slip" the clutch. Once a clutch is fully engaged, there is no heat generated and little or no wear However, during the bref period when the clutch is picking up the load, considerable heat is generated By riding or slipping the clutch, the period of partial engagement is lengthened - causing unncessary heat and wear.



Always start in the proper gear. Obviously, an empty vehicle can be started In a higher gear than a fully loaded one But starting In a gear too high for the load can cause clutch slippage, too much heat and unnecessary wear. Drivers should be trained to use a gear low enough to prevent excess wear on the clutch. A gear that will start the vehicle moving with the engine at idle speed Is usually correct If the engine must be revved up to prevent stalling, the gear selection is too high

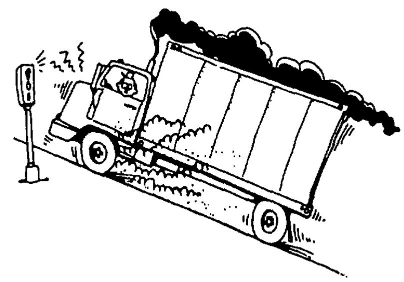
Do not shift until vehicle has reached proper speed. Upshifting before the vehicle has reached the right speed is almost as bad as starting off in too high a gear. When the difference between the vehicle speed and the engine speed is too great, the clutch is forced to slip. The result is extra heat and wear.

Match the clutch to the vehicle and the Job. Improper specification may result in a clutch too light duty for the job it must perform, resulting In early burn-out. It may be a perfectly good clutch when used in the application for which it was designed, but totally Inadequate for heavy duty use



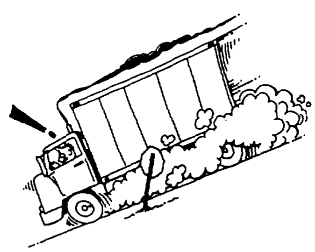
Mismatching the clutch to the vehicle is not only bad for the clutch, it can cause early wear on the whole drive train.

Never hold a vehicle on a hill with the clutch. To hold on a hill with the clutch requires that the clutch be purposely slipped. By doing this enough heat can be generated to burn up the clutch.



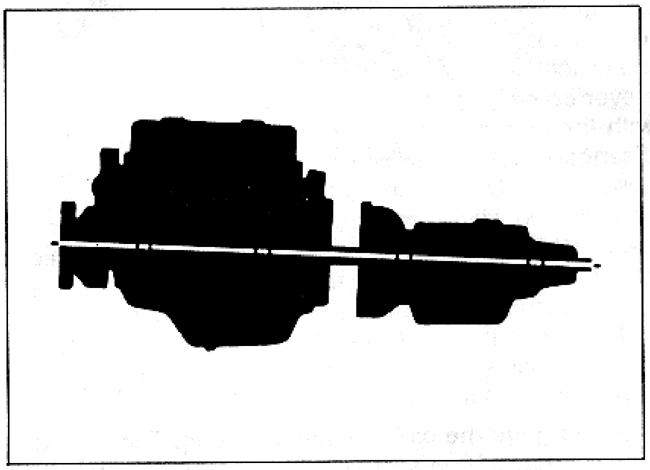
Never coast with the clutch disengaged. This can cause clutch failure by the very high RPM encountered when coasting in gear with the clutch released. In this situation, the rear wheels are driving the disc through the multiplication of the rear axle and transmission ratios. This can result in over 10,000 RPM, beyond the burst strength of the facing material. Something as simple as coasting down an unloading ramp can burst a driven disc.

Never engage the clutch while coasting. This should not even have to be said, since responsible drivers should never coast with clutch disengaged. Re-engaging a clutch after coasting causes tremendous shock to the clutch and the whole drive train. It can result in internal engine damage and/ or clutch and flywheel failure. **Always report unusual clutch operation promptly.**



Proper maintenance, performed on time, will greatly extend the life of the clutch. The driver should report any change in free pedal (free travel), slippage or any strange "feel" to the clutch operation.

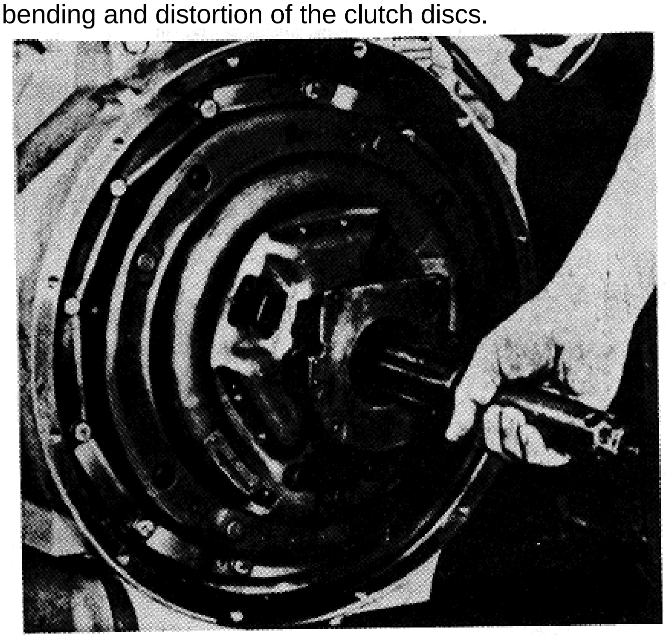
TRANSMISSION AND CLUTCH REMOVAL FOR SAS-1402 TWO PLATE



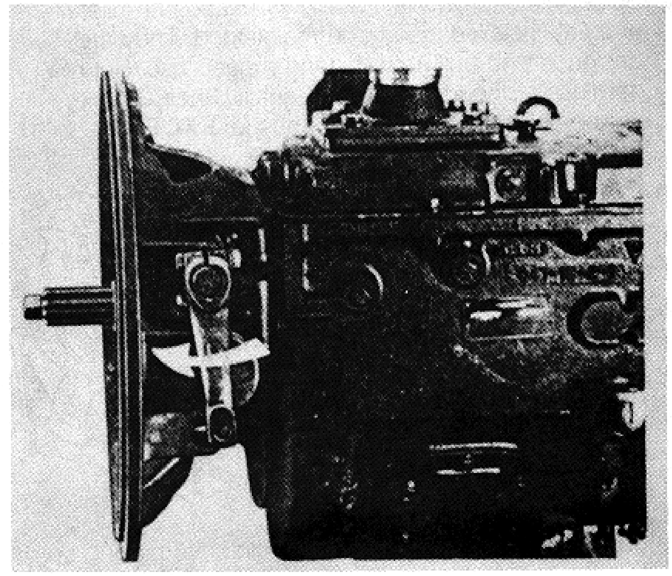
Spicer clutches should be replaced when adjustment cannot correct for a loss of free pedal or a slipping clutch.

TRANSMISSION REMOVAL

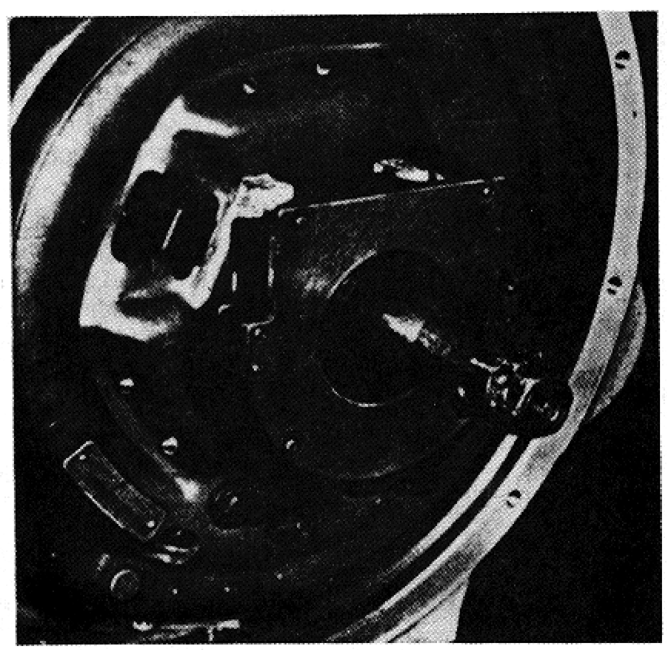
A sling or a jack supporting the transmission and drive shaft during removal helps maintain alignment. Do not let the rear of the transmission drop. or let the transmission hang unsupported in the splined hubs of the clutch discs Taking these precautions will prevent bending and distortion of the clutch discs.



