TECHNICAL MANUAL

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

FOR

TRUCK, FIREFIGHTING, MINI-PUMPER

18,000 GVW

NSN 4210-01-026-2567

Approved for public release; distribution is unlimited

HEADQUARTERS, DEPARTMENT OF THE ARMY
18 JUNE 1987

VOLUME 1

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

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

REPORTING EQUIPMENT IMPROVEMENTS (EIR's)

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

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CHAPTER 1. INTRODUCTION
Section I. General

1. PURPOSE

A. This manual contains instructions for the operation and maintenance of fire fighting, mini-pumper model AWW1037 through 1043 equipped with 250 GPM pump. Manufactured by Almont Welding Works, Inc. 4091 Van Dyke, Almont, Michigan 48003. Vendor code.

B. Apparatus components are described in this manual. Additional maintenance information referenced below must be used in conjunction with this publication.

1. International service manual and parts manual

2. Hale fire pump manual CBP-4

2. ENGINE OPERATING PRECAUTIONS

A. Internal combustion gases are poisonous.

B. Visual inspection of exhaust systems for possible gas leaks should be performed at least once monthly.

WARNING

Engine must not be operated within a completely enclosed area unless adequate means of extracting exhaust fumes have been provided such as forced -air ducts, or a gas-tight muffler tail pipe extension discharging into exhaust ducts or directly out-of-doors.

Section II. DESCRIPTION AND DATA

1. DESCRIPTION

A. Almont Welding Works, Inc. model AWW 1037 through 1048 is a commercial type 4 x 4 International cab and chassis powered by a 400 cubic inch V8 gasoline engine. The fire truck is equipped with a PTO driven 250 GPM booster pump, 300 gallon booster tank and 30 gallon foam tank.

B. The fire truck is capable of satisfactory performance in any ambient temperature from 125° F to -20° F. The truck will deliver the following rated pumping capacities at any elevation from sea level to 3,000 feet at the above stated temperatures:

GALLONS PER MINUTE	PRESSURE P.S.I.
250	150
175	200
125	250

2. COMPILED DATA

A. Fire Truck

National Stock Number	4210-01-026-2567
Serial Number Range	1037 - 1047
Registration Number	CH9911 - CH9922
Manufacturer	Almont Welding Works, Inc.
Model	AWW1037 - 1047
Contract Number	DAAJ09-80-C-5156
Truck Length	245"
Truck Width	92"
Truck Height	108"
Capacity or Payload	17,000 lbs.
Shipping Weight	13,460 lbs.
Cube	1614 cubic feet

B. Chassis

Manufacturer	International
Model	1824S
Wheel Base	140"

C. Engine

Manufacturer	International
Model	404 - V8
Fuel	Gasoline

D. Water Pump (Fire Fighting)

Manufacturer	Hale Fire Pump Co.
Model	CBP-4
Capacity	250 GPM @ 150 PSI

Complied Data (cont)

E. Capacities

Water Tank	300 gallons
Foam Tank	30 gallons
Fuel Tank	37 gallons
Cooling System	23 quarts
Crankcase	8 quarts
Pump Gear Case	1 quarts
Pump Priming Tank	1 gallon
Tire Pressure	N/A

CHAPTER 2. CONTROLS AND INSTRUMENTS
Section 1
Pump and Accessory Controls

1. General

This section identifies and describes the function of controls and indicators used in operating this fire fighting equipment.

Note

All control valves are, pull to open and push close, and are located at the operator's pump control panel.

2. Control Valves

A. #1 crosslay. (20, Fig. 3) used to control #1 - 1 1/2" crosslay discharge.

B. #2 crosslay. (21, Fig. 3) used to control #2 - 1 1/2" crosslay discharge.

C. Pressure relief valve. (22, Fig. 3) used to control pump pressure by turning handle CW to increase CCW to decrease. The relief valve is used in conjunction with engine throttle control (16, Fig. 3).

D. Water to proportioner valve. (23, Fig. 3) used in conjunction with the foam to proportioner (37, Fig. 3) to control water supply to foam proportioner.

E. Tank to pump valve. (24, Fig. 3) used to open or close tank to pump line.

F. Tank fill valve. (25, Fig. 3) use to fill 300 gallon tank.

G. Hose reel valve. (26, Fig. 3) used to control water discharge to hose reel.

H. Auxiliary suction valve. (27, Fig. 3) used to control auxiliary suction at rear of truck.

I. #1 discharge valve. (28, Fig. 3) used to control 2 1/2" #1 discharge (29, Fig. 3).

J. Suction manifold valve. (31, Fig. 3) used to control 2 1/2" suction manifold (30, Fig. 3).

K. Pump primer. (32, Fig. 3) used to control primer to draft water.

L. #1 discharge drain. (33, Fig. 3) used to drain #1 discharge manifold.

M. Engine cooler. (34, Fig. 3) used to supply water to engine heat exchanger, CCW to open.

N. Proportioner control. (36, Fig. 3) used to meter the amount of foam to enter water supply.

O. Pump flush valve. (35, Fig. 3) used to flush foam from pump.

P. Foam to proportioner valve. (37, Fig. 3) used to control foam supply to proportioner.

Q. Pump drain. (38, Fig. 3) used to drain water from pump.

3. Gauges and Meters

A. Oil pressure gauge. The oil pressure gauge (18, Fig. 3), located on the left side operator's pump control panel, is a dial-type gauge graduated from 0 to 80 pounds per square inch that indicates the engine oil pressure.

B. Tachometer. The tachometer (15, Fig. 3), located on the left side operator's pump control panel, is a dial type gauge graduated from 0 to 6. Each graduation indicates 1000 revolutions per minute. The tachometer measures the revolutions per minute of the fire truck engine.

C. Water temperature gauge. The water temperature gauge (19, Fig. 3), located on the left side operator's pump control panel, is a dial-type graduated from 600F to 2400F that indicates the engine water temperature.

D. Master pump discharge pressure gauge. The pump discharge pressure gauge (1, Fig. 3), located on the left side operator's pump control panel, is a dial-type gauge graduated from 0 to 600 pounds per square inch of pressure and 0 to 30 inches of mercury. It indicates the maximum discharge pump pressure.

E. Vacuum gauge. The vacuum gauge (9, Fig. 3), located on the left side operator's pump control panel, is a dial-type graduated from 0 to 600 scale indicates the amount of pressure in the intake side of the pump, the 0 to 30 scale indicates the vacuum developed in the intake side of the pump.

F. Discharge gauges. (2,3,4, Fig. 3), #2, Monitors #1 2 1/2" discharge, #3 monitors #1 1 1/2" crosslay discharge, #4 monitors'"#2 1 1/2" crosslay discharge.

Section 2. DRIVER's OPERATING CONTROLS

1. VEHICLE CONTROLS

For detailed information on all controls necessary for operation of the fire truck chassis and engine, refer to the International service and parts manual included with each vehicle.

2. PUMP ENGAGE CONTROL

The road-to-pump shift control is located on the cab floor. To operates (1) engage service brakes; (2) engage the truck transmission in drive; (3) to engage the power take-off, pull the pump shift control up; (4) for stationary pumping, put the truck transmission back to neutral position-and engage parking brake; (5) for pump & roll, leave the truck transmission engaged in 1st gear or 2nd gear.

CHAPTER 3.
SERVICE ON RECEIPT OF EQUIPMENT

1. UNLOADING EQUIPMENT

A. The type of shipping method will determine the unloading procedure.

B. To unload the fire truck under its own power:

1. Remove all block, bracing, and tiedown hooks.
2. Check engine oil level and pump gear case oil level.
3. Check engine cooling system for proper coolant and antifreeze.
4. Connect battery cables.
5. Check brake fluid level.
6. Start the engine.
7. Drive fire truck from rail, car, or truck trailer.

2. INSPECTING FOR IN-SHIPMENT DAMAGE

A. Make a complete visual inspection of the fire truck particular attention should be given to any missing items or items damaged during shipment.

B. Inspect all controls, and handles for missing parts or damage, inspect all hose connections for leaks.

3. PREPARATION FOR USE

A. The fire truck is shipped from the factory fully serviced and ready for operation.

B. When fire fighting equipment is furnished, it should be unpacked, inspected, and installed in the proper locations on the mounting devices to the fire truck.

CHAPTER 4. OPERATING INSTRUCTIONS
Section 1. Preliminary Procedures

1. GENERAL

A. The following instructions are for the personnel responsible for the operation of the fire truck.

B. The operator should know how to perform every operation of which the fire truck is capable. This chapter provides instructions for starting and stopping the fire truck, and how to operate the controls to perform basic functions for which the fire truck was designed.

2. STARTING THE ENGINE

A. Set the parking brake control.

B. Place the transmission gear shifting lever into NEUTRAL.

C. Select either battery #1 or #2 by turning the battery selector switch located below drivers seat to ON position.

D. Turn the starter switch key clockwise to engage starter.

E. Pull out the throttle control or depress the accelerator sufficiently to "crack" the throttle. The engine will then run at "fast idle" speed. The throttle control should be gradually pushed in until the proper idle speed is obtained.

3. ENGINE SHUTDOWN

A. Place transmission shifting lever in NEUTRAL.

B. Set parking brake control.

C. Turn the ignition key switch off.

D. Turn battery selector switch to OFF position.

CAUTION

Never turn battery selector switch to off before engine has stopped. Serious damage could occur to alternator or voltage regulator.

Section II. OPERATING PROCEDURES

1. OPERATING DETAILS

A. Priming Water Pump.

1. Start the engine. Refer to Section 1.

2. Engage the service brake.

3. Refer to section 2 driver's operating controls section 2 pump shift control.

4. Set emergency brake.

5. Leave cab and proceed to pump instrument panel at left side of truck.

6. Close all drains, and discharge lines.

7. When priming from open water, remove suction cap from left side or rear of truck and attach one end of the hose to the pump suction arm. Place the suction strainer on the other end of the hose and place in water.

NOTE

Connection must be air tight.

8. Before operating from a suction lift, see that the strainer at the lower end of the suction hose is at least two feet below the water surface to avoid drawing air. The strainer should not rest on the bottom to prevent pumping sand and foreign matter.

WARNING

Excessive sand and foreign matter in water pump will eventually decrease pump efficiency.

9. Prime the pump by activating the primer control (5, Fig. 3) at this time a vacuum reading will show on vacuum gauge, the pump is primed when water is expelled to the ground under the pump and a pressure reading shows on pressure gauge. When the pump is primed, release the primer control.

10. If priming from the water tank, open the tank to pump valve (7, Fig. 3). When priming from the water tank, the primer control need not be used.

11. When priming from a hydrant through either the suction line or the auxiliary suction line, the primer control need not be used.

B. Filling the 300 gallon booster Water tank once pump is primed:

1. Close the water tank, drain valve (11, Fig. 3)

2. Close the tank-to-pump valve (7, fig. 3)

3. Open the tank fill valve (22, Fig. 3).

4. Fill the tank slowly. When the tank is full, close the tank fill valve (22, Fig. 3)

C. Filling the 30 gallon foam tank:

1. Close the foam tank drain valve (12, Fig. 3)

2. Close the foam to proportioner valve (6,Fig. 3)

3. Open the foam tank cover lid (3, Fig. 10)

4. Open the foam container and fill with required foam.

2. PUMPING DETAILS

A. Pumping water from 300 gallon water tank through the hose reel.

1. Start engine (refer to section 1).

2. Prime the water pump (refer to para 1)

3. Open the water tank-to-pump valve (24, Fig. 3)

4. Unwind the hose from the hose reel as needed (8, Fig. 2)

5. Open the hose reel valve (26, Fig. #).

6. Increase engine speed using the throttle (16, Fig. 3) until the desired pump pressure is shown on the master pump pressure gauge (3, Fig. 3).

B. Pumping water from hydrant

1. Start engine (refer to section 1.)

2. Use either 2 1/2" hard suction hose or a 2 1/2" soft suction hose when supplying water to the fire truck. Connect hose and make sure connections are tight.

3. Prime the water pump (refer to para. 1)

4. Connect the discharge hose to the required discharge outlet, and open corresponding discharge valve.

5. Increase engine speed using the throttle (16, Fig. 3) until the desired pump pressure is shown on the master pump pressure gauge (1 Fig. 3).

NOTE

If the master pump gauge (1, Fig. 3) registers vacuum before the desired pressure is reached, it is draining more water than the hydrant can supply. Close the nozzle or use a smaller tip to obtain more pressure.

CAUTION

When pumping from a hydrant, the Master pump gauge must register 5 PSI or serious damage may occur in the water pump.

C. Pumping water from an open body of water.

1. Start engine (refer to section 1).

2. Use 2 1/2" suction line to supply water to the fire truck, connect hose and make sure connections are tight.

3. Before operating from a suction lift, see that the strainer at the lower end of the suction hose is at least two feet below the water surface. To avoid draining air, the strainer should not rest on the bottom to prevent pumping sand and foreign matter.

WARNING

Excessive sand and foreign matter in water pump will eventually effect pump efficiency.

4. Prime the water pump (refer to para 1).

5. Connect the discharge hose to the required discharge outlet, and open corresponding discharge valve.

6. Increase engine speed using the throttle (16, Fig. 3) until the desired pump pressure is shown on the master pump pressure gauge (1, Fig. 3).

WARNING

If the master pump gauge (1, Fig. 3) shows an excessive vacuum stop pumping and check suction strainer for leaves, dirt, and other foreign material.

D. Pumping foam using water from booster tank.

1. Start engine (refer to section 1).

2. Prime pump (refer to para 1).

3. Connect the discharge hose and nozzle to the required discharge outlet, and open corresponding discharge valve, or 1 1/2" crosslay.

4. Open the water tank-to-pump valve (24, Fig. 3).

5. Open the water-to-proportioner valve (23, fig. 3).

6. Set the foam metering valve (36, Fig. 3) (if not already pre-set) at appropriate setting based on type of extinguishing agent use. (see selection chart for correct setting based on use of double strength (3%) and regular strength (6%) foam liquids).

7 the foam metering valve (if not already pre-set) at appropriate setting based on type of extinguishing agent used.

8. Increase engine speed as required using throttle (16, Fig. 3) on operator's control panel.

9. Open foam-to-proportioner valve on operator's control panel (37, Fig. 3).

10. Open nozzle on end of discharge line and operate.

11. After use, flush the system with fresh water.

E. Pumping foam from an open body of water.

1. Start the engine.

2. Connect the 2 1/2" hard suction hose to the pump panel or rear pump suction arm.

3. Connect the discharge hose and nozzle to the required outlet, and open corresponding discharge valve, or use booster hose.

4. Prime pump.

5. Close the water tank-to-pump valve on operator's control panel (24, Fig. 3).

6. Open the water-to proportioner valve on operator's control panel (23, Fig. 3).

7. Set the foam metering valve (if not already pre-set) at appropriate setting based on type of extinguishing agent used (36, Fig. 3).

8. Increase engine speed as required using throttle on operator's control panel (16, Fig. 3)

9. Open foam-to-proportioner valve (37, Fig. 3)

10. Open nozzle on end of discharge line and operate.

11 DRAINING AND FLUSHING DETAILS

A. Draining and flushing the 30 gallon foam concentrate tank.

1. Close the foam-to-proportioner (37, Fig. 3)

2. With a hose, run a sufficient amount of water through the tank to flush the remaining foam concentrate from the tank.

3. Close the foam tank drain valve (12, Fig. 3).

WARNING

After each operation of the system refill foam tank. It is highly desirable to keep the liquid level of the tank at the top of the tank. Experience has shown that the possibility of foam contamination may occur in the vapor space above the liquid level.