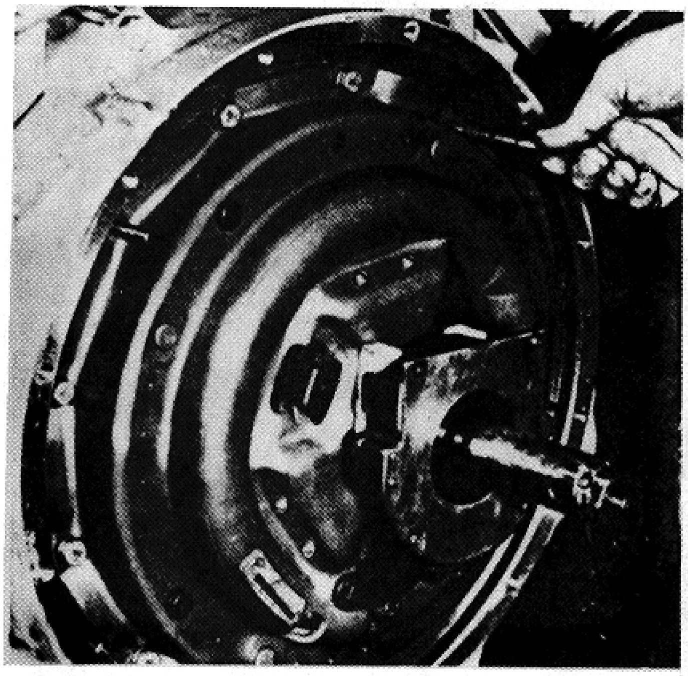
Install the spline aligning tool Into the release bearing assembly and driven discs, An old transmission Input shaft may be used for this purpose.



Disconnect the external clutch linkage before pulling the transmission free

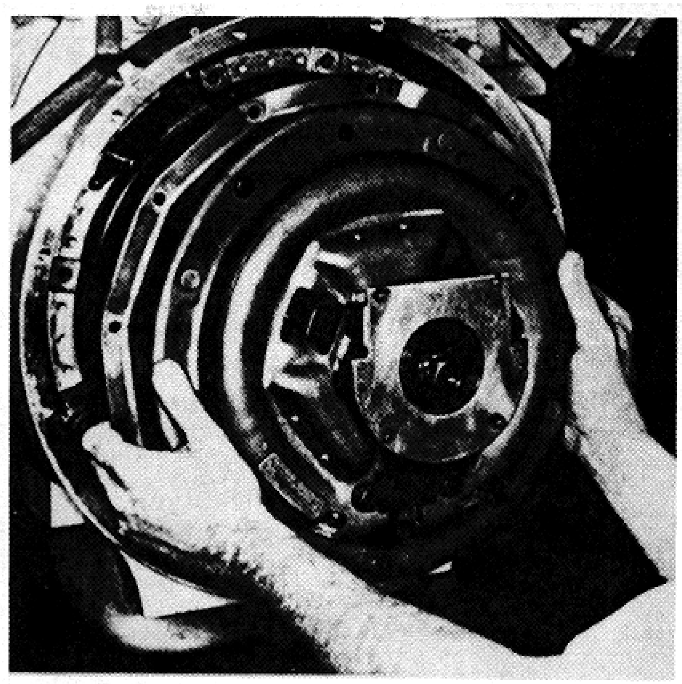


Insert two 5/8" spacers between the flywheel ring and the release bearing housing Spacers relieve the heavy internal spring load In the clutch assembly.

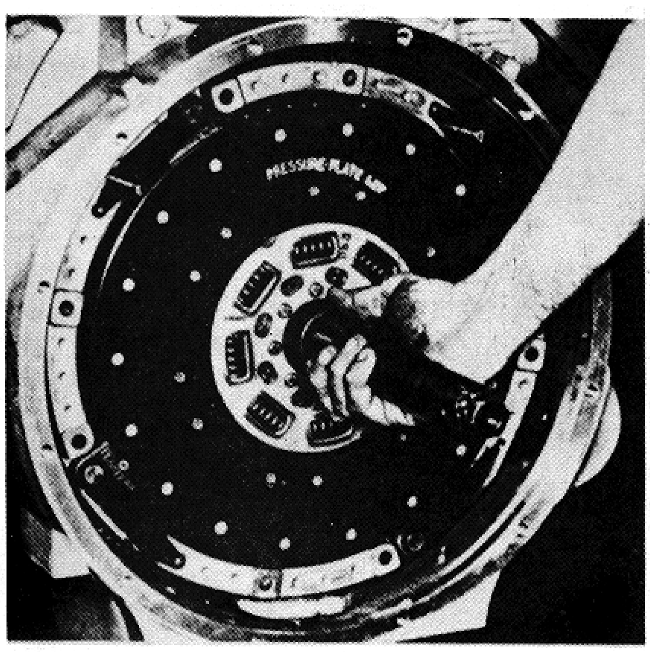


Loosen the mounting bolts around the flywheel in a criss-cross pattern to prevent cocking and bending of the clutch mounting bolts **Do Not Remove the Bolts.**

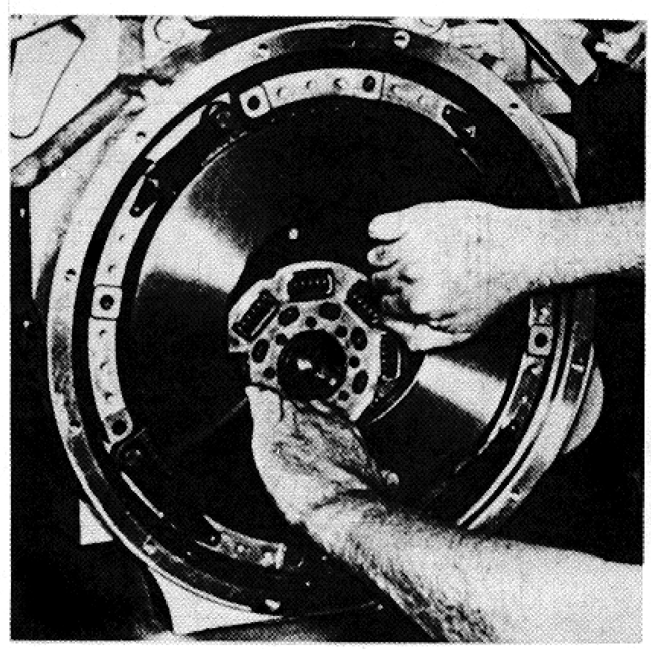
NOTE: *Because of the weight of a 14" clutch, the one piece adapter ring and the strap drive intermediate plate, Install two guide studs in the top mounting bolt holes to facilitate removal*



Now remove the mounting bolts and carefully remove the clutch assembly.



Remove the spline aligning tool and rear driven disc.



Remove the one-piece adapter ring and strap drive intermediate plate. Finally, remove the front driven disc.

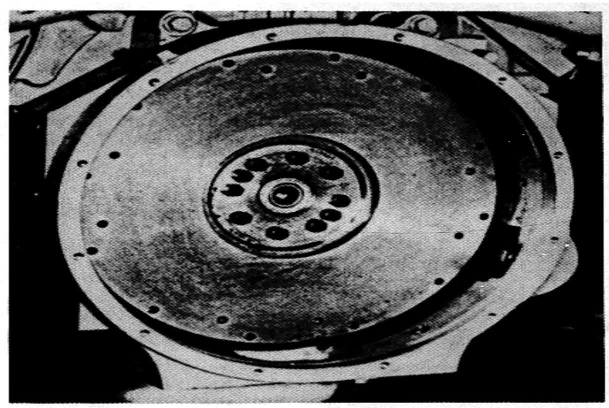
INSPECTION OF FLYWHEEL/ENGINE HOUSING

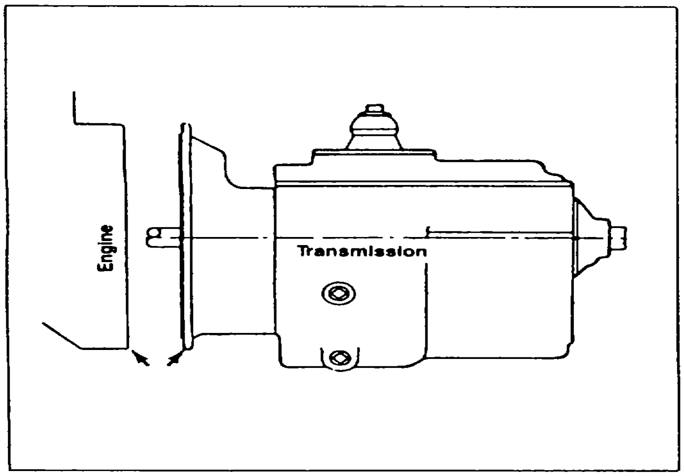
INSPECTION

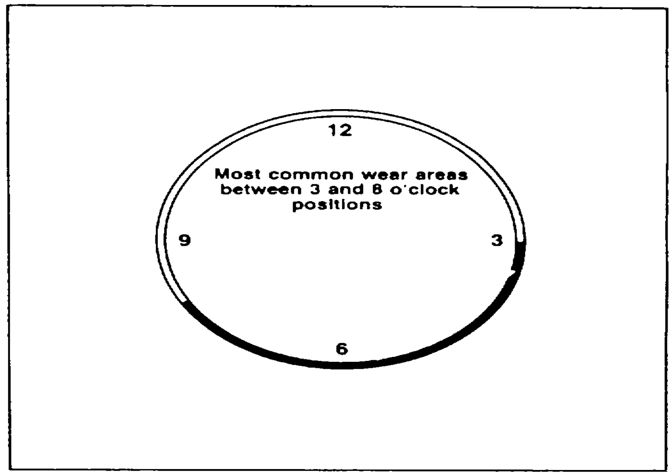
Inspect the flywheel. If it is heat checked or warped, refer to the engine manufacturer's recommendations for resurfacing or replacement.

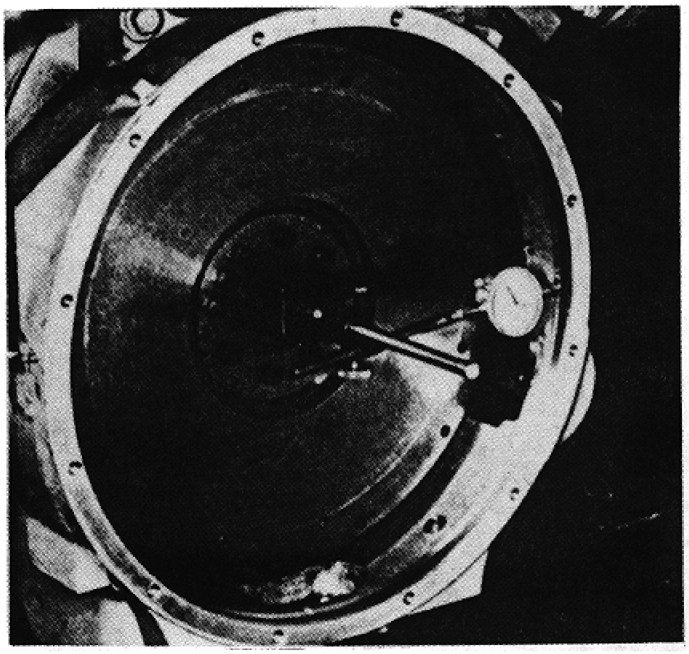
Inspect the mating faces of the transmission clutch housing and the engine flywheel housing. Any appreciable wear on either housing will cause misalignment Most wear is found on the lower half of the facings between the 3 and 8 o'clock positions.

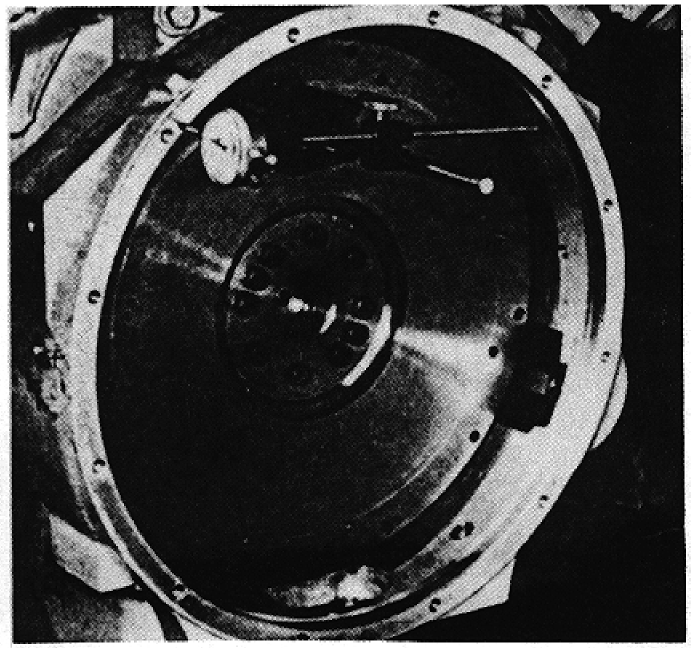
Replace housing if worn





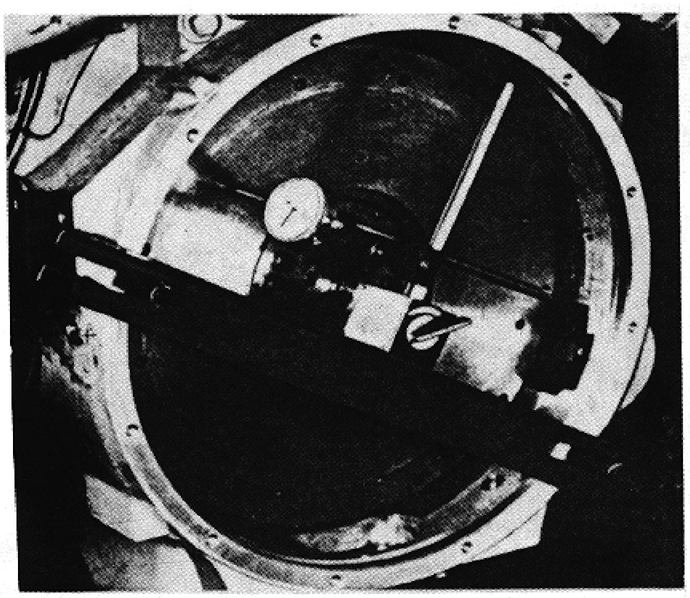


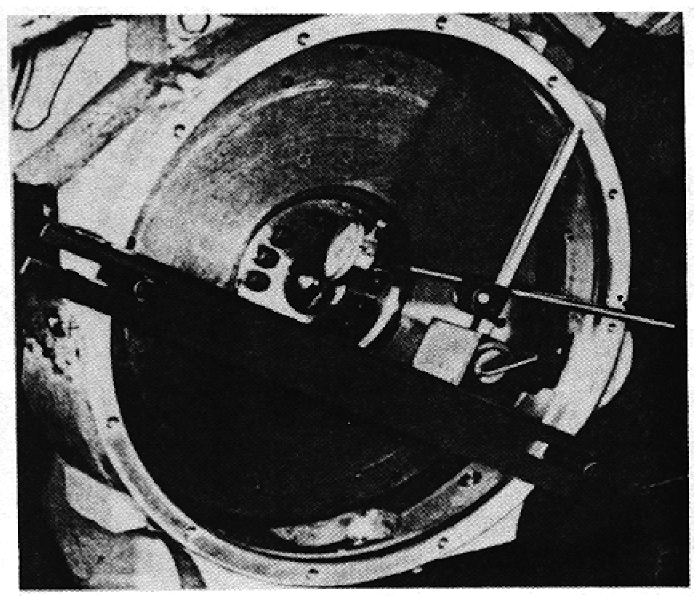




Secure the dial indicator to engine flywheel or crankshaft, and place the gauge finger against the housing pilot. Rotate the flywheel by hand, marking the high and low points with chalk or soapstone. Total indicated difference between high and low points must NOT EXCEED .008".

Now move the gauge finger to contact the face of the engine flywheel housing. Rotate the flywheel and mark high and low points. Total runout should not exceed 008".

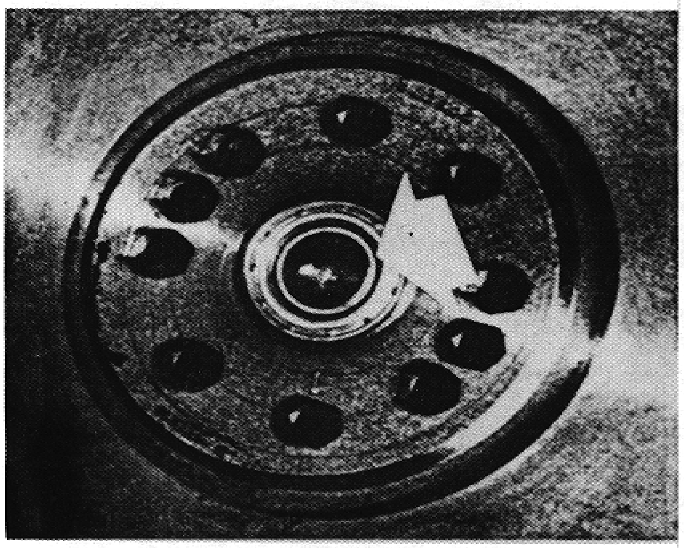




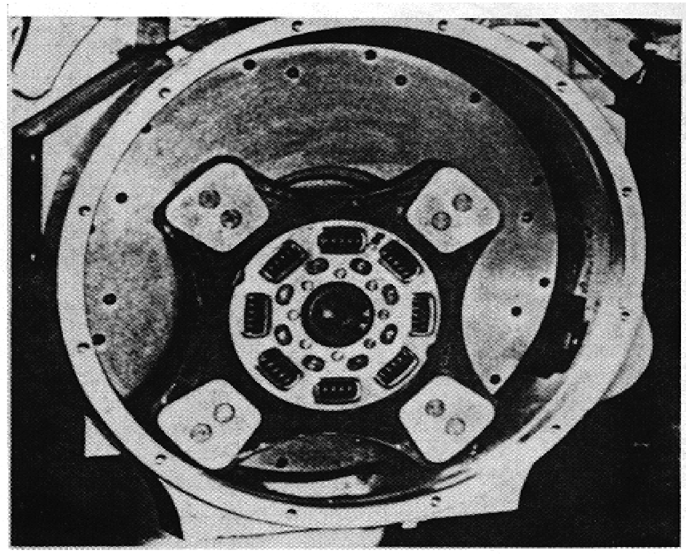
Next, secure the dial indicator to the engine flywheel housing with gauge finger on the face of the flywheel near the outer edge. Rotate flywheel. Maximum allowable runout is .0005" per inch of flywheel diameter. For example, 007" runout is allowable for a 14" clutch Now move the gauge finger to contact the pilot bearing bore surface. Rotate flywheel. Maximum allowable runout is .005".

Exceeding these limits causes misalignment. If not corrected misalignment causes premature wear of drive train components.