B. Draining the 300 gallon water tank and flushing the discharge line system.

1. Open the drain valve (11, Fig. 3) located below the vehicle left running board to drain the 300 gallon water tank.

2. After draining, flush the tank with clean water.
3. Close the drain valve and fill the tank with clean water.
4. Open all the discharge lines.
5. Open the pump master drain (8 Fig. 3).
6. Run the pump until water is clear and free of foam.
7. Close all valves.
8. Refill water tank.

4. OPERATION IN COLD WEATHER

A. General. The fire truck is not designed to operate in extreme cold. When operating the fire truck in temperatures below 32 care must be taken in draining the fire pump and piping. Do not allow water to spray over the body of the truck or the compartment. Doors will freeze shut.

B. Chassis cold weather operation. Refer to International operator's manual for cold weather operation.

5. OPERATION IN EXTREME HEAT

A. General. When operating in extreme heat, particular attention must be paid to the lubrication and cooling systems. Protect the fire truck from the direct rays of the sun as much as possible. The water pump must be properly lubricated.

B. Chassis lubrication. Refer to International operator manual for proper lubrication.

C. Pump with engine hood closed for best cooling.

6. OPERATION IN SANDY OR DUSTY AREAS

Lubrication. Keep all lubrication points clean and well lubricated. Lubricate sparingly but more frequently than under normal conditions. Wipe fittings thoroughly before applying grease. Clean all oily or greasy surfaces, paying particular attention to the pump gear case breather. Service the chassis air cleaner, breather and oil filter more frequently than under normal conditions. Service the radiator, fuel tank and fuel filter.

7. OPERATION IN HUMID CONDITIONS

   A. General. High humidity causes a rusting and corrosive action on exposed metal surfaces. Coat all exposed metal surfaces with oil or appropriate protective coating.

   B. Fuel System. Keep the fuel tank as full as possible to eliminate condensation. Replace the fuel filter every 12,000 miles.

8. OPERATION IN SALT WATER AREAS

   A. General. The deterioration and corrosion of exposed metal is greatly accelerated in salt water areas. Coat all exposed metal surfaces with an approved lubricant. When the fire truck has been sprayed with salt water, wash down with fresh water.

   B. Pumping Salt Water. DO NOT use salt water except in case of EXTREME EMERGENCY. At the earliest opportunity after pumping salt water, flush the water pump and piping thoroughly with fresh water. After flushing drain the pump.

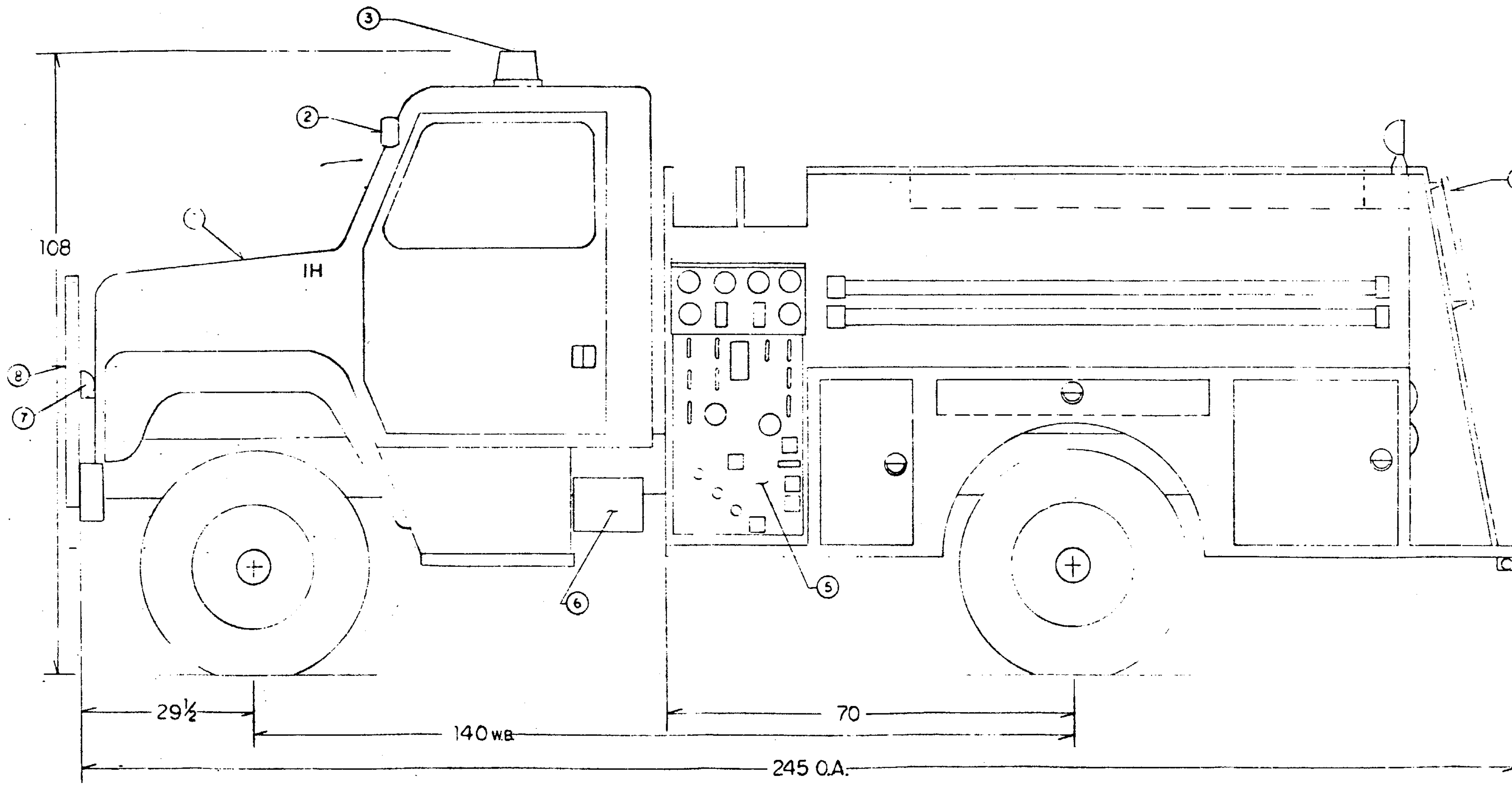


FIGURE 1

FIGURE 1

PARTS IDENTIFICATION

Part No.	Description	Manufacturer
1	Mini Pumper Model 1037-1048	Almont Welding Works, Inc.
2	Spotlight	Unity
3	Light Bar	Dietz
4	Grab Rail	Akron
5	Pump Panel	Ref. to Fig. 3
6	Battery Box	International
7	Front Warning Lights	Dietz
8	Brush Guard	Almont Welding Works, Inc.

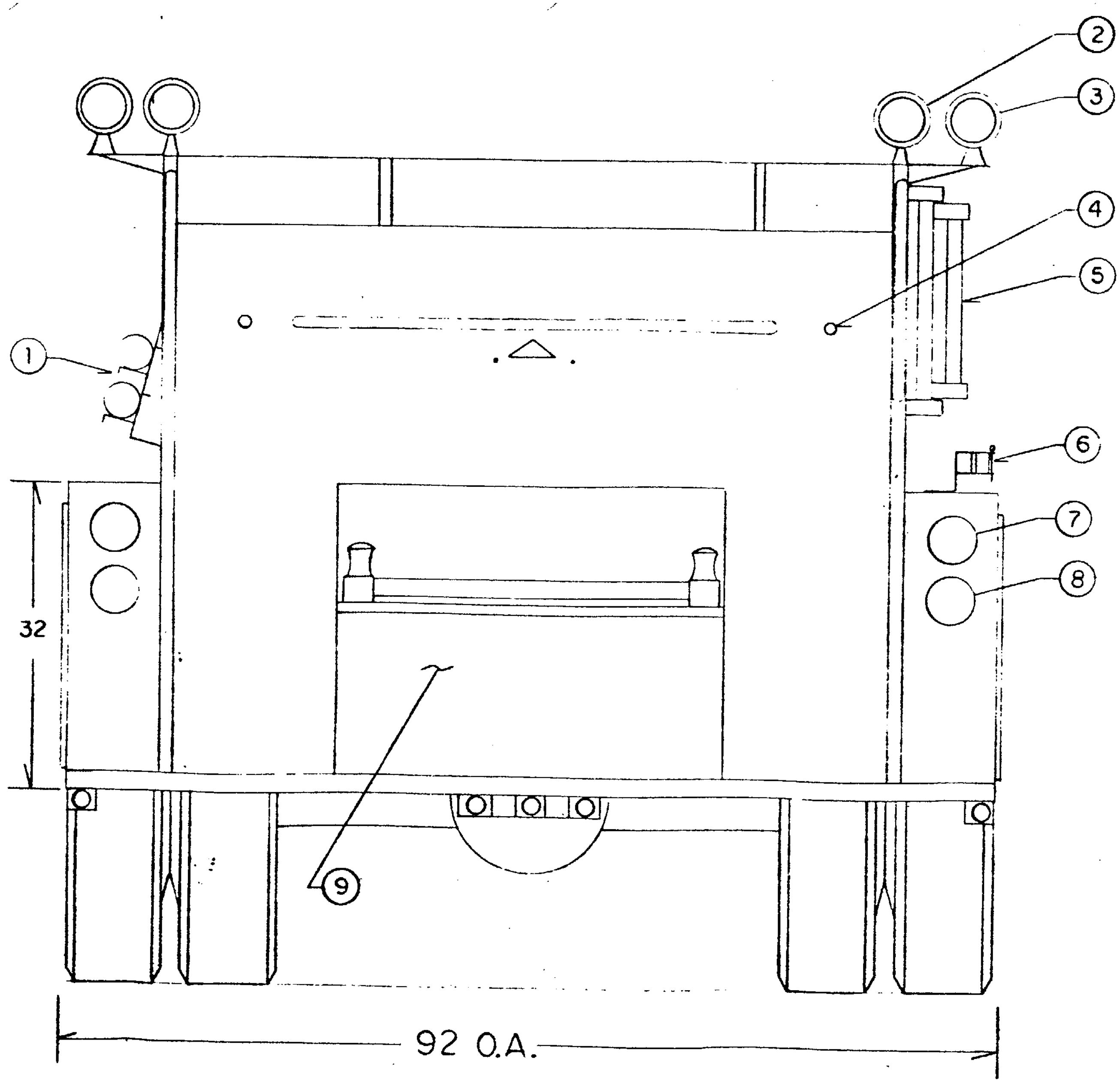
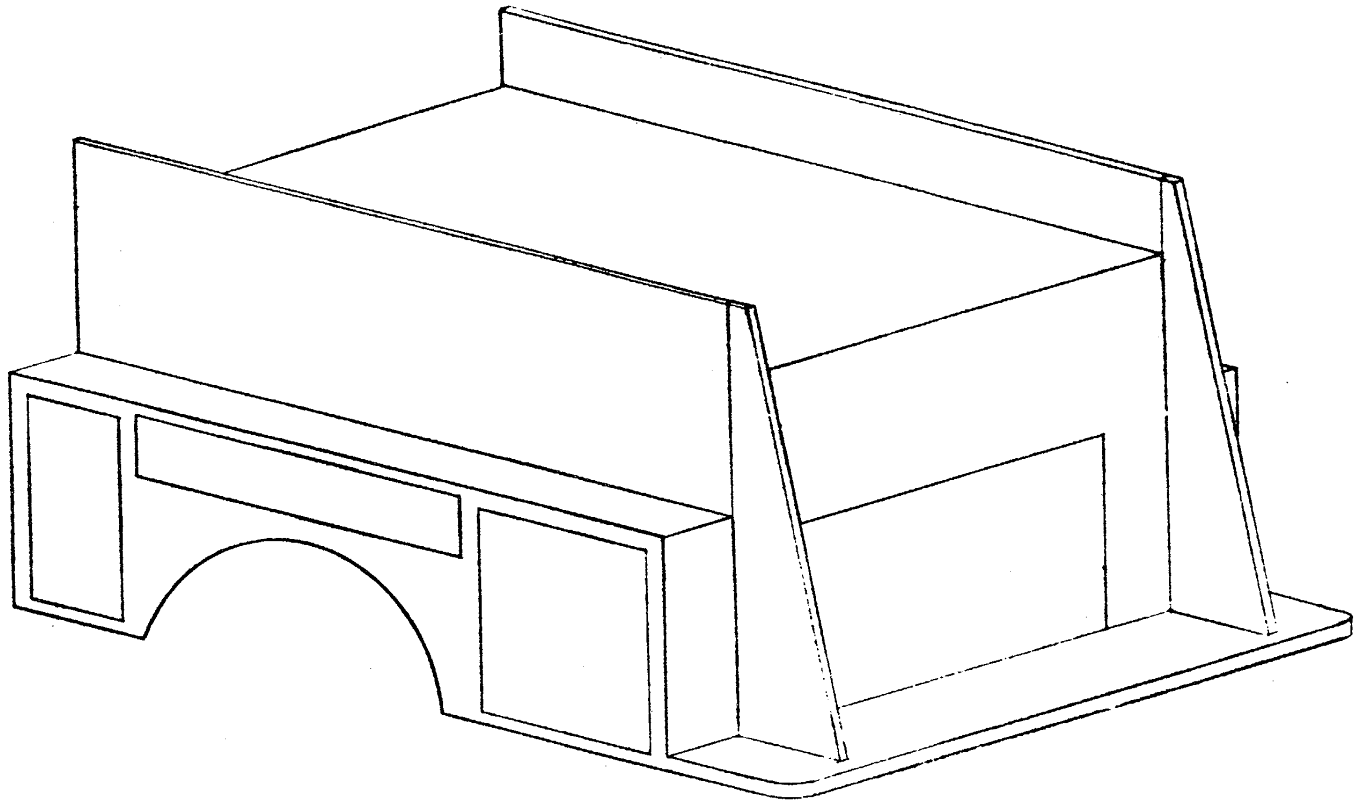