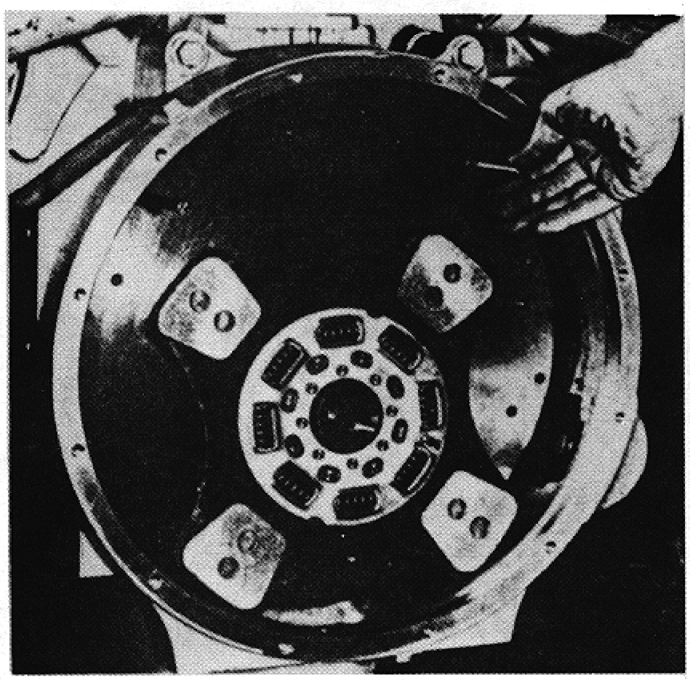
INSTALLATION OF SAS-1402 (Two Plate)

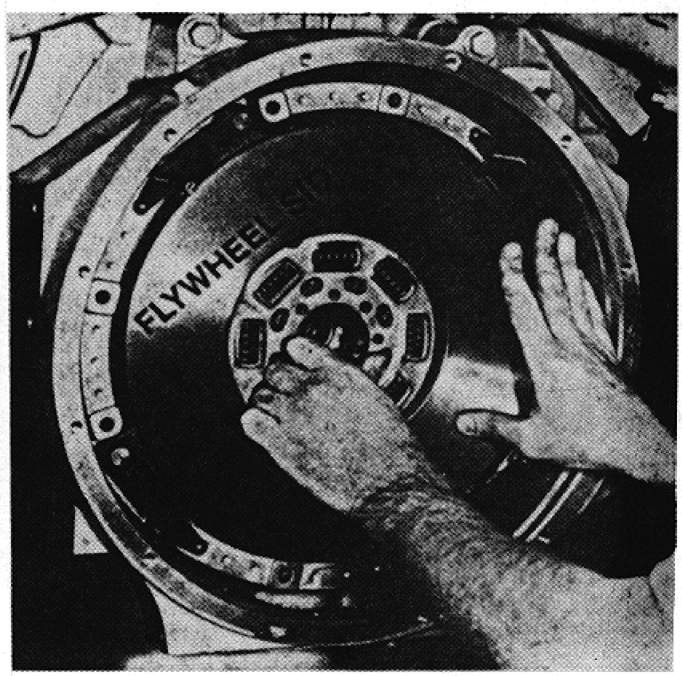


Replace the pilot bearing. The bearing must have a press fit.



Place the front disc In the engine housing with the side marked FLYWHEEL SIDE to the flywheel.

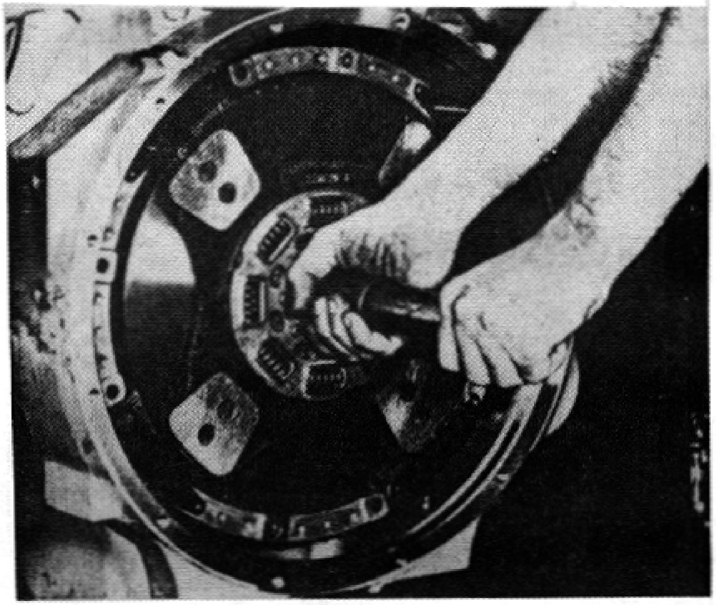




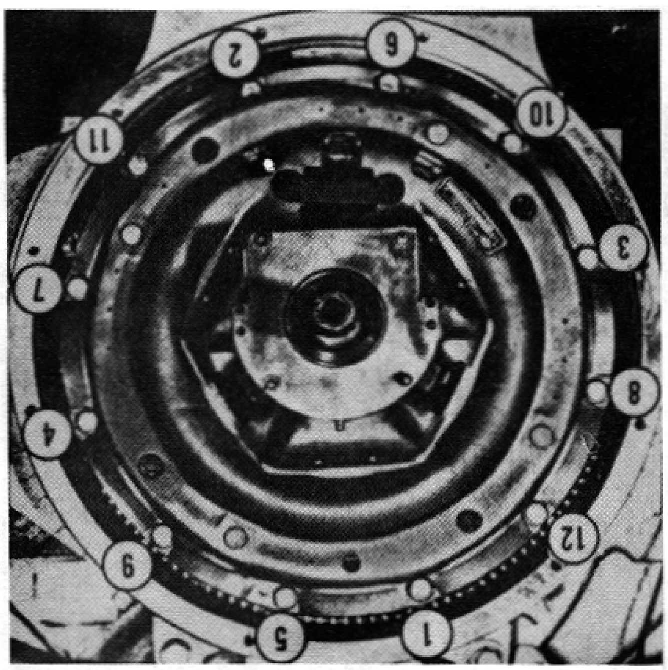
Install two guide studs, 3/8" x 16 thread, 3" long at the 11 and 1 o'clock positions.

Install the strap drive intermediate plate over the guide studs. The four through holes at the drive straps are the pilot holes for the adapter ring. Make sure the side marked **FLYWHEEL SIDE** faces the flywheel **(Drive Straps must Face Pressure Plate)** Raise the front disc to tit Into the intermediate plate opening

.



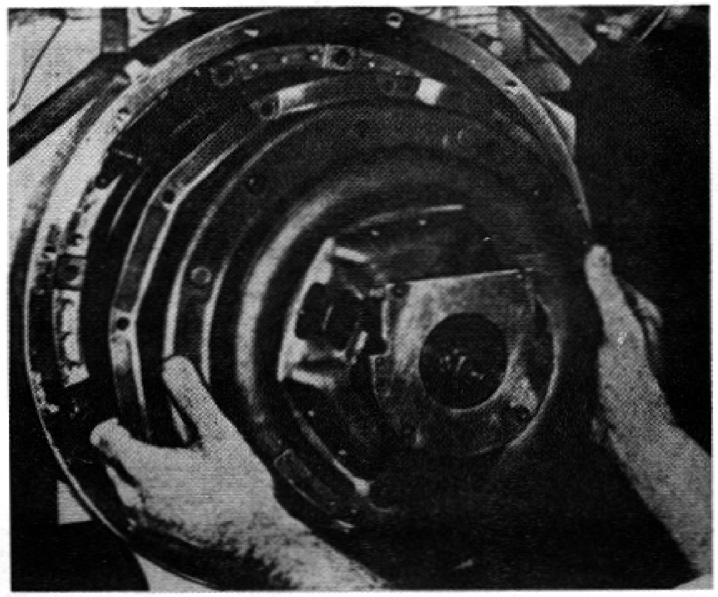
Install the rear disc by inserting the aligning tool through both splines and Into the pilot bearing. Make sure the rear disc marked **Pressure Plate Side** faces the pressure plate.



Install and hand tighten the cap screws and lockwashers according to the sequence shown, then tighten to 35-40 lbs ft.

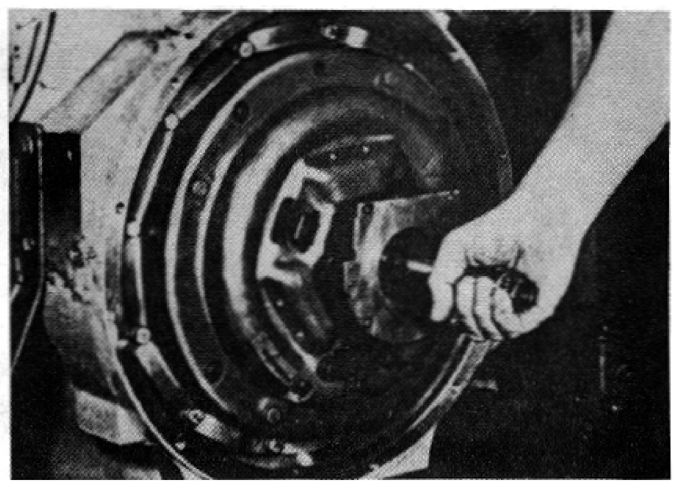
NOTE: Grade 8 cap screws should be used

Replace the two guide studs with two cap screws.
Tighten the cap screws to 35-40 lbs. ft

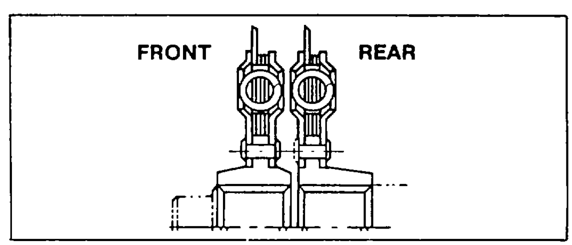


With the aligning tool still in place, carefully slide the clutch assembly over the aligning tool. Align the lock strap or self-adjuster with the access hole in the bell housing.

Slide the clutch assembly over the guide studs and against the spacer ring.

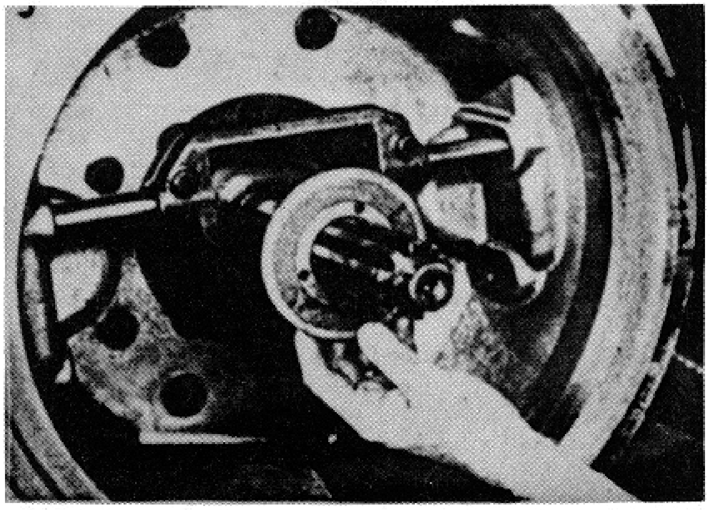


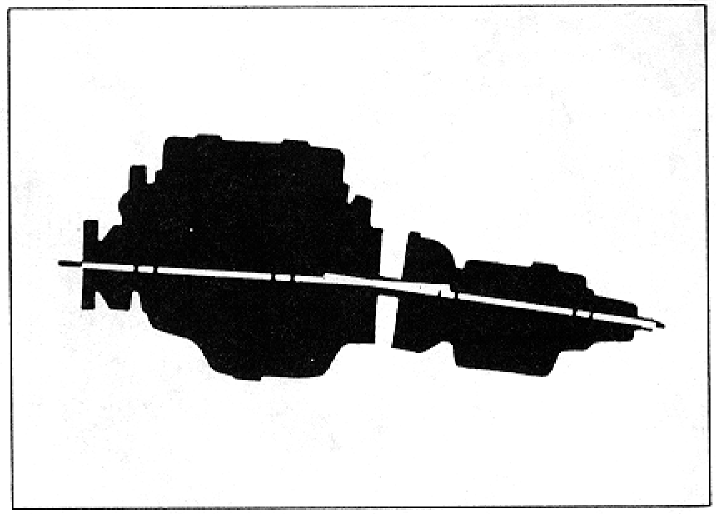
Remove the two wooden blocks from between the release bearing housing and flywheel ring. Remove aligning tool.



Driven disc positions.

TRANSMISSION INSTALLATION





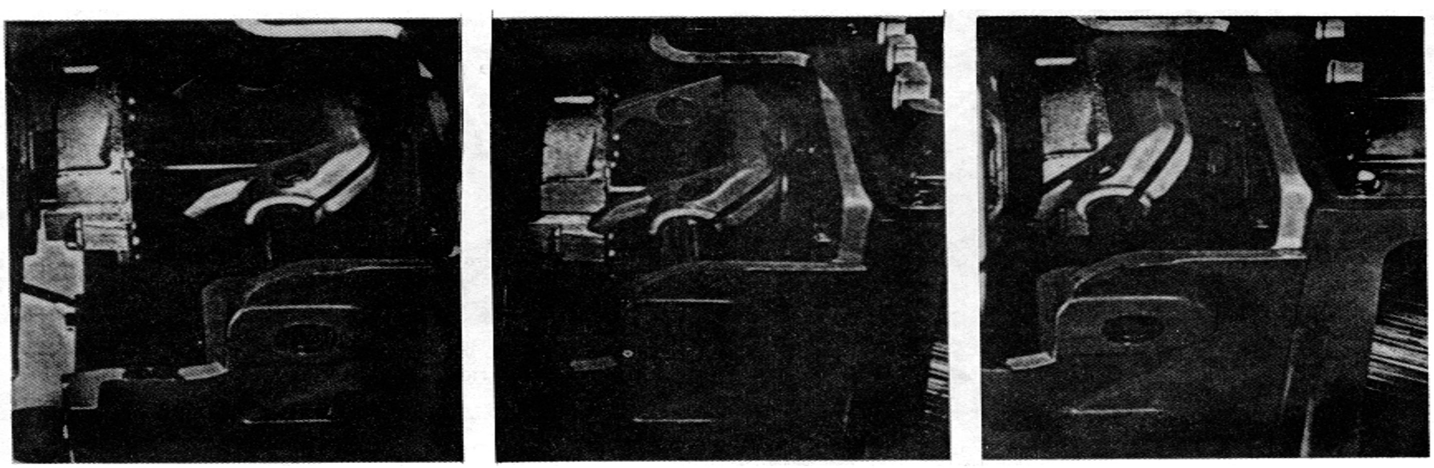
Be sure the transmission is square to and aligned with the engine when it is raised Into position to maintain the proper engine/transmission alignment.

TRANSMISSION INSTALLATION

Observe the following notes and cautions when installing the transmission.

Shift the transmission into gear

Check wear on fingers of clutch release yoke, cross shaft and cross shaft bushings. Replace yoke, if necessary.



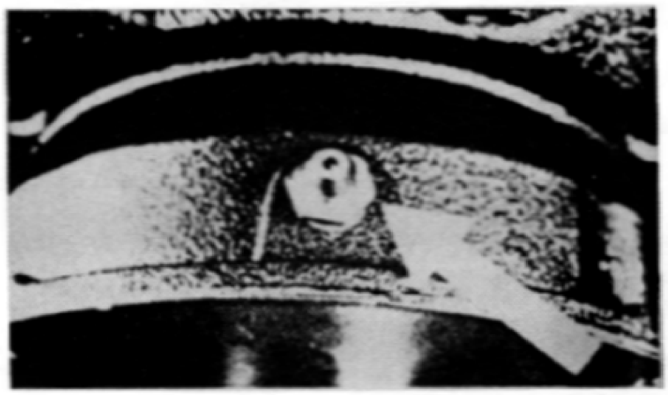
Be sure the release bearing yoke clears the bearing and is rotated over the wear pads as the transmission is moved forward.

Align the splines by turning the transmission output shaft Do not force the transmission into the clutch or flywheel housing. If it does not enter freely, investigate the cause of the problem.

Don't let the transmission drop or hang unsupported in the driven discs Install transmission mounting bolts, torque to proper specs and attach linkage. You are now ready to adjust the clutch.

LUBRICATION

Clutches should be lubricated after adjustment and at regular maintenance intervals. Lubricate the release bearing with IH 251 H EP multi-purpose #2 Lithium lubricant, or equivalent.



Sealed Type

Some models are supplied with a sealed release bearing' These are not equipped with a lube fitting and require no additional grease for the life of the clutch.

Greasable Type - WARNING

1. release bearing housing has **not been, pre; packed with grease!** It-must be lubricated when the clutch is installed in the-vehicle or premature failure will occur.

2. Only high temperature greases should be used. Chassis lube or all purpose lubricants are not recommended.

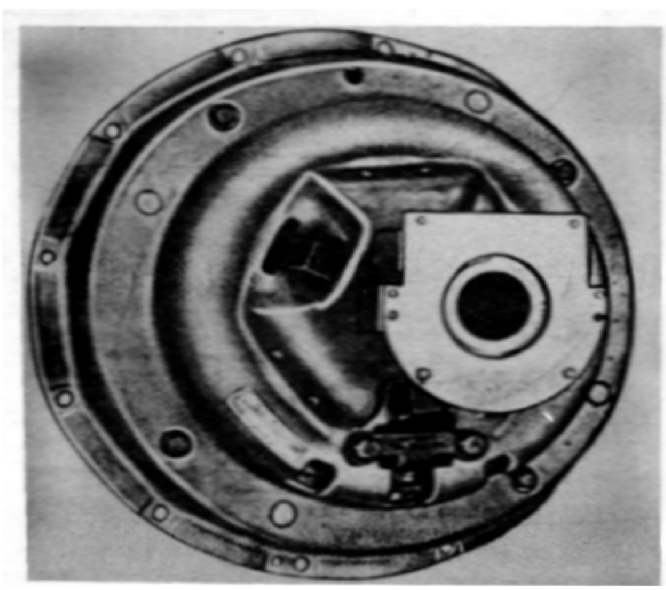
3. Add lubricant at each chassis lubrication period or more often if service is extreme.