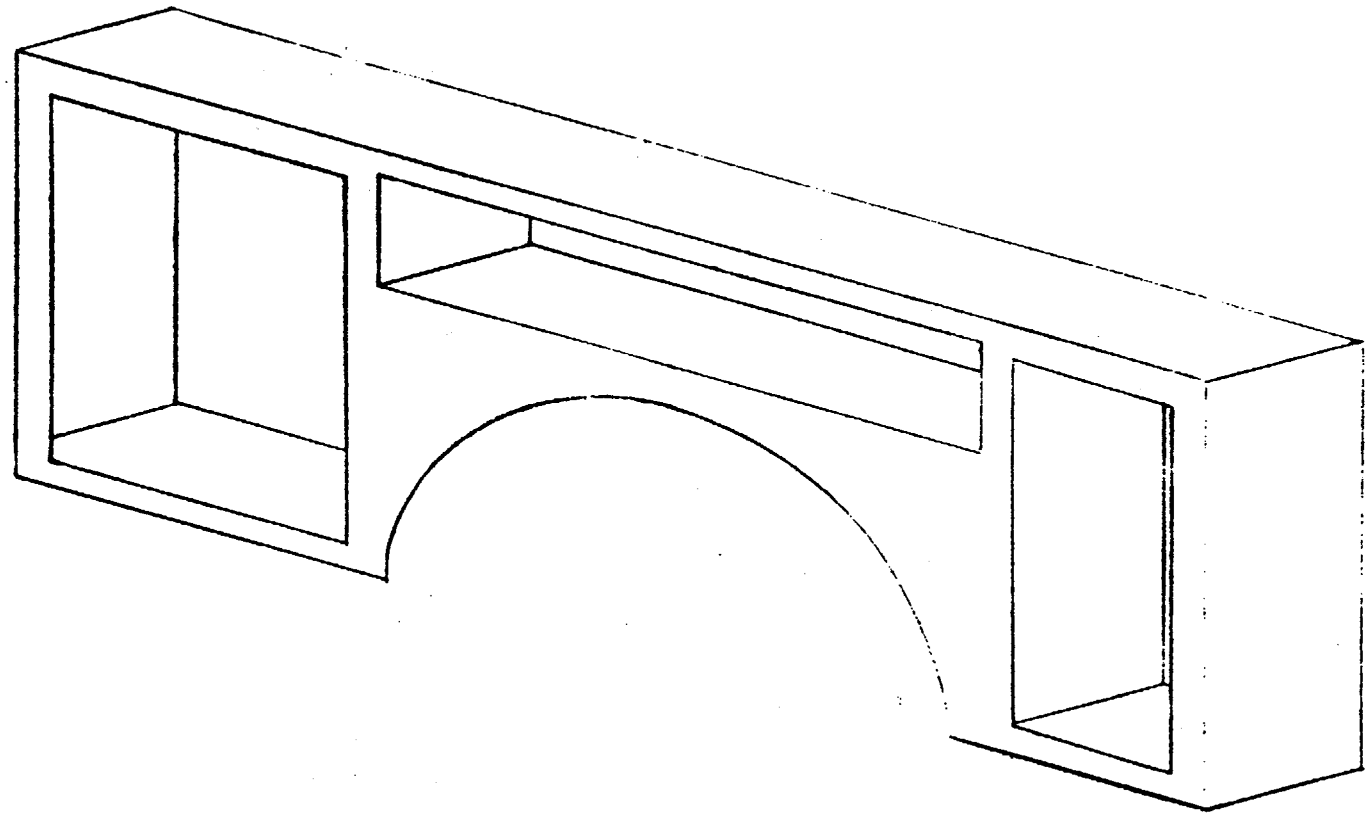
FIGURE 2

FIGURE 2
PARTS IDENTIFICATION

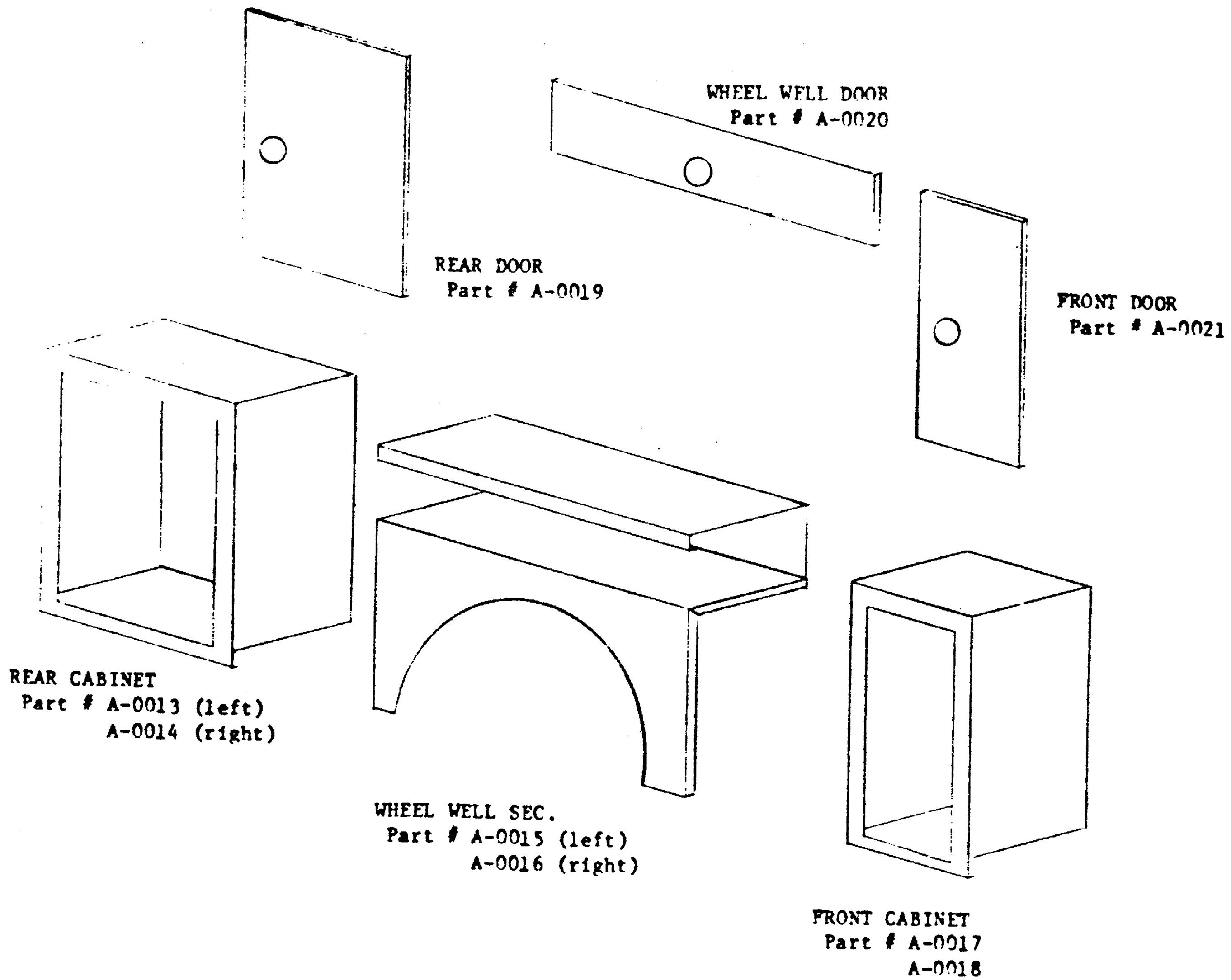
Part No.	Description	Manufacturer
1	Hose Bed Lights	Unity
2	Rear Warning Lights	Unity
3	Warning Buzzer Switch	Cole-Hersee
4	20' 2 Section Ladder	Duo-Safety
5	Attic Ladder	Duo-Safety
6	7" Tail and Stop Light	Weldon
7	7" Backup Light	Weldon
8	Hose Reel	Hannay
9	2 Section Hard Suction	Goodrich



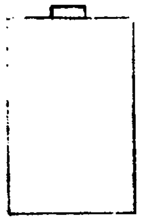
COMPLETE BODY LESS DOORS & HARDWARE
Part # A-0010



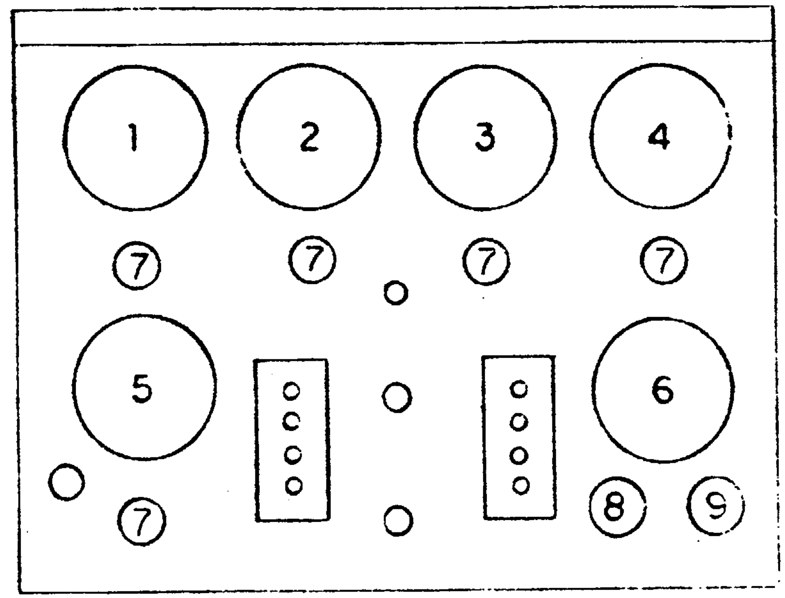
COMPLETE CABINET SIDE LESS DOORS & HARDWARE
Part # A0011 (left side)
A-0012 (right side)



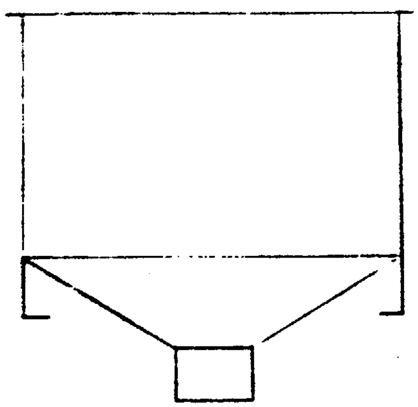
CABINET & WHEEL WELL SEC.



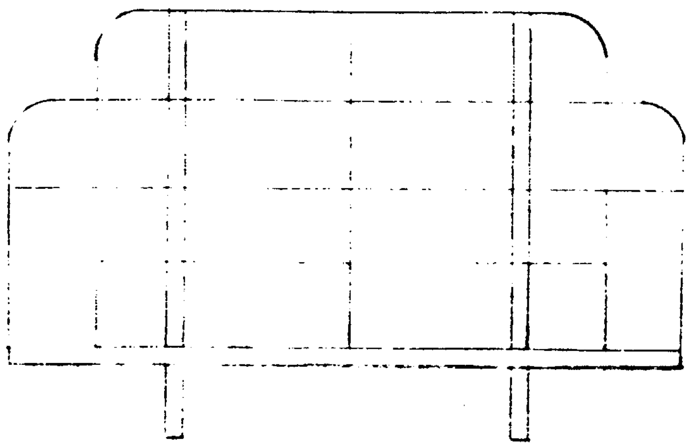
FOAM TANK
Part # A-0026



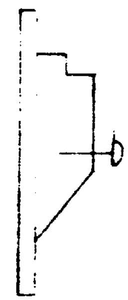
1-5 MARSF COMB. GAGES Part # 1-APF-24360-BFJ-001
6 S W TACH. Part # 82150
7 DARLEY VALVE Part # L978
8 WATER TEMP. GAGE Part # 82307 Sender 280ED
9 OIL PRESSURE GAGE Part # 82304 Sender 279A Light Sender D364L



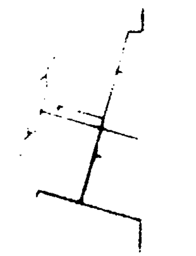
WATER TANK
Part # A-0025



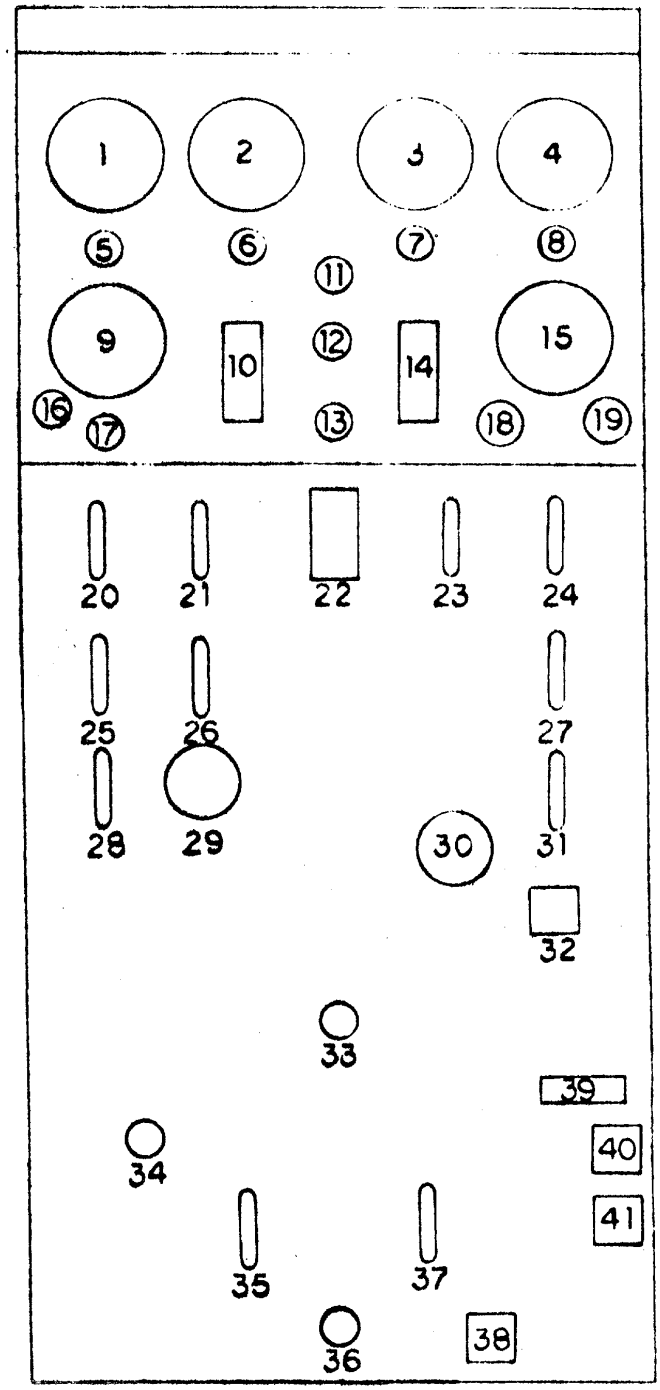
BRUSHGARD
Part # A-0022



LADDER BRK.
Part # A-0023



HOSE LAY
Part # A-0024



GAUGE & PUMP PANEL
FIGURE 3

1. Pressure Gauge
2. #1 Discharge Gauge
3. #1 Crosslay Gauge
4. #2 Crosslay Gauge
5. Gauge Dampers
9. Vacuum Gauge
10. Foam Level Gauge
11. Low Oil Pressure Indicator
12. Panel Light Switch
13. Pump Compartment Light Switch
14. Water Level Gauge
15. Tachometer
16. Throttle
17. Damper for Vacuum Gauge
18. Oil Pressure Gauge
19. Water Temperature
20. #1 Crosslay
21. .#2 Crosslay
22. Pressure Relief Valve
23. Water to Proportioner Valve
24. Tank to Pump Valve
25. Tank Fill Valve
26. Hose Reel Valve
27. Auxiliary Suction Valve
28. #1 Discharge Valve

30. Suction Manifold
31. Suction Manifold Valve
32. Pump Primer
33. #1 Discharge Drain
34. Engine Cooler
35. Pump Flush Valve
36. Proportioner Control
37. Foam to Proportioner Valve
38. Pump Drain

39. Test Gauge Panel
40. Battery #1 Charge Connection
41. Battery #2 Charge Connection

Figure 4
PRESSURE SIDE OF PUMP

A - 2 1/2" Discharge Valve
B - 2 1/2" Tee
C - 2 1/2" - 2 Bushing
D - 45° Elbow
EE - 90° Elbow (Pressure to Relief Valve)
F - 2 1/2" Cross
a - 2 1/2" - 1 1/2" Bushing
H - 1 1/2" Tee
I - 1 1/2" - 900 Elbow

J - Hose Reel Valve
X - Cross Lay Valves
N - 1/2" Tee
0 - Tank Fill Valve
P - Pump 250 GPM
Q - 450 Elbow
R,U - Discharge Elbow
V - Victaulic Couplings

Notes

1. Pressure Line to Eductor

3. Pressure Line to Foam Metering Valve

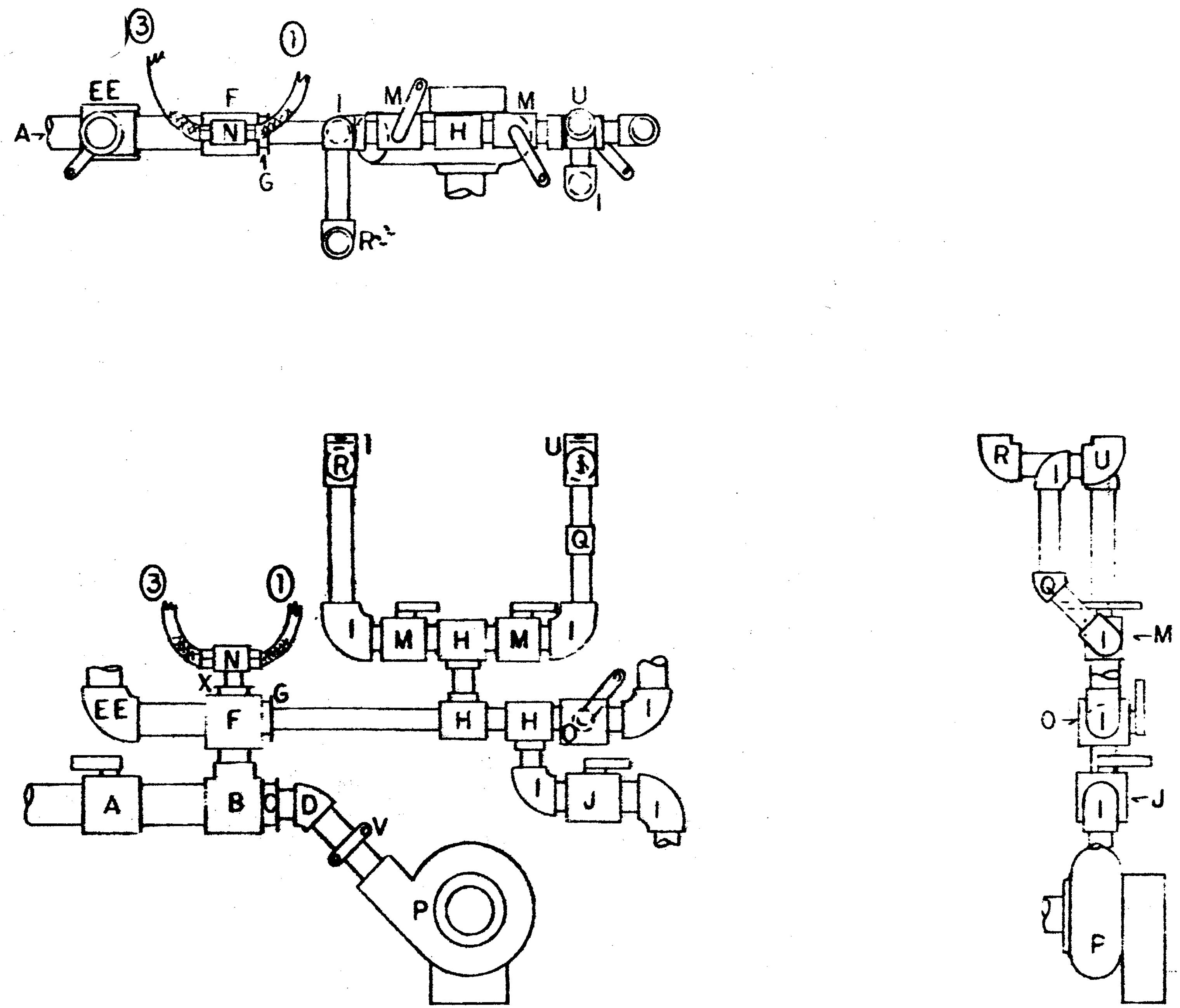

3
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FIGURE 4

Figure 5
SUCTION SIDE OF PUMP

A - Suction Inlet Valve (left side)
B - Suction Inlet Valve (rear)
C - 3" Tee
D - 34' - 450 Elbow
E - 3" - 900 Elbow
F - 3" to 2 1/2" Bushing
G - Relief Valve From Pressure Side of Pump
H - 2 1/2" Tee

I - Check Valve
J - Eductor
K - Water to Eductor Valve (1 1/2")
L - 1 1/2" Elbow
M - Tank to Pump Check Valve
0 - Tank to Pump Valve
P - Pump 250 GPM
V - Victualic Couplings

Notes

All Suction Piping is 3"
1. Pressure Lint to Eductor
2. Line From Foam Metering Valve

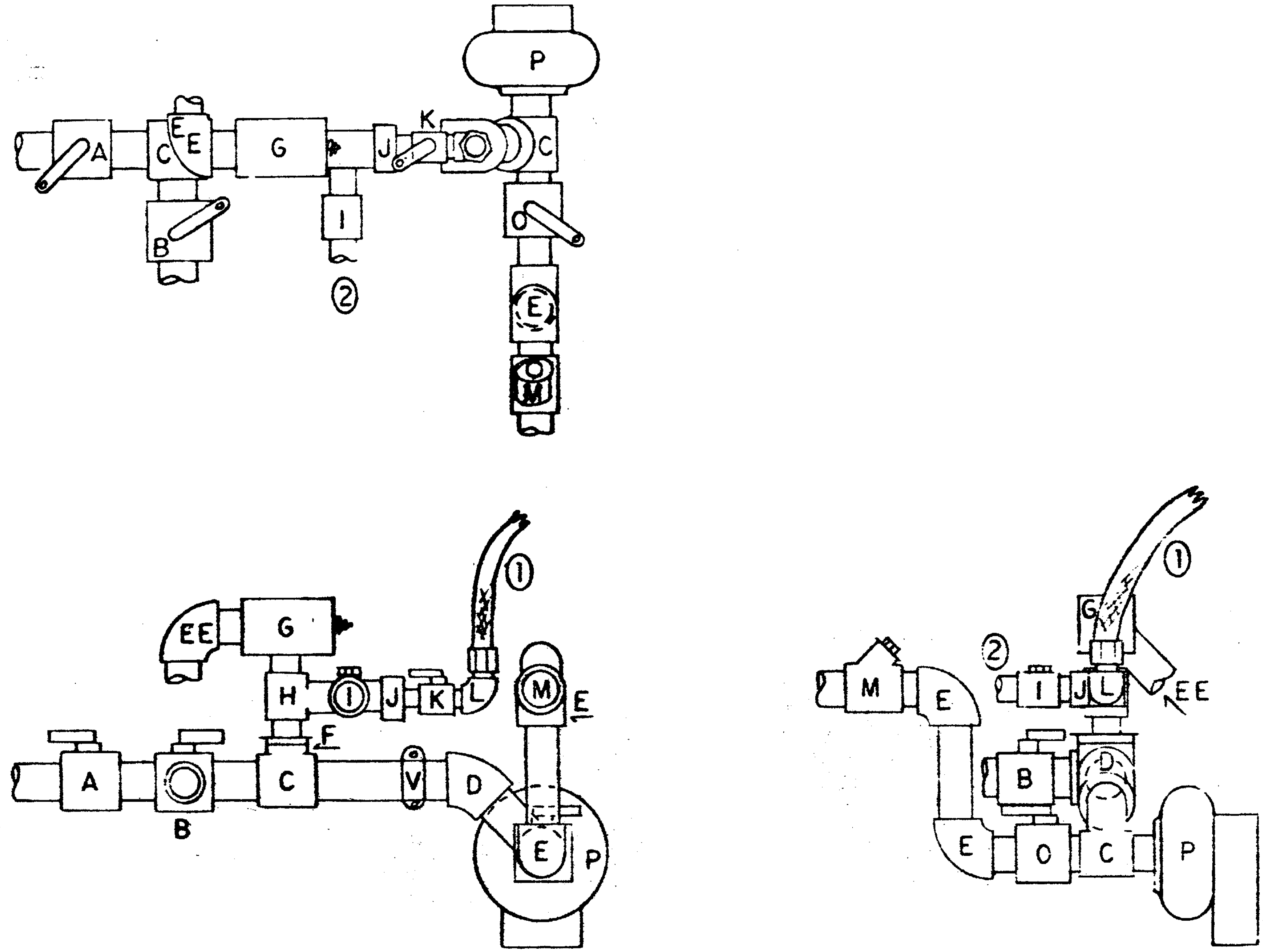


FIGURE 5
SUCTION SIDE OF PUMP
INCLUDING RELIEF VALVE AN FOAM EDUCTOR

Figure 5
SUCTION SIDE OF PUMP

A - Suction Inlet Valve (left side)

B - Suction Inlet Valve (rear!

C - 3" Tee

C - 3" - 45° Elbow

E - 3" - 90° Elbow

P - 3″ to 2 1/2" Bushing

G - Relief Valve Prom Pressure Side of Pump

H - 2 1/2" Tee

I - Check Valve

J - Eductor

K - Water to Eductor Valve (1 1/2")

L - 1 1/2" Elbow

M - Tank to Pump Check Valve

O - Tank to Pump Valve

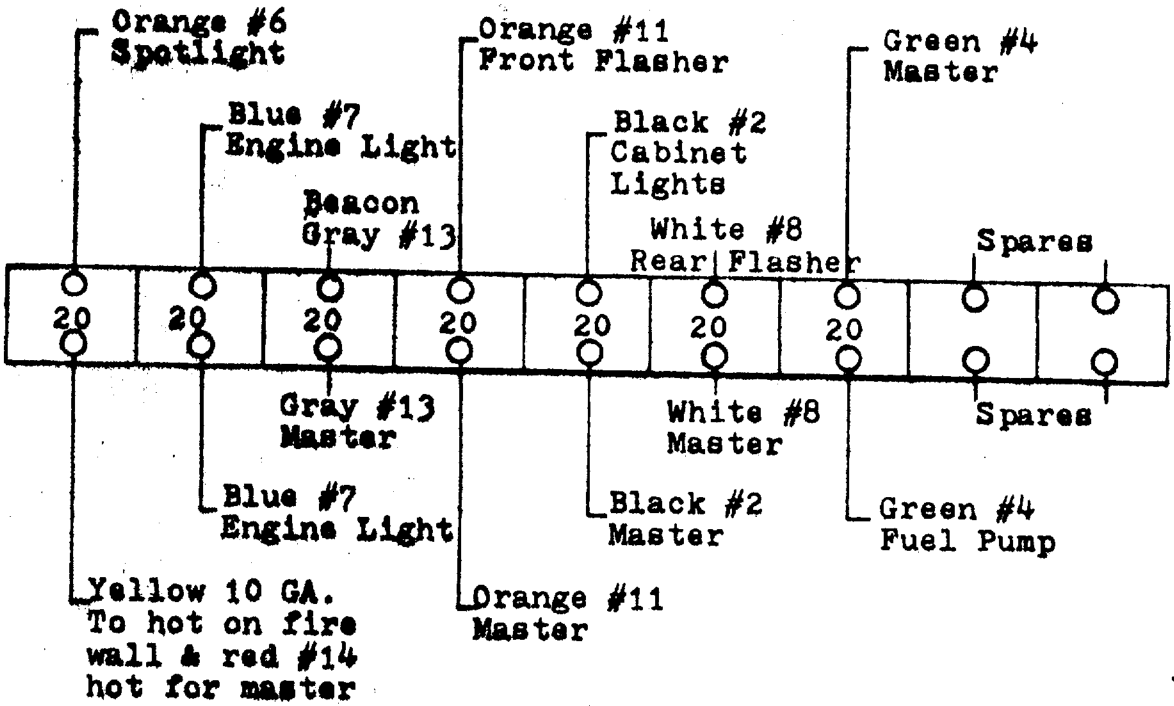
P - Pump 250 GPM

V - Victualic Couplings

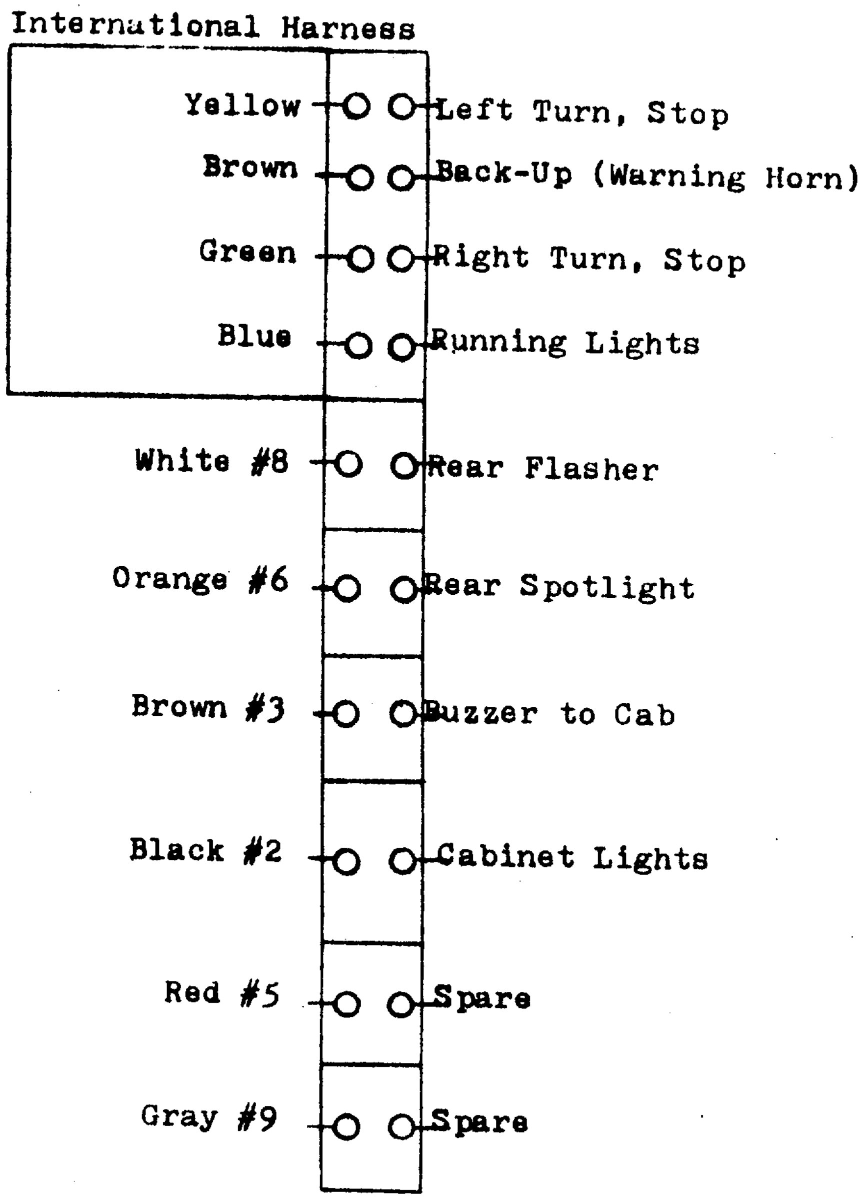
Note:

All Suction Piping is 3"

1. Pressure Lint to Eductor
2. Line From Foam Metering Valve



<u>Engine Wiring</u>
Blue #16 Water Temperature Sender
Yellow #1 Oil Pressure Sender
White #12 Tachometer


International Harness
Yellow
Left Turn, Stop
Brown
Back-Up (Warning Horn)
Green
Right Turn, Stop
Blue
Running Lights
White #8
Rear Flasher
Orange #6
Rear Spotlight
Brown #3
Buzzer to Cab
Black #2
Cabinet Lights
Red #5
Spare
Gray #9
Spare

A.W.W.#	DESCRIPTION	MANUFACTER NAME	MANUFACTER PART #
A-0025	LIGHT BAR	DIETZ	7-90101
A-0026	CLEAR LENS (LIGHT BAR)	"	77-79002
A-0027	SPOTLIGHT w/FLASHER	UNITY	10300 V
A-0028	RED WARNING LIGHTS (FRONT)	DIETZ	9-51204
A-0029	" " " (REAR)	UNITY	300R
A-0030	ELECTRONIC SIREN w/P.A.	FEDERAL	PA20A
A-0031	BACKUP ALARM	PRECO	LDA-50
A-0032	SWITCH MOUNT	FEDERAL	SW-70
A-0033	ROCKER SWITCH	"	SW-6
A-0034	MICERPHONE (P.A.)	"	MNC
A-0035	FLASHER	WELDON	9150
A-0036	CIRUIT BREAKERS	VELVAC	59L-amprage
A-0037	ELEC. FUEL PUMP	S.W.	235-A
A-0038	MASTER BAT. SWITCH	COLE HERSEE	M705
A-0039	J-BLOCK BOX	BERG	2002
A-0040	CIRCUIT BREAKER BOX	"	21411
A-0041	UNDER HOOD AND PUMP COMP.LIGHT	SIGNAL STAT	9363 W
A-0042	CABINET LIGHT SWITCH	COLE HERSEE	9003
A-0043	" " SOCKET	"	2609
A-0044	DECK BUZZER SWITCH	"	90030
A-0045	" "	"	4099
A-0046	HOSE REEL REWIND SWITCH	"	9231
A-0047	LOW OIL INDIC.LIGHT	"	PC-36-RC
A-0048	STOP & TAIL LIGHT	WELDON	3-1010-0300
A-0049	BACKUP LIGHT	"	1-1010-0320
A-0050	LIC. PLATE LIGHT	ARROW	437-08-332
A-0051	MARKER LIGHT	"	050-04-222
A-0052	RED REFLECTORS	"	217-00-210
A-0053	DECK LIGHTS	UNITY	AG
A-0054	FOAM LEVEL GAUGE	M.C.PROD.	16,5 DEEP
A-0055	WATER " "	"	30 DEEP
A-0056	PUMP 250 G.P.M.	HALE	CBP-4 ENG.ROT.
A-0057	P.T.O.	CHELSEA	260-AAHP-W3xD
A-0058	P.T.O. SHAFT	JOINT CLUCHT & GEAR	
A-0059	RELIEF VALVE	HALE	P25
A-0060	PRIMER	HALE	SMV-12
A-0061	AUX. HEAT EXCHANGER	"	EKE
A-0062	FOAM PROPORTIONER	FEECON CO.	HCAP-1.5
A-0063	1"FOAM " VALVES	AKRON	7810
A-0064	2.5"DISCHARGE VALVES	AKRON	2825
A-0065	3"SUCTION	"	830
A-0066	3" Tank to Pump Valves	"	7830
A-0067	1 1/2" CROSSLAY VALVES	ELKHART	2891KKD
A-0068	1 1/2" TANK FILL VALVES	"	2891KKD
A-0069	1 1/2" REEL HOSE VLAVES	"	2891KKD
A-0070	3-2 1/2" ADP. FOR SUCTION HOSE	AKRON	338
A-0071	2 1/2" PLUG w/CHAIN	"	347
A-0072	2 1/2"-2 1/2" ADP. FORE DISCHARGE	ELKHART	418-S
A-0073	2 1/2-1 1/2" " " "	"	A-327
A-0074	1 t/2" CAP w/CHAIN	"	310
A-0075	90° MATTYDALE ELBOW	"	348
A-0076	45° Elbow	"	105

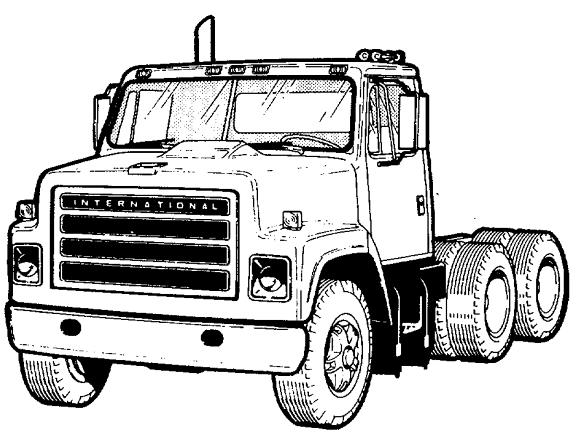
A-0077	3/4" DRAINS (DISCHARGE)	AKRON	7
A-0078	TEST PANEL	"	44
A-0079	3" CHECK VALVE	GRTNNEL	3310
A-0080	3" VICTAULIC	M.P.	STYLE90
A-0081	2" "	"	" "
A-0082	2 1/2" "	"	" "
A-0083	"T" PULL HANDLES	AKRON	1489
A-0084	HOSE REEL	HANNAY	EPF-28-23-24
A-0085	3" HARD SUCTION HOSE	GOODRICH	3" x 8'-21/2"
A-0086	1" BOOSTER HOSE	"	1' x 50' (800 l
A-0087	HARD SUCTION HOLD DOWN CLAMP	UNV. FIRE. APP.	4 x 4 1/2" Dou;
A-0088	LADDER BRK. CLAMPS	ELKHART	775-7
A-0089	HANDRAIL BRK.	AKRON	601
A-0090	20' 2 SEC. LADDER	DUO SAFTEY	1000-A
A-0091	10' FOLDING (ATTIC) LADDER	"	585-A
A-0092	HOSE REEL NOZZLE 1"	AKRON	1708
A-0093	"D" HANDLES	HANSON	92-C
A-0094	CROSS LAY ROLLERS	HANNAY	B-7" ve. B-2 1/2" Horz.
A-0095	SPARK ARESTER	WALKER	21580
A-0096	FOLD STEP	POLAR	900
A-0097	GRAB HANDLE (CAB)	VALVAC	69023
A-0098	BAT. COVER (CHARGER)	BELL	224V
A-0099	BAT.CHARGER OUTLET	HUBBEL	5552-B
A-0100	" " PLUG	"	9758VY

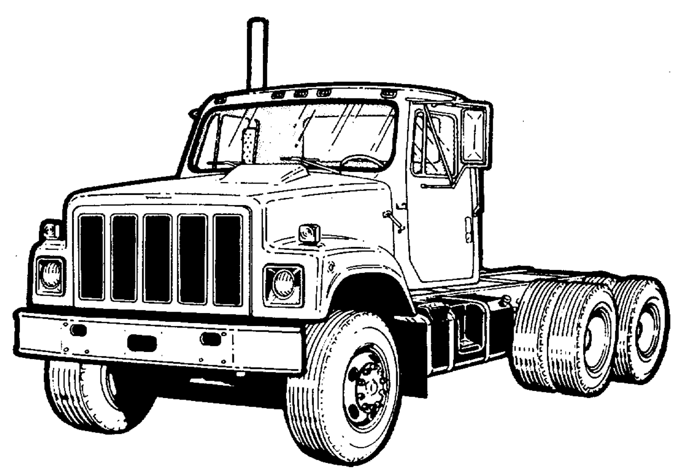
INTERNATIONAL

SECTION I

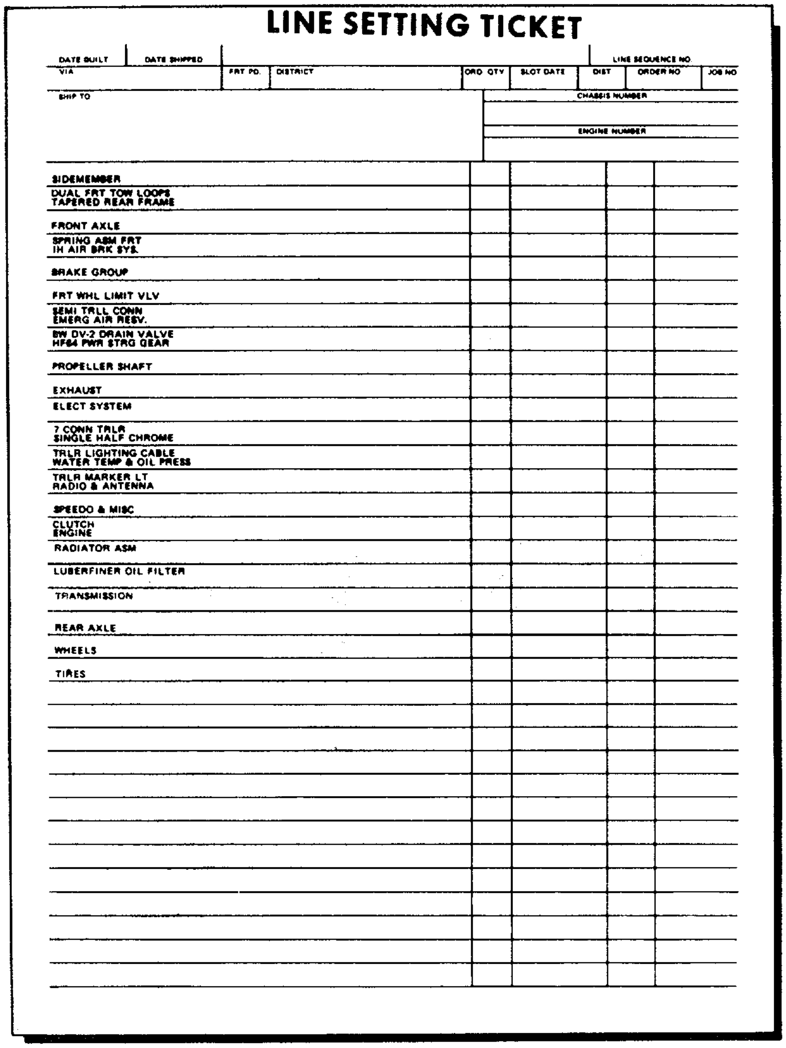
OPERATOR'S MANUAL

S SERIES





CONTROLS - INSTRUMENTS - GAUGES
LUBRICATION - MAINTENANCE - OPERATION
SAFETY - SPECIFICATIONS



LINE SETTING TICKET

DATE BUILT | DATE SHIPPED | LINE SEQUENCE NO

VIA | FRT PO. | DISTRICT | ORD QTY | SLOT DATE | DIST | ORDER NO | JOB NO

SHIP TO

CHASSIS NUMBER

ENGINE NUMBER

SIDEMEMBER
DUAL FRT TOW LOOPS
TAPERED REAR FRAME
FRONT AXLE
SPRING ASM FRT
IH AIR BRK SYS.
BRAKE GROUP
FRT WHL LIMIT VLV
SEMI TRLL CONN
EMERG AIR RESV.
BW DV-2 DRAIN VALVE
HF64 PWR STRG GEAR
PROPELLER SHAFT
EXHAUST
ELECT SYSTEM
7 CONN TRLR
SINGLE HALF CHROME
TRLR LIGHTING CABLE
WATER TEMP & OIL PRESS
TRLR MARKER LT
RADIO & ANTENNA
SPEEDO & MISC
CLUTCH
ENGINE
RADIATOR ASM
LUBERFINER OIL FILTER
TRANSMISSION
REAR AXLE
WHEELS
TIRES

The code numbers on the line setting ticket positively identify units used in building your vehicle. You can be sure of getting the correct replacement parts if you take the line setting ticket with you.

DO NOT REMOVE THE LINE SETTING TICKET ATTACHED TO THE VEHICLE.

IMPORTANT

You were presented with an "Owners Service Policy" by the dealership from whom you purchased your new International vehicle.
Should the occasion arise where warranty service is required it will be necessary that you present to the servicing dealer this "Owners Service Policy" to verify warranty qualification. For this reason it is important that this policy be kept with the vehicle at all times.

NOTICE

Those instructions, illustrations and specifications comprising this Operator's Manual were compiled from latest information available at publication time.

The International Harvester Company reserves the right to make changes or improvements without notification or applying these changes or improvements to vehicles previously manufactured.

TABLE OF CONTENTS

TO THE OWNER AND OPERATOR

INTRODUCTION

This manual will familiarize you with your vehicle and provide sufficient information to enable you to perform minor services necessary for continued efficient operation. Study this manual before you start to operate the vehicle.

When parts are required, always provide the unit code number, vehicle model and vehicle serial number. Request the salesman to assist you in obtaining this information upon delivery, and write this information in the spaces provided.

For information not given in this manual, or if you require services of a trained serviceman we urge you to contact an IH dealer in your locality. IH dealers keep abreast of the latest methods in servicing IH equipment, and have up-to-date facilities for providing prompt, first-class service.

ENGINE SERIAL NUMBER
CATERPILLAR
(Plate on left rear side of crankcase.)

CUMMINS ENGINES
(Stamped on plate, left side of gear case, front of engine.)

DETROIT DIESEL
(Stamped on crankcase, right side near rear end plate.)

DT-446
(Stamped on pad located on crankcase left side.)

9.0 LITER
(Stamped on crankcase front corner right bank.)

D-150 D-170 D-190
(Stamped on crankcase front corner right bank.)

MV-404 MV-446
(Front of distributor on crankcase.)

V-345 V-392 V-537
(Stamped on crankcase front corner right bank.)

(For Caterpillar, Cummins, Detroit Diesel, IH DT-466, 9.0 liter and D-150-170-190 engines, refer to separate Operator's Manual).

FRONT AXLE CODE

(From line setting ticket)

REAR AXLE CODE

(From line setting ticket)

TRANSFER CASE CODE

(From line setting ticket)

TRANSMISSION CODE

(From line setting ticket)

VEHICLE IDENTIFICATION

Stamped on frame left side rail front (and at the following location)

(Stamped on plate cab door inner panel, left side)

VEHICLE CERTIFICATION LABEL

A Vehicle Certification Label is affixed to all vehicles in addition to the serial or warranty plate. This label certifies that the vehicle conforms to all applicable Federal Motor Vehicle Safety Standards in effect at the date of manufacture.

<u>Do not remove or deface this label</u>. The label contains the Certified Gross Vehicle Weight Rating (GVWR) and Gross Axle Weight Rating (GAWR). The GVWR means the maximum design weight of the vehicle including the vehicle itself and everything that is loaded into or onto the single vehicle. The GAWR is the maximum weight that any one axle can carry. Note that the sum of the axle GAWR's may be greater than the GVWR, so that it is not necessarily proper to load both axles at the same time to the maximum capacity shown for each. The maximum GVWR should never be exceeded.

These ratings are developed on the basis of the minimum component capability, be it axles, springs or tires.

For assistance in understanding your vehicle weight carrying capability, consult your local IH dealer.