ADJUSTMENT PROCEDURE FOR STAMPED ANGLE-SPRING PULL CLUTCHES

Before beginning adjustments, review the conditions required for proper clutch action.

• A pull-type clutch permits use of a simple clutch brake when used with an non-synchronized transmission. The brake "squeeze" should begin at about 1" from the floor board or the end of the pedal stroke

• All clutches require 1 *Y/"* of free pedal at the top of the pedal stroke to prevent slipping and burning Never adjust free pedal with the linkage.



SAS - Manual

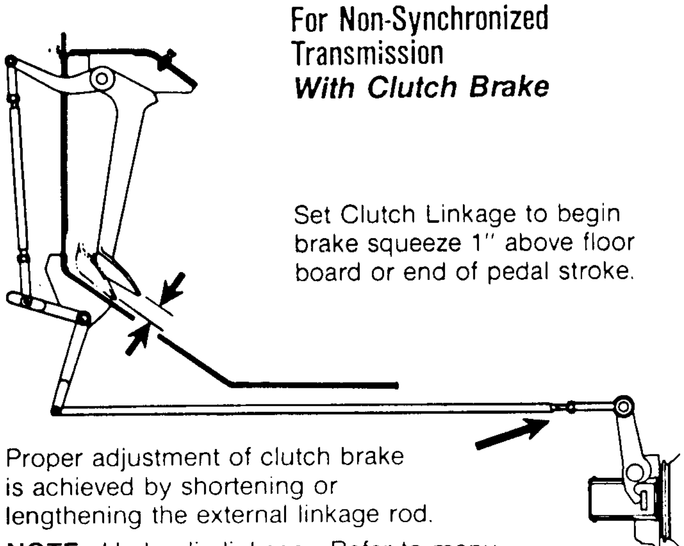
• To release properly, the clutch release bearing must move about 1/"' This occurs between the end of free pedal travel and the brake actuation point.

For external (linkage) adjustment procedures, refer to the Clutch Linkage Section of the Service Manual which covers the vehicle model being serviced.

ADJUSTMENT PROCEDURE FOR STAMPED ANGLE-SPRING PULL CLUTCHES

STEP 1 CLUTCH BRAKE ADJUSTMENT FOR BOTH MANUAL & SELF-ADJUSTING CLUTCHES

For Non-Synchronized Transmission
With Clutch Brake



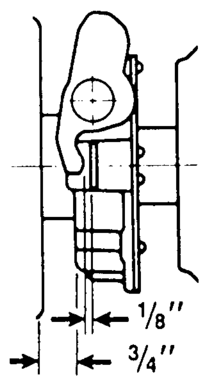
Set Clutch Linkage to begin brake squeeze 1" above floor board or end of pedal stroke.

Proper adjustment of clutch brake is achieved by shortening or lengthening the external linkage rod.

NOTE: Hydraulic linkage—Refer to manufacturer's specifications for proper adjustment of system.

Verify 1/2" release travel

Two Plate



To set ⅛ dimension:
Adjust external linkage by shortening or lengthening to obtain ⅛" between the release yoke fingers and the wear pads on the release bearing housing. This ⅛" will provide approximately 1½" free travel at the pedal. Be sure to tighten all locknuts.

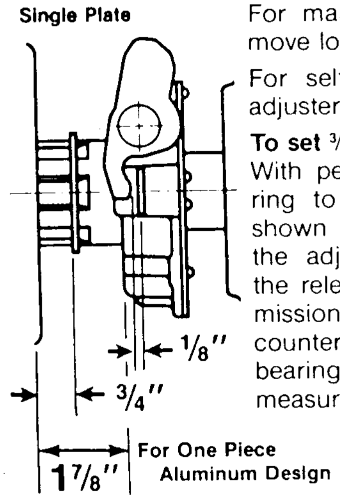
NOTE: Hydraulic linkage—Refer to manufacturer's specifications for proper adjustment of system.

Complete adjustment as shown in Step 4.

CLUTCH ADJUSTMENT *WITHOUT* CLUTCH BRAKE FOR BOTH MANUAL AND SELF-ADJUSTING CLUTCHES

For Synchronized Transmissions **Only**

Single Plate

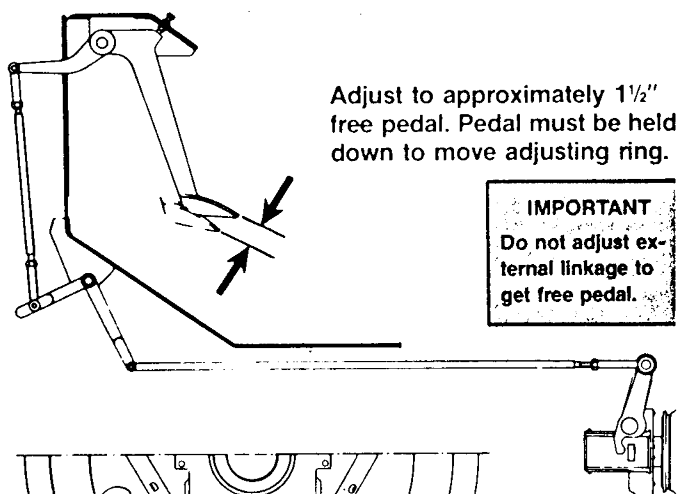


For manually adjusted clutches: Remove lockstrap.

For self-adjusting clutches: Position adjuster as shown in Step 2, A & B.

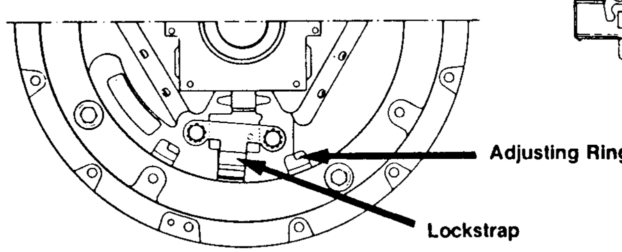
To set ¾ dimension:
With pedal depressed, turn adjusting ring to obtain approximately ¾" as shown in both illustrations. Turning the adjusting ring clockwise moves the release bearing toward the transmission. Turning the adjusting ring counter clockwise moves the release bearing toward the engine. Check measurement with pedal up.

STEP 2 FREE PEDAL ADJUSTMENT (Internal Clutch Adjustment) FOR MANUALLY ADJUSTED CLUTCHES ONLY



Adjust to approximately 1½" free pedal. Pedal must be held down to move adjusting ring.

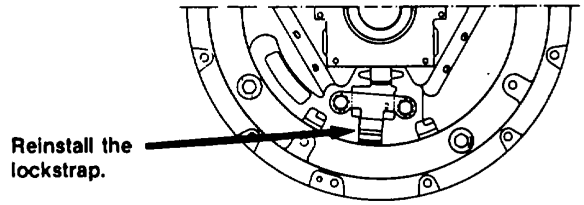
> **IMPORTANT**
> **Do not adjust external linkage to get free pedal.**



Remove adjusting lockstrap
Turning the adjusting ring clockwise moves the release bearing toward the transmission. (Increases Free Pedal).

Turning adjusting ring counterclockwise moves the release bearing toward the engine. (Decreases Free Pedal).

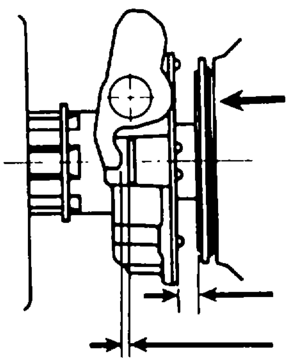
STEP (4) REINSTALL LOCK STRAP FOR MANUALLY ADJUSTED CLUTCHES ONLY



NOTE: Tighten both bolts.
(30-35 lbs. ft. torque).
(40-47 N-m)

STEP (3) VISUAL INSPECTION FOR BOTH MANUAL & SELF-ADJUSTING CLUTCHES

With Clutch Brake



Codes
11369

SPECIFICATIONS

SUBJECT	SAS-1402 TWO PLATE
Minimum Bell Housing Size for Mounting (S.A.E.)	No. 2
Bolt Circle (inches)	15.500"
Flywheel	Flat
Clutch Bell to C/L of Release Yoke (inches)	3-¾" (105-C-137 Yoke) 4-$\frac{3}{16}$" (105-C-64 Yoke)
Disc & Facing Thickness — Organic	.463"/.428"
Hub Spline Size (inches, No. splines)	1¾"-10 2"-10
Disc. Assembly Max. Runout (T.I.R.)	.015"
Disc. Assembly Max. Out-of-Flat	.020"
Release Sleeve Bushing Dia. (new)	1.754"/.1.750" 2.010"/2.008"
Intermediate Plate	Strap Drive
Pressure Plates	Strap Drive
Intermediate Plates & Pressure Plates: Out-of-Flat	.000" to .004" Concave
Scoring-Max. depth that can be re-used	.015"
Mounting Bolt Torque	35-40 lbs. ft.*

* (47-54 N-m)

TROUBLE SHOOTING

CLUTCH SLIPPING

Probable Cause	Correction
1. No free pedal.	1. Re-adjust per instructions.
2. Release mechanism binding.	2. Check release mechanism 'and' linkage, Lube if necessary.
3. Worn clutch facings	3. Replace facings or complete disc,: if necessary.
4. Grease, or oil on facings.	4. Replace facings.
5. Weak pressure springs.	5. Replace springs.
6. Overloaded clutch.	
6. Check to assure that proper clutch has been specified.	