VEHICLE STORAGE INSTRUCTIONS

When a vehicle is not to be used for an extended period of time certain precautionary measures must be observed to prevent deterioration of the various units. It is recommended that you contact your dealer who will advise you of measures to be taken when storing vehicles, as well as precautions to be followed when a vehicle is to be returned to service.

TO THE OWNER AND OPERATOR
OWNER ASSISTANCE GUIDE

It is our sincere belief that every customer is entitled to, and shall receive, two distinct services--one from the product itself and the other from the firm who sells and services that product.

If, for any reason, you do not feel you are receiving these services in connection with the operation of your vehicle or the sales transaction, you should return to the dealership from which your vehicle was purchased so that these matters can be corrected to your satisfaction. If the matter is not resolved at that time, it is suggested that the following procedures be followed:

A. CONTACT A MEMBER OF MANAGEMENT AT THE SELLING LOCATION.

Discuss the details of the difficulty. In most instances any problem can be resolved to your satisfaction by the owner or manager in charge.

B. IF YOUR PROBLEM IS NOT RESOLVED AT THE SELLING LOCATION, CONTACT THE CLOSEST <u>INTERNATIONAL TRUCK REGION</u> TO YOUR RESIDENCE AS LISTED ON THE FOLLOWING PAGE.

The matter will receive the attention of the Regional Service Department. It would be very helpful to include the following information in your communication.

1. Name under which new vehicle was purchased, address and telephone number of purchaser.
2. Vehicle model and year.
3. Vehicle delivery date and present mileage.
4. Location where purchased.
5. Details of the problem.

C. IF YOUR PROBLEM STILL REMAINS UNRESOLVED, CONTACT THE MANAGER, CUSTOMER RELATIONS, TRUCK DIVISION,

INTERNATIONAL HARVESTER CO.
401 North Michigan Avenue
Chicago, Illinois 60611

IN CANADA:

INTERNATIONAL HARVESTER CO.
3228 South Service Road
Burlington, Ontario L7N3K9

Please provide the information requested in Procedure B, plus the following:

1. Name of person and date contacted in Procedure A.
2. Name of person and date contacted in Procedure B.

He will review the matter and provide direction to the personnel directly responsible for the sales and service of our products in the area in which you reside.

You will be contacted by a Company representative for final disposition.

We sincerely appreciate your purchase of an INTERNATIONAL vehicle. Remember, you are entitled to and shall receive every consideration and complete service involving your vehicle. Thank you for favoring us with your business!

TO THE OWNER AND OPERATOR

TRUCK SALES REGIONS

EASTERN
International Harvester Company
Two Echelon Plaza - Suite 150
Voorhees, New Jersey 08043
(609) 772-1400

SOUTHEAST
International Harvester Company
1726 Montreal Circle - Suite 18
Tucker, Georgia 30084
(404) 934-0660

EAST CENTRAL
International Harvester Company
Suite 519 - Holiday Park Tower
644 Linn Street
Cincinnati, Ohio 45203
(513) 651-3800

MIDWEST
International Harvester Company
1525 Holmes Street
Kansas City, Missouri 68108
(816) 471-2007

SOUTHWEST
International Harvester Company
4825 LBJ Freeway - Suite 280
Dallas, Texas 75215
(214) 744-4131

WESTERN
International Harvester Company
8393 Capwall Drive
Oakland, California 94621
(415) 568-6300

IN CANADA:

ONTARIO

International Harvester Company
3228 South Service Road
Burlington, Ontario L7N3K9
(416) 681-1311

CONTROLS

CARBURETOR CHOKE

The choke is used to enrich the fuel mixture by restricting the air flow to the carburetor. The distance the choke control is pulled out regulates the fuel-air mixture and increases the engine speed to a fast idle to prevent stalling during the engine warm-up period. Push the choke in when the engine is warmed up.

CARBURETOR THROTTLE

The throttle control may be used to open the throttle slightly when starting the engine or to set the throttle at any position to maintain a constant engine speed.

CIGAR LIGHTER

The cigar lighter is located on the instrument panel. Push the lighter knob in all the way. The lighter will automatically return to the normal position when hot.

DOOR CONTROL AND LOCK

To lock the doors from inside the cab, push the door lock control downward. To unlock the doors, pull the control upward.

To lock the doors from the outside, doors must be locked with a key, turn the key clockwise and remove. To unlock, turn the key counterclockwise and remove.

To open door from outside, insert fingertips into door control recess and pull handle outward.

To open door from inside, pull upward on handle.

Keep doors locked when vehicle is in motion.

DOOR GLASS WINDOW REGULATOR

To lower door glass, turn window regulator handle clockwise. To raise glass, turn handle counterclockwise.

ENGINE STOP (Diesel Engine)

To stop engine pull out on control.

FRONT AXLE CONTROL (4x4)

The front axle control engages or disengages the front axle.

See Vehicle Operation section for operating instructions.

FUEL GAUGE SWITCH

(Vehicles Equipped with Auxiliary Fuel Tanks)

The fuel gauge switch should be positioned to indicate the tank (left, right or forward rear) from which fuel is being used. The fuel gauge will only indicate the level of the fuel in the tank being used.

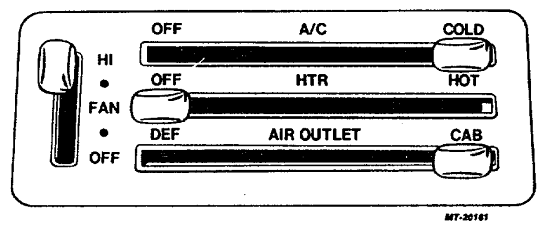
FUEL PRIMER SWITCH (DIESEL ENGINE)

This truck is equipped with an electric in-tank mounted fuel pump. In addition, an electric fuel system primer switch is located on the instrument panel.

HEADLIGHT BEAM SELECTOR

The beam selector permits the driver to lower the headlight beam when approaching or passing vehicles, and to raise the headlight beam for open highway use or whenever necessary. A light located in the instrument cluster glows when the headlights are on "upper" beam. See gauges and instruments for location of indicator light.

HEATER-AIR CONDITIONER



IMPORTANT

The air conditioning system incorporates a low pressure switch which disengages the compressor clutch if evaporator outlet falls below a certain level. To restart the air conditioning system after an automatic shut-down has occurred, the operator must do one of the following:

1. Place "A/C" lever in "OFF" position and then back "ON".

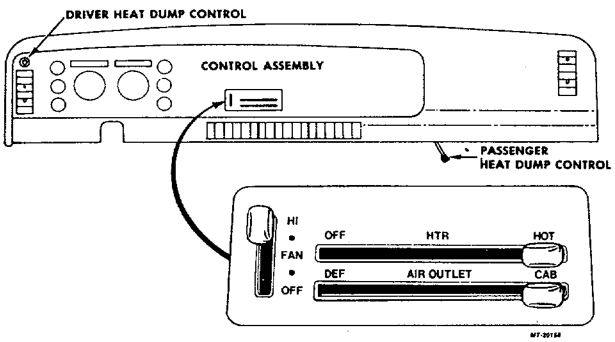
2. Place blower switch in "OFF" position and then back "ON".

If system continues to shut down automatically, it will be necessary to have the system checked for the cause of low pressure

CONTROLS

HEATING

For proper cold weather operation the heat should be directed toward the floor level; therefore, close all instrument panel outlets and fully open driver floor dump outlet. The driver floor dump is cable operated from a push-pull control at the instrument panel's upper left-hand side.



Adjust the temperature "HTR" (heat) lever as required to give the desired degree of heat. The full right "HOT" position provides the maximum heat. Move the "AIR OUTLETS" control lever either to the full cab position or to any of the other three detented positions in order to obtain the desired air flow distribution between cab heat and defrost requirements. For the maximum air flow, move the fan switch to the "HI" position. The heater will also operate with the fan motor in the "OFF" position due to the ram air introduced during vehicle operation.

DEFROSTING

To obtain maximum defrosting, move the "HTR" lever to the "HOT" position and place the "AIR OUTLETS" lever on "DEF". Adjust the fan speed to provide the desired air flow.

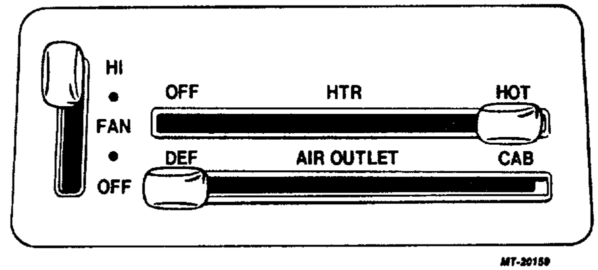
CAUTION

To clear system of humid air, operate blowers for 30 seconds at "HI" speed before moving the "Air Outlets" lever to the "Def" position. This will minimize rapid fogging of the glass, which can occur if humid air is blown onto a cool windshield.

REMEMBER a fogging condition limits vision thru the windshield, which could result in personal injury or property damage in the event of an accident.

NEVER drive vehicle unless windshield, rear window, rear view mirrors and other surrounding glass area is clear.

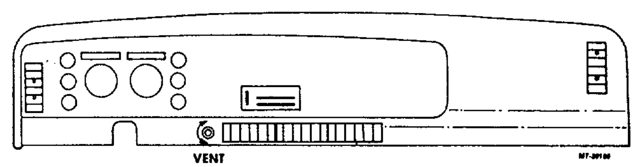
To improve defroster efficiency, remove ice and/or snow from glass area.



FRESH AIR VENTILATION

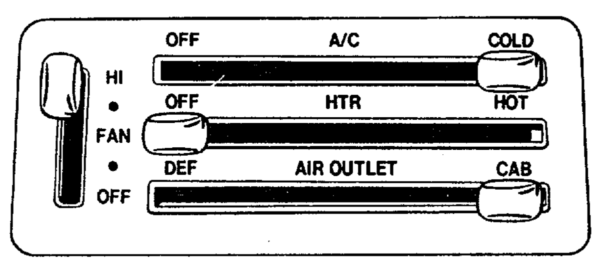
Fresh air enters the cab through either an independent ventilation system or through the heater system itself. The ventilation system is controlled by rotating the vent knob located just left of the center instrument panel outlets. When the knob is turned counterclockwise, air enters the cab from the hood scoop and flows through the instrument panel outlets and floor dump. Except for the ventilation mode, the knob should be rotated to its full clockwise position (vent door closed) for all other modes of operation.

To increase the quantity of air entering the cab in the ventilation mode, the fan may be used to power ventilate. Adjust the fan speed and air outlets for the desired air flow.



AIR CONDITIONING

To properly air condition your cab in warm weather close the driver heat dump and open the instrument panel outlets. Close all windows and ensure the vent knob is turned to its full clockwise position (vent door closed). Set the "OFF" position and "A/C" lever on "COLD". For maximum cooling move the "FAN" switch to the "HI" position. (The fan must be' on for A/C operation.) Place the "AIR OUTLETS" lever on the "CAB" position, then adjust the instrument panel outlets to evenly distribute the air around the occupant's head, chest and belt areas. If foot areas feel warm, partially open heat dump to achieve desired comfort.



CONTROLS

IMPORTANT

Always park in the shade when possible.

If your vehicle has been parked in the sun with the windows up, remove overheated air inside by driving with windows down and the air conditioner "ON" for one or two city blocks.

At least once or twice a month turn on the air conditioner for a few minutes while the engine is running. This periodic operation keeps all the mechanical parts of your air conditioner in good operating condition.

Have your IH air conditioner checked each spring for refrigerant, compressor oil level and belt tension. Keep radiator area free of bugs, leaves, etc.

Do not cover the condenser in front of radiator with a screen wire. Small amounts of water draining out moisture which has been removed from the air inside your vehicle. Air conditioning sometimes causes engine of the vehicle to run slightly warmer than usual.

STALE AIR AND SMOKE

To remove stale air or smoke while air conditioner is operating, you may want to open a window vent slightly for a short period of time.

SERVICE CHECK-UPS

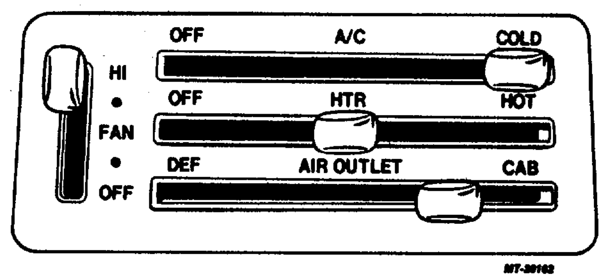
Compressor belt tension should be checked periodically. Keep radiator and condenser areas free of bugs, leaves, etc. Do not cover the condenser with a screen wire. Small amounts of water draining out of air conditioner's drain tube is normal and represents condensed moisture which has been removed from the air inside your vehicle.

AIR FILTER

When air conditioner is being used daily, remove air filter once each season and check for dirt, lint, etc. Replace if necessary. Vehicles operating in unusually dusty conditions may require replacing the air filter more often.

DEHUMIDIFICATION

The heater-defroster systems can be operated simultaneously with the air conditioner during mild weather and high humidity conditions for dehumidification of the moist air. To obtain maximum dehumidification, set the "A/C" lever to "COLD", place the fan switch on "HI" and move the "HTR" lever towards "HOT" until a comfortable temperature is maintained. The air conditioner will remove the humidity while the heater keeps the cab comfortable.



HORN

In compliance with Noise Control Laws as stipulated in certain localities, the operator must be aware of the proper horn to use when within City Limits. If this vehicle is equipped with both an electric and air horn system, the electric horn will be known as the "City" horn while the air horn will be known as the "Country" horn.

WHEN TO USE

Electric Horn (City Horn)

The electric horn (city horn) is applicable to operations within the City Limits.

Air Horn (Country Horn)

The air horn (country horn) is restricted to operation outside the City Limits.

HOOD
RAISING THE HOOD

1. Release latch at each side of cowl.
2. Pull on hood tilt assist handle at front of hood.

LOWERING THE HOOD

1. Slowly lower hood to closed position.
2. Engage latches at side of cowl.

IGNITION SWITCH

See Engine Starting under Vehicle Operation.

LIGHTING SWITCH

When the lighting switch is pulled out halfway, the parking, side marker and taillights are

CONTROLS

"on". When the lighting switch is pulled out all the way, the headlights, side marker lights and taillights are "on". To light the instrument panel, turn the light switch control to the left; a built-in rheostat controls the intensity of the panel light from "off" to full "on". To turn the cab interior light on, turn the lighting switch control counterclockwise to the extreme left position.

PARKING BRAKE CONTROL

The primary purpose of this brake is to hold the vehicle in a parked position or to assist in bringing it to an emergency stop. The parking brake should not be used to brake the vehicle during normal driving.

AIR OPERATED

To apply the parking brake, pull out control. To release the parking brake, push in on control.

If air pressure is reduced to approximately 69 kPa (10 psi) in both the primary and secondary systems, the parking brake control will automatically apply.

MECHANICAL

The Orscheln (parking) brake lever is the over-center locking type. It is tightened (while released) by turning the adjusting knob clockwise. When properly adjusted, it pulls overcenter with a distinct click.

POWER DIVIDER LOCK CONTROL
(For tandem drive axles)

The power divider lock control is used with vehicles equipped with dual rear axles having inter-axle differentials.

A light, located on the instrument panel will illuminate when the power divider lock is engaged.

POWER TAKE OFF CONTROL

The power take off control is used to assist in operating the winch, dump body or wrecker equipment.

RADIO

ON OFF SWITCH & VOLUME CONTROL The on-off switch and volume control are combined and are operated with the left-hand knob.