NOISY CLUTCH

Probable Cause	Correction
1. Clutch release bearing dry or damaged.	1. Lubricate bearings or replace.
2. Flywheel pilot bearing dry or damaged.	2. Lubricate bearings, or replace.
3. Clutch release bearing housing striking shafts, flywheel ring.	3. Adjust clutch. Also check wear on cross bell housing bushings and release yoke fingers. Replace if necessary.

POOR CLUTCH RELEASE

Probable Cause	Correction
1. Clutch adjustment not correct	1. Recheck adjustment per instructions.
2. Flywheel pilot bearing too tight in flywheel or end of drive gear	2. Free pilot bearing to a light push. If bearing is on rough, replace it.
3. Damaged clutch release bearing	3. Replace bearing. If bearing is grease type, lubricate with recommended lube.
4. Clutch release shaft projecting through release yoke	4. Relocate release shaft so that it does not project Check bell housing bushings and release yoke for wear.
5. Release yoke contacting cover assembly at full release position	5. Replace release yoke with proper yoke.
6. Release yoke not aligned properly with release bearing	6. Check flywheel. Probably has been resurfaced more than the .060" recommended.
7. Pressure plate not retracting	7. a. Check pressure plate drive straps for .006" clearance. b. Check amount of release travel. c. Lever nose out of groove.
8. Driven disc distorted	8. Should be straight within .015". Replace if they can't be straightened.
9. Worn splines on drive gear of transmission	9. Check drive gear and driven disc hubs for excess wear.
10. Disc facings gummed with oil or grease	10. Replace facings or entire disc. Cleaning not recommended. Check for leak causing gumming.
11. Broken intermediate plate	11. Replace entire intermediate plate/driven disc. assembly. Damage such as this is almost, always caused by abusive use of clutch.

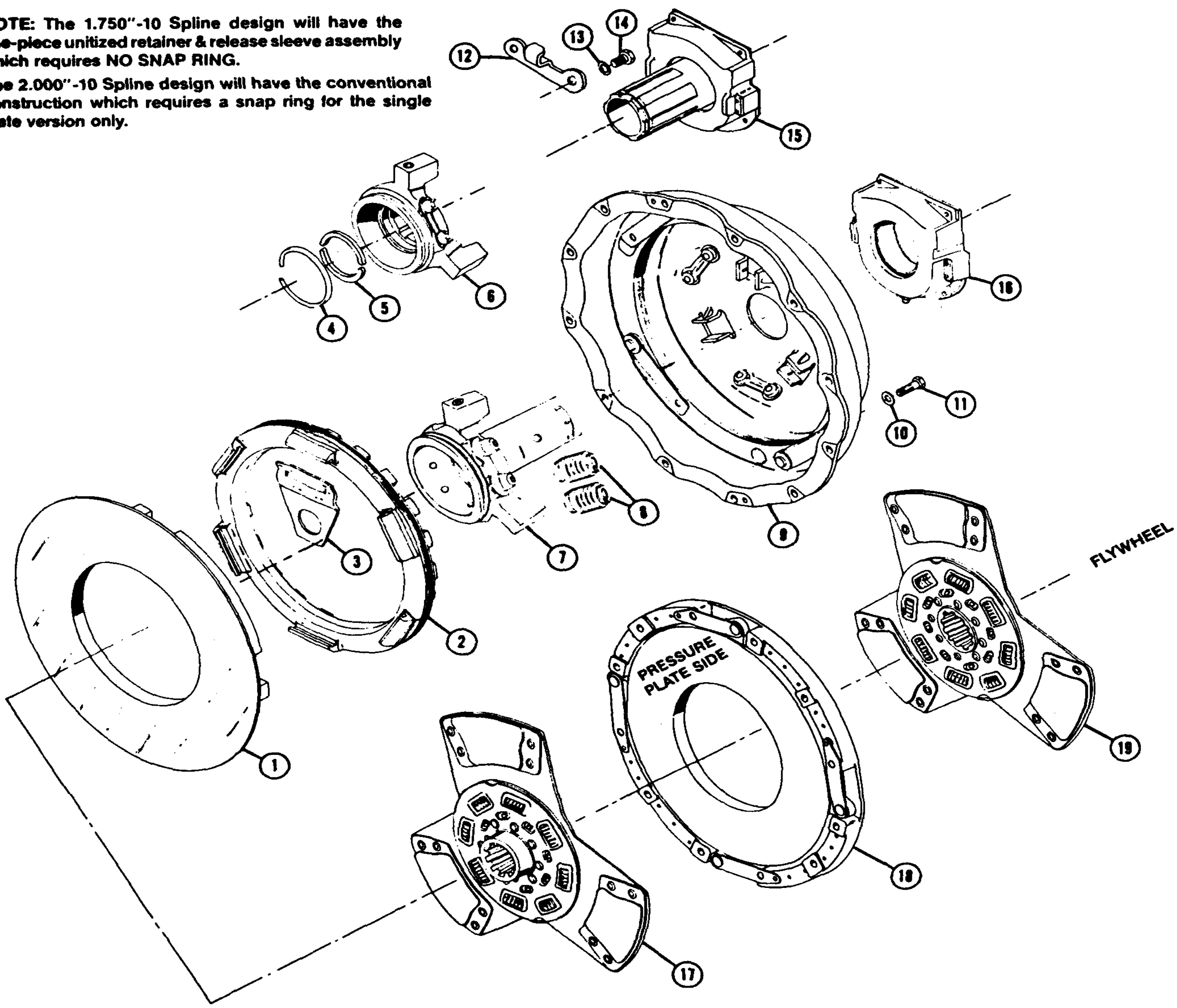
STAMPED ANGLE SPRING CLUTCH.
PARTS IDENTIFICATION LIST
FOR STAMPED ANGLE SPRING (Two Plate) MANUAL

Call-Out No.	Part Name	No. Req'd.
1	Pressure Plate	1
2	Adjusting Ring	1
3	Lever	6
4	Snap Ring	1
5	Release Sleeve Ring	2
6	Retainer Assembly	1
7	Retainer Assembly & Release Sleeve Assembly	1
8	Pressure Spring	6
9	Flywheel Ring Assembly	1
10	Washer	4
11	Cap Screw	4

Call-Out No.	Part Name	No. Req'd
12	Lock Strap	1
13	Lock Washer	2
14	Cap Screw	2
15	Release Sleeve & Bearing Assembly	1
16	Release Bearing Assembly	1
17	Front Driven Disc Assembly	1
18	Intermediate Plate & Adapter Ring Assembly	1
19	Rear Driven Disc Assembly	1

NOTE: The 1.750"-10 Spline design will have the one-piece unitized retainer & release sleeve assembly which requires NO SNAP RING.

The 2.000"-10 Spline design will have the conventional construction which requires a snap ring for the single plate version only.



CLUTCH

CLUTCH LINKAGE

S SERIES VEHICLES

CONTENTS

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.

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.

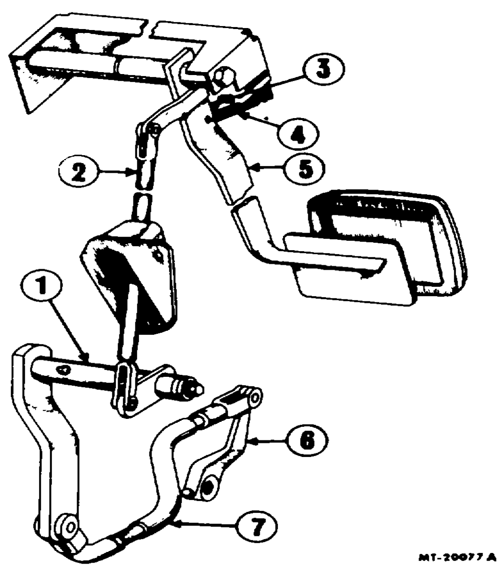


Fig. 1 Clutch Control Linkage (Typical)

1 Relay Assembly (Bellcrank)
2 Upper Control Rod
3 Pedal Stop
4 Return Spring
5 Pedal
6 Release Shaft Lever
7 Lower Control Rod

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 of the 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.

Adjustment procedures, which vary between clutch types, are outlined on the following pages.

PULL TYPE CLUTCHES

Two types of adjustments must be made: (1) clutch internal (release bearing) adjustment and (2) external (linkage) adjustment.

> IMPORTANT
>
> Do not 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.