TONE CONTROL Tone control is behind the on-off switch. Turn the tone control fully clockwise for voice position; mid-position for music; fully counterclockwise for bass.

TO TUNE STATIONS MANUALLY Turn the right-hand knob either left or right.

PUSH-BUTTON TUNING is accomplished by firmly pressing one of the push-buttons which automatically selects the station for which it was set. (See Section "TO SET PUSH-BUTTONS".)

FADER/BALANCE CONTROL Fader/Balance Control is behind tuning knob. Turn control knob either clockwise or counterclockwise to get desired relative volume between speakers. (All models do not have this control.) To Set Push Buttons.

Stations may be set up in any order. However, for convenience in remembering, it is suggested that stations be set up in frequency sequence.

1. Turn radio on and allow to operate for fifteen minutes.

2. Unlock push-buttons by pulling them out.

3. Accurately tune in a station with the manual tuning knob.

4. Lock on push-button to that station by pushing firmly in.

5. Repeat above procedure to remaining pushbuttons.

In metropolitan areas, it is recommended that the push-buttons be set up on a shielded place where signals are weak, such as under a viaduct or in a steel-constructed building.

Antenna Trimmer Adjustment (Radio)

a. Turn radio on and increase volume until an audible sound or station is heard.

b. Tune in a weak station (or random noise level between stations) between 1400 and 1600 KHz.

c. Remove right radio control knobs (pull out).

d. Insert screwdriver through access hole in radio mounting cover and adjust antenna trimmer screw for maximum volume.

CONTROLS

REAR VIEW MIRROR

The rear view mirror contributes to safe operation of the vehicle and can be adjusted to the position desired by the operator.

RECEPTACLE (Ash)

The ash receptacle is located in the center of the instrument panel and is convenient to both the operator and passenger.

SEAT ADJUSTMENT
(Standard Seat)

Position yourself behind the steering wheel and push the seat adjustment lever toward the rear of cab to release the locking mechanism. Then move the seat forward or backward to desired position.

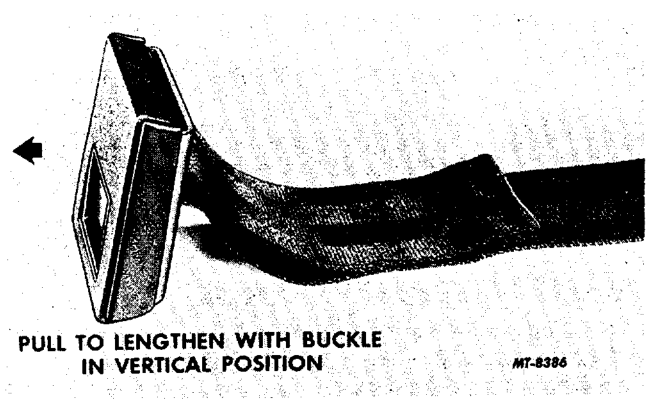
Adjustment instructions for optional seats may be found on seat base.

SEAT BELTS

Use of Seat Belts. Seat belts should be worn at all times. Before fastening a front seat belt, always adjust the driver's seat to the position in which you will drive. Seat belts should be worn across the pelvic region (hip bone) and adjusted snugly. Never adjust a seat belt across the abdomen.

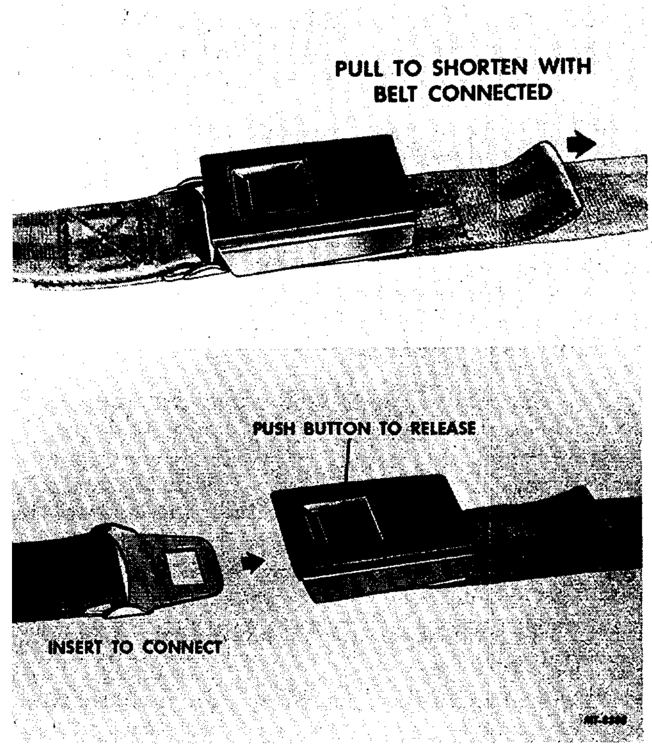
To Lengthen Tip the buckle end downward, as shown, and pull the buckle until the ends can be joined. Insert tongue into open end of buckle and snap together. The belt can be shortened after it is connected by pulling on the loose end until the belt is snug and comfortable.

To Release Push in on the button release latch to release the seat belt.



Always pull the belt completely out of the retractor before adjusting and fastening the other half of the belt unit.

Care of Seat Belts Seat belts should receive the same care as the finest fabric. Clean with mild soap; do not use cleaning solvents or abrasives.



CAUTION

Do not bleach or re-dry color webbing as same may cause a severe loss of strength.

This loss of strength could allow the seat belt to break upon vehicle impact, thus resulting in personal injury.

The entire seat belt assembly should be inspected periodically for corrosion, wear, fraying or weak spots. The seat belt mounting bolts should be tight at all times. Any seat belt severely strained in an accident should be replaced immediately. All belts should be replaced at least every five years.

SUN VISOR

To shade the operator's eyes from the direct rays of the sun, the visor can be positioned at the door window as well as at the windshield.

CONTROLS

TRAILER EMERGENCY VALVE (TRACTOR PROTECTION)

With the control in "Released" position, the service and emergency braking functions of the tractor and trailer are normal in all respects.

Should a condition resulting in severe air loss from the tractor or trailer system be detected, or if for any other reason it is desirable, in the operator's opinion, to cause an emergency application of the trailer brakes, and to close off both the service and emergency brake lines on the tractor, the operator can move the control to the "Emergency" position. If the control is not moved from the "Released" position under these conditions, the tractor protection valve will automatically close the air lines leading to the trailer and apply the trailer brakes.

The operator should also move the control to the "Emergency" position when connecting or disconnecting the trailer, or when operating a truck-tractor without a trailer. It is important that, after connecting to a trailer, the control be returned to "Released" position to permit charing of the trailer air system and normal braking control of both tractor and trailer.

TRAFFIC HAZARD WARNING LIGHT SWITCH

The traffic hazard warning light switch is required to flash both front and rear directional signals simultaneously, thus warning traffic of an emergency. The switch is located on the end of the turn signal control.

With the turn signal lever in center position, pull switch out to operate signal lights. To turn off, push switch in. Hazard warning operation is indicated by simultaneous flashing of both turn signal indicators. Hazard warning system should be used for emergency only in compliance with the laws of the state in which the vehicle is operated.

TRAILER BRAKE HAND CONTROL

The trailer brake hand control is used to apply the trailer brakes without the use of the tractor brakes. On slippery roads, use the trailer brake control to prevent the trailer from jackknifing.

IMPORTANT

Do not use the trailer brake hand control for parking purposes.

Have the air brake system periodically inspected by your IH Dealer for safety on the highway.

TRAILER MARKER LIGHT SWITCH

This switch controls the clearance (marker) lights on the cab and trailer.

TRANSFER CASE CONTROL (4x4)

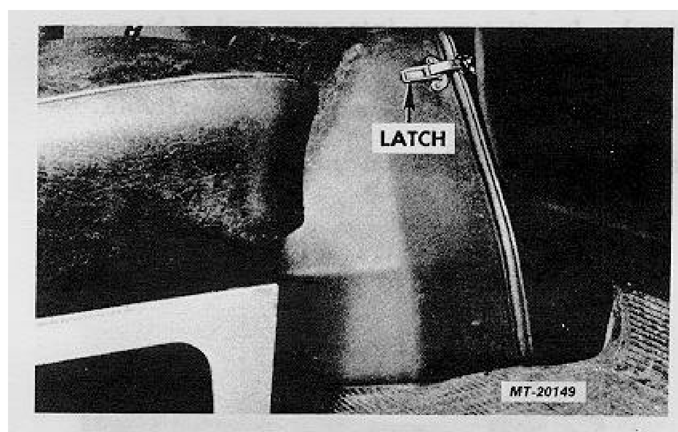
The transfer case control is used to select the high or low speed range of the transfer case See Vehicle Operation section for operating instructions.

TRANSMISSION CONTROLS (Main and Auxiliary)

These controls are used to select the various gear ratios or speeds provided within the transmission.

See Vehicle Operation section for operating instructions.

TUNNEL COVER (Engine)



To remove the engine cover (in cab), pull outward on the cover latches.

TURN INDICATOR CONTROL

To signal for a right turn, push the control away from you. For a left turn, pull the control toward you. Signal lights on the front and rear of the truck and in the instrument cluster "blink" on and off when the turn indicator is operating.

CONTROLS

TWO-SPEED REAR AXLE SWITCH

A switch attached to the transmission control permits selection of either the high or low axle ratio. When the switch control is pushed down, the axle is in low (power) ratio. When the switch control is pulled up, the rear axle is in high (speed) ratio. See Vehicle Operation section for operating instructions.

VENT WINDOW LOCK

To open the vent windows, turn the lock clockwise and push the window outward to the position desired.

WINDSHIELD WASHERS

To operate the windshield washers, press in on the switch on the instrument panel to spray solution on the windshield. Then, turn on the windshield wipers to clean the windshield.

Keep the fluid reservoir filled with IH windshield washer solvent.

WINDSHIELD WIPER CONTRO
Air and Electric)

Pulling the knob outward or turning the knob to the right starts either the air or electric wipers. Speed of the air wiper can be regulated as desired by rotating the knob. The electric wiper has two speeds, "high" and "low".

IMPORTANT

To avoid damage to mechanism of the windshield wiper, DO NOT MOVE THE WIPERS BACK AND FORTH BY HAND. Lift the blade outward when cleaning the windshield.

GAUGES AND INSTRUMENTS

BRAKES-AIR

AIR GAUGE, LOW AIR PRESSURE BUZZER AND INDICATOR LIGHT

Should air pressure in either section of the dual air brake system be reduced to 483 ± 41 kPa (70 ± 6 psi) the warning buzzer will sound and a light on the instrument panel will glow. Also, the air gauge/gauges will indicate low air pressure in at least one of the independent systems.

The warning buzzer and light will automatically shut off when the air pressure in both systems is sufficient, approximately 483 kPa (70 psi) to operate the vehicle.

Should the light and buzzer not shut off soon after start-up, the air pressure gauge should indicate at least one section of the dual system has low air pressure. If the light, buzzer and gauge indicate a loss of pressure while driving, the vehicle still has a portion of the braking capability.

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 the portion of dual air system not having a failure.

ANTILOCK MONITOR (Warning) LIGHT

This light indicates condition of the antilock system. Refer to "Brakes Air" under Vehicle Operation.

BRAKES-HYDRAULIC

The vehicle may be equipped with either a single hydraulic brake system (codes 04011 or 04058) or split hydraulic system (codes 04044, 04055 or 04059) depending upon the front axle gross weight rating.

There are two (2) brake indicator lights (except vehicles with single system less vacuum reservoir) located on the instrument panel to determine the general condition of the hydraulic brake system. They are "PARK BRAKE" and "BRAKE PRESSURE".

PARK BRAKE INDICATOR (Bus chassis only)

The "PARK BRAKE" indicator is operated in conjunction with the parking brake. During engine cranking period the "PARK BRAKE" indicator should illuminate. This light will go out after engine is started providing the parking brake is not applied. If parking brake is applied, this light will remain on after engine has started. If light does not illuminate during cranking period the light bulb may be defective.

BRAKE PRESSURE INDICATOR (For Brake Codes 04011 and 04058 with Vacuum Reservoir Code 04510)

The BRAKE PRESSURE INDICATOR in the single hydraulic system indicates only vacuum supply available in vacuum reservoir.

When the ignition switch is turned to "ON" position with engine off and no vacuum reservoir supply, the "BRAKE PRESSURE" light should illuminate indicating that the light bulb is functioning. If vehicle has a vacuum supply, pump the brake pedal to. deplete the vacuum supply. BRAKE PRESSURE INDICATOR should then illuminate with engine off and ignition switch "ON". After the engine has started the "BRAKE PRESSURE" light should go off indicating that the hydraulic brake system has a vacuum supply.

BRAKE PRESSURE INDICATOR (For Brake Code 04044,04055,04059)

When the ignition switch is turned to "ON" position with engine off, the "BRAKE PRESSURE" light should illuminate indicating that the light bulb is functioning. After the engine has started the "BRAKE PRESSURE" light should go off indicating that the hydraulic brake system is functioning properly. Continued illumination of the "BRAKE PRESSURE" indicator could be caused by either a loss of power booster assist, low vacuum or a faulty condition in one side of the split hydraulic system.

Should the "BRAKE PRESSURE" light come on during vehicle operation when the brakes are not applied, the problem is in the booster system. If the light should come on during brake application, the problem could be either in one of the split hydraulic systems, or booster system.

Should the "BRAKE PRESSURE" light illuminate, the vehicle should be operated only with the extreme caution to a repair facility due to reduced braking capability.

Even if a failure should result in both the primary and backup boosters, the master cylinder alone will provide a very limited means of stopping the vehicle.

CAUTION

Hydraulic brake systems used on S-Series models are power assisted. Braking capabilities will be greatly reduced without engine assist. DO NOT MOVE VEHICLE WITH DEAD ENGINE.

GAUGES AND INSTRUMENTS

If a failure is experienced in one side of the split hydraulic system, the vehicle will still have the remaining portion of the split system to allow stopping the vehicle; however, the vehicle should be operated only with extreme caution to reach a repair facility since the braking capabilities will be reduced.

BATTERY GENERATING SYSTEM GAUGE VOLTMETER

The battery, generating system indicator gauge indicates the condition of the battery, alternator and the voltage regulator.

The gauge is divided into two sections. The left hand side for the battery and right hand side for generating system.

Before starting engine the gauge will show the condition of the battery. The battery section of the gauge is subdivided into two colored segments.

GREEN - a properly-charged battery
RED - a low battery charge

With the engine running at operating speeds, the gauge will show the condition of the generating section as the gauge is divided into two colored segments:

GREEN - generating system working properly
RED - voltage output too high or too low

Constant reading in either RED area indicates that a complete check of the battery and generating system be made.

ENGINE SHUTDOWN WARNING LIGHT OR BUZZER

Vehicles may be equipped with an automatic shutdown system which stops the engine in the event of high coolant temperature or low engine oil pressure. A warning light on the instrument panel along with a buzzer or bell will indicate high coolant temperature or low oil pressure. If the temperature and/or pressure continued to change beyond the warning point to a predetermined level, the engine will automatically shut down. Vehicles are equipped with an override feature which will allow the engine to be re-started so that the vehicle can be moved. The engine should be run no longer than absolutely necessary. A decal located in front of the operator provides instructions on how the override should be operated.

FRONT AXLE ENGAGEMENT LIGHT

This light will glow when the front axle is engaged.

FUEL GAUGE

The fuel gauge is electrically operated and indicates the level of fuel in the tank. The gauge registers only when the ignition is "on".

HOUR METER

In certain types of operations, the speedometer (odometer) reading is not an accurate guide for engine or chassis lubrication intervals The hour meter reading can be used as a guide in determining lubrication and maintenance intervals.

For example: Short haul operations involving considerable reverse gear work.

The hour meter records the number of hours that the engine has operated.

OIL PRESSURE GAUGE ENGINE

The engine oil pressure gauge indicates the amount of oil pressure being delivered to the engine.

If gauge fluctuates or does not register when the engine is operating, stop the engine immediately and correct cause.

OIL PRESSURE WARNING LIGHT

With ignition switch turned "ON" the light will glow before engine starts. If light fails to go "OUT" after starting engine, stop engine and determine cause of low oil pressure.

PYROMETER

A pyrometer is connected to a thermocouple to indicate the temperature of the exhaust gases entering the turbine side of the turbocharger.

SPEEDOMETER AND ODOMETER

The speedometer indicates the vehicle speed in miles or kilometers, per hour. The odometer records the total of numbers of miles travelled.

TACHOGRAPH

The tachograph indicates the engine speed in revolutions per minute and records the number of hours the engine has operated. The hour meter is based upon the average of 100,000 revolutions per hour.

GAUGES AND INSTRUMENTS

TACHOMETER

The purpose of the tachometer is to indicate the engine RPM.

TEMPERATURE GAUGE (Coolant)

The temperature gauge indicates the temperature of the coolant in the cooling system. The gauge operates only when the ignition switch is turned to the "on" position. If the indicator suddenly rises to the "hot" position, the engine should be stopped and the cause of overheating determined.

TRANSMISSION OIL TEMPERATURE GAUGE

This gauge indicates temperature of the transmission oil.

VACUUM GAUGE & LOW VACUUM INDICATOR LIGHT (Vehicles with Vacuum Power Cylinder and Reserve Tank)

The vacuum gauge registers the amount of vacuum in the brake system. If vacuum falls below 20.3 cm (8 in.) a warning light on the instrument panel will glow. The warning light will go out when vacuum in the system is sufficient to operate vehicle.

WATER TEMPERATURE WARNING LIGHT

This light will glow when the engine coolant is in excess of recommended operating temperature.

VEHICLE OPERATION

AXLE-REAR (With Locking Differential)

CAUTION

To avoid personal injury or property damage, pay strict attention to the following:

If your vehicle is equipped with a locking differential, power will be transmitted to the opposite wheel should one of the wheels slip. Both wheels must be raised free of the ground should it be necessary to operate one wheel with the vehicle stationary; otherwise the wheel that is not raised will pull the vehicle off its supports.

As with any vehicle, care should be taken to avoid sudden accelerations when both drive wheels are on a slippery surface. This could cause both drive wheels to spin, and allow the vehicle to slide sideways on the crowned surface of a road or in a turn.

BRAKES (Air)

The purpose of this dual system is to provide a means of stopping the vehicle should a failure occur in one of the two independent brake systems. In the event air pressure loss occurs in one system, the remaining system continues to provide braking action.

The air system splits at the supply reservoir where it branches into separate service reservoirs. Each service reservoir supplies air to a separate section of the dual brake valve.

The brake valve is equipped with two separate supply and delivery systems for service and emergency braking, thus providing the operator with a graduated control for applying and releasing the vehicle brakes, even in the event of an air loss in either the primary or secondary system.

The primary air system on all trucks and tractors supply air to rear axle brakes and the secondary air system supplies air to the front axle brakes.

Tractor systems are designed to control the towed unit from both braking systems. Should failure occur in either system, control of the trailer service brakes is maintained through the use of air from the remaining system.

On a straight truck the primary (rear) brakes are designed to stop the truck in required distance in the event of air loss in the secondary system.

If a loss of air occurs in the primary system, the air system on a straight truck is designed to allow 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.

Even though there will be enough braking capability for emergency stopping, the vehicle should not be operated when a failure is indicated.

All vehicles are equipped with spring brakes for parking. The parking system is operated manually by a single valve, which in the case of a tractor also controls the parking system on the towed unit. This total vehicle parking capability, using the parking valve as the master control, requires the parking brake be released and trailer emergency valve in the "released" position to permit charging of the trailer air system. The need for an emergency release reservoir is eliminated due to its function being provided by either of the two service brake systems. The parking brakes will automatically apply only if both service system air pressures are depleted.

BRAKE ANTILOCK SYSTEM

The antilock system has been added to air braked vehicles as an aid in helping to keep the vehicle in its traffic lane during severe braking. It assists the driver by keeping the wheels from sliding during hard brake applications without sacrificing stopping distance. Some wheel lock may be experienced at very low speeds.

The antilock system analyzes wheel speed information and detects a rapid change in wheel speed such as that caused during hard braking. It will decrease air pressure momentarily reducting brake power allowing the wheels on affected axles to roll more freely, thus preventing the wheel or brake lock-up which would result in loss of vehicle control as well as flat spotting of tires. Just as soon as the wheels return to a controlled percentage of their original speed, the brakes are automatically reapplied. A sequence of releasing and reapplying air pressure of the brakes is known as an antilock cycle and may be repeated several times during a stop, depending upon the initial speed, road surface and brake force applied by the driver.

Each cycle can be felt by the driver as a "lurch" or the same type of feeling that would be obtained when the brake pedal is rapidly pumped during a stop. On icy roads cycling may continue long enough that reservoir pressure could be depleted to a point that the low air pressure buzzer and light will come on. This is not a cause of immediate alarm since braking is still available even at this reduced pressure.

Poor brake adjustment will aggravate air consumption since long chamber strokes will require more air to be used during each cycle. This means that reservoir air pressure will be depleted faster than would be the case with good brake adjustment and short chamber strokes.

VEHICLE OPERATION

BRAKE ANTILOCK MONITOR (Warning) LIGHT

A satisfactory antilock system is indicated each time the ignition key switch is turned to either "ON" or "RUN" position with the antilock warning light momentarily illuminating, followed by the light going out and remaining off.

If the warning light should remain "ON" a problem is indicated in the antilock control system. Should this condition occur, the service brakes will function in the normal manner; however, the vehicle will not have the added safety and advantage of the antilock.

If the antilock warning light comes on and stays on, the antilock system should have an "Ignition Cycle Check" performed to determine if all or any computer modules and air control valves are operating satisfactorily. Refer to VEHICLE MAINTENANCE "Brake Antilock System" for Ignition Cycle Check.

As the vehicle is driven about 24 km (15 mph) the antilock warning light should remain "OFF". If the light should come "ON" and remain on above 24 km (15 mph), a wheel sensor problem may exist. Excessive spin on one drive wheel relative to the other on some axles may cause the monitor light to go "ON". To correct this condition, the ignition switch must be turned "OFF" and back "ON" to reset the system and correct the condition.

If wheel spin is not the cause of the light remaining on, one or more of the sensors could be the problem. Refer to VEHICLE MAINTENANCE "Brake Antilock System" for quick trouble shooting of antilock system.

BRAKE PEDAL

When making a stop for a traffic light or going down a long grade, do not "fan" the air brake pedal as this wastes air pressure. On long grades, use snubbing "on-off" brake application to reduce the possibility of extreme heat and wear to the brake lining. A good policy to follow is to downshift your vehicle on long grades to obtain maximum engine assistance in reducing vehicle speed. The best way to make a stop is to apply the brakes as hard at first as the road and load conditions will permit and then gradually reduce the pressure, so that at the end of the stop there is sufficient air pressure to hold the vehicle.

BRAKES PARKING

If both air systems fail or are depleted the spring brakes apply.

To release, repair air leak and recharge system to 483 kPa (70 psi). If leak cannot be repaired and the vehicle must be moved, the spring brake must be manually released.

CAUTION

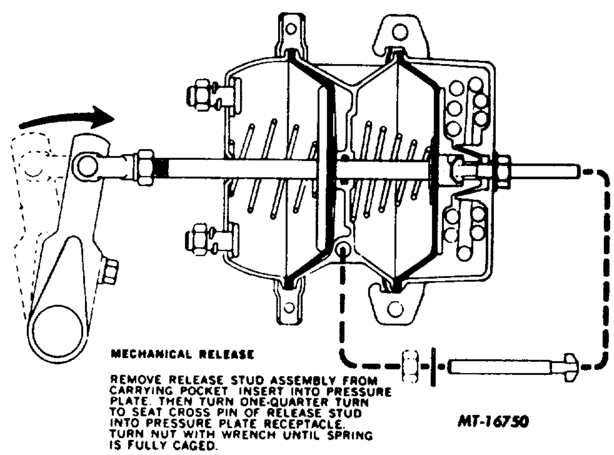
To avoid personal injury or property damage when manually releasing the spring brakes, be sure to block the wheels so that vehicle cannot move when the brakes are released. For towing, make sure the vehicle is connected or secured to tow vehicle before releasing the spring brakes.

BRAKE RELEASE (Parking) ANCHOR LOK SPRING BRAKE

In the event it is necessary to move the vehicle after an emergency application (before air pressure can be restored), the emergency parking spring can be compressed mechanically to release the brake. A release stud "spring caging tool" is furnished with the brake chamber assembly. The release stud engages in the spring pressure plate and its nut is tightened to compress "cage" the spring and release the brake.

Apply a light coat of Never Seeze to the threads of the release stud to avoid any unnecessary wear of the threads. Remove the access plug from the end of the spring chamber. Insert the release stud through the opening in the chamber and into the spring pressure plate.

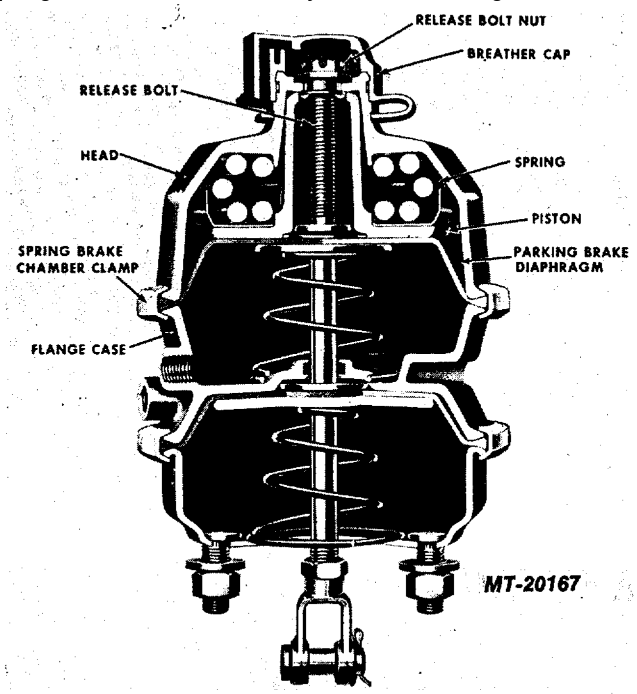
Turn the release stud 1/4 turn to engage the tangs on the release stud into the slot in the pressure plate. Install the nut on the release stud. Be sure tang on release stud stays engaged with slot on pressure plate while installing the nut. Tighten the nut with a wrench to compress the spring.



VEHICLE OPERATION

BRAKE RELEASE (Parking)
MGM SPRING BRAKE

To release the spring brake (manual release) in the event there is loss of air and the vehicle must be towed, the spring brake must be manually released or “caged”.



Cross Section of MGM Spring Brake Assembly

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 can be backed off by removing the breather cap and turning the release bolt counterclockwise 57.15 to 63.5 mm (2 1/4" to 2 1/2") or approximately 30 turns. When turning the bolt you will actually be pulling or collapsing the spring manually.

BRAKE RESET (Anchor Lok)

Charge spring brake chambers with air pressure. Remove the release stud and nut from the spring housing and reinstall the access plug in the housing opening. Reinstall the release stud and nut in the carrying pocket on the brake chamber housing.

BRAKE RESET (MGM)

If the release bolt threads are dry apply a light coat of "Never Seeze" lubricant or equivalent to the threads. Do not apply "Never Seeze" lubricant supplied in an aerosol can.

To manually reset parking brake at each spring brake chamber, screw release bolt down into unit until nut is bottomed against the receiver. Torque nut to 67.79 N.m (50 ft.lbs.) and reinstall breather caps.

BRAKES (Hydraulic)

CAUTION

Hydraulic brake systems used on S-Series models are power assisted. Braking capabilities will be greatly reduced without engine assist. DO NOT MOVE VEHICLE WITH DEAD ENGINE.

If a failure is experienced in one side of the split hydraulic system, the vehicle will still have the remaining portion of the split system to allow stopping the vehicle; however, the vehicle should be operated only with extreme caution to reach a repair facility since the braking capabilities will be reduced.

BRAKE PEDAL

Should the brake become wet, immediately dry them while the vehicle is moving by light application of the brake pedal.

PARKING BRAKE (Burnishing)

Refer to Maintenance Section.

CLUTCH PEDAL

Do not ride the clutch pedal. Keep your foot off the clutch pedal except to shift gears or when the truck is being brought to a stop.

DRIVING (Manual Transmission)

1. Always check the brake system by depressing the brake pedal before attempting to drive the vehicle. This will familiarize you with the brake pedal action. Observe the air gauges to determine if the minimum of 483 kPa (70 psi) pressure exists.
2. Depress the clutch pedal.
3. Shift the transmission into first gear position.
4. Release the parking brake.
5. Depress the accelerator pedal to speed up the engine sufficiently to pick up the load. Release the clutch pedal slowly and further depress the accelerator pedal to prevent the engine from stalling while the vehicle moves forward.
6. As the speed increases, release the accelerator and at the same time depress the clutch pedal. Then shift the transmission to the next higher transmission gear. Release the clutch slowly and depress the accelerator as described above. Repeat this procedure as you shift progressively into the higher speed ranges.

DRIVING DOWNHILL

A safety rule followed by all experienced drivers when driving downhill, is to use the brakes and transmission gear combinations to keep the vehicle under control. Before entering the downhill grade, apply the brakes to reduce speed and shift the transmission into a lower gear. This will provide additional braking effort from the engine.

When shifting from a higher gear to a lower gear with the vehicle in motion, the engine and vehicle speed must be synchronized to permit lower gear engagement. This is accomplished by "Double Clutching" as follows:

1. Depress the clutch pedal.

2. Place the transmission control in neutral.

3. Engage the clutch and at the same time increase the engine speed.

4. Depress the clutch pedal.

5. Shift the transmission to the desired lower range.

6. Synchronize the engine speed with the vehicle speed as the clutch is engaged.

After entering the downhill grade, reduce the vehicle speed with the brakes from time to time as required, to prevent engine speeds exceeding maximum engine rpm.

Use hard "on-off" brake application to "snubdown" the vehicle to keep it well under control.

With the vehicle driving the engine it is possible for the engine speed to reach far in excess of the maximum recommended rpm, causing serious damage to the engine. In other words, on a downhill grade the vehicle should never be driving the engine any faster than the engine would normally be operating in the same gear pulling the load.

ENGINE BREAK-IN Gasoline

(For Caterpillar, Cummins, Detroit Diesel, IH DT-466, 9.0 liter and D-150-170-190 engines, refer to separate Operator's Manual).

For the first 400 Km (250 Miles) hold vehicle speed below 72 Km