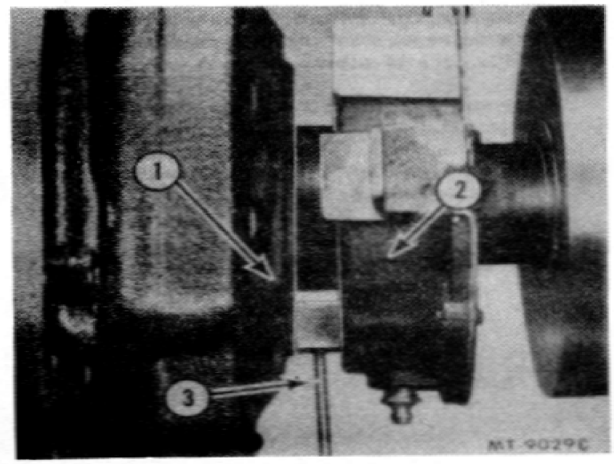


Fig. 4 Checking Release Bearing Adjustment (Without Clutch Brake) (Dana Clutch)

1 Clutch Cover
2 Release Bearing
3 Gauge Tool

For Dane Angle Spring Clutches

1. Remove clutch housing inspection cover and check release bearing clearance as follows:

   Vehicles without clutch brake: 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.

2. 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.

   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.

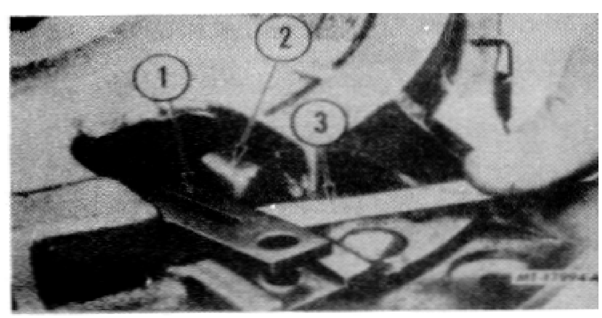


Fig 5 Removing Adjusting Ring Lock (Dana Clutch) (Manual Adjustment Type)

1 Lock
2 Adjusting Ring
3 Screwdriver

d. 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.

<u>Vehicles With Adjusting Yoke at Front End of Lower (Horizontal) Control Rod:</u>

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.

d. 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 (Horizontal) Control Rod:</u>

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.

5. 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.

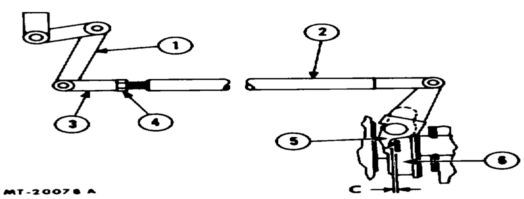


Fig. 11 Release Bearing-to-Release Shaft Yoke Clearance (Pull Type Clutch)

1 Relay Lever
2 Lower Control Rod
3 Adjusting Yoke
4 Lock Nut
5 Release Yoke (Fork)
6 Release Bearing
C Clearance

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.

6. 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.

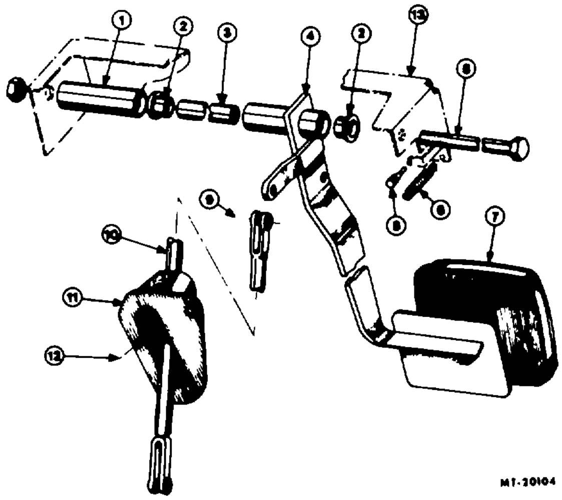


Fig. 16 Clutch Pedal Shaft Details

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, Seal
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.

11. Tighten pedal shaft lock nut to specified torque (see BOLT TORQUE CHART). Be sure pedal(s) pivot(s) freely after tightening lock nut.

12. 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.

16. Check clutch control adjustments and readjust as needed (see ADJUSTMENT).

RELAY SHAFT BUSHING REPLACEMENT

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.

2. 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.

5. 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).

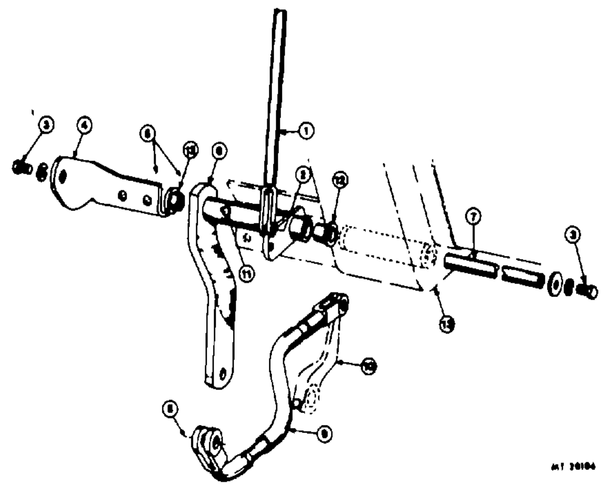


Fig. 18 Relay Shaft Details (Vehicles Except 2200 Series) (Typical)

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

TROUBLE SHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE
Clutch won't release:	1. Improper adjustments. 2. Driven disc hub binding on main drive gear splines. 3. Faulty clutch assembly.
Clutch dragging:	1. See causes for "Clutch won't release." 2. Dirt or foreign material in clutch. 3. Oil or grease on driven disc linings. 4. Misalignment. 5. Broken driven disc linings. 6. Warped or damaged driven disc, pressure plate or flywheel.
Clutch slipping:	1. Improper adjustment. 2. Oil or grease on driven disc linings. 3. Worn driven disc linings. 4. Weak or broken clutch pressure plate springs.
"Grabby" clutch:	1. Oil or grease on driven disc linings. 2. 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. 6. Loss of tension in driven disc cushioning springs (where used).
Noisy clutch:	1. Insufficient pedal free travel. 2. Improper adjustment. 3. Worn or damaged release bearing. 4. Clutch assembly loose on flywheel. 5. Faulty clutch assembly. 6. Bent main drive gear shaft.
Premature clutch wear:	1. Abusive driving habits. 2. Improper adjustment. 3. Incorrect type or improperly installed driven disc facings. 4. Weak or broken clutch pressure plate springs. 5. Warped clutch pressure plate.

BOLT TORQUE CHART

Location	Bolt Size	Specified Torque Newton-meters (Pound-Feet)
Pedal Shaft Bolt	1/2 - 13	102 - 115 (75 - 85)
Relay Shaft Bolts (Vehicles Except 2200 Series)	1/2 - 13	68 - 81 (50 - 60)
Lower Control Rod Adjustment Yoke Lock Nut	1/2 - 20	68 - 81 (50 - 60)
Relay Shaft Bracket Mounting Bolts	3/8 - 16 5/16- 18	28 - 36 (21 - 27) 18 - 22 (13 - 16)

SPECIFICATIONS

<table>
<tr><th>CLUTCH TYPE</th><th>RELEASE BEARING CLEARANCE</th><th>CLUTCH PEDAL
FREE TRAVEL</th></tr>
<tr><td>Push Type
bearing and clutch fingers.</td><td>3 mm (1/8") between release</td><td>32 mm
(1-1/4")</td></tr>
<tr><td>Pull Type
356 mm (14-Inch)
Single Plate

Codes:
11347 11349
11348 11350</td><td rowspan="2">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 (Linkage) Adjustment:

3 mm (1/8)**</td><td rowspan="2">32 mm
(1-1/4")</td></tr>
<tr><td>Pull Type
356 mm (14-Inch),
394 mm (15.5-Inch)
Two Plate

Codes:
11145 11351
11346 11352
11252</td></tr>
<tr><td>Pull Type
356 mm (14-Inch)
Single Plate

Codes:
11359
11360</td><td rowspan="2">Clutch Internal Adjustment:

With Clutch Brake--

13 mm (1/2") between release bearing housing and clutch brake disc.

Without Clutch Brake--

14 mm (9/16") between release bearing housing and clutch cover.
or
19 + 3 mm
release bearing housing and transmission front bearing cap.

External (Linkage) Adjustment:

3 mm (1/8)**</td><td rowspan="2">32 mm
(1-1/4")

(3/4 + 1/8") between</td></tr>
<tr><td>Pull Type
356 mm (14-Inch),
394 mm (15.5-Inch)
Two Plate

Codes:
11239 11353
11249 11354
11250
11155
11254</td></tr>
</table>

* 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:

CARL E. VUONO
Genera4 United States Army
Chief of Staff

Official:

WILLIAM J. MEEHAN, II
Brigadier General, United States Army
The Adjutant General

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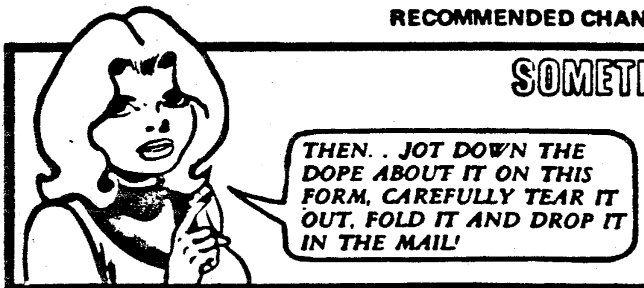

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TEAR ALONG PERFORATED LINE

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 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 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	*To*	*Multiply by*	*To change*	*To*	*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 temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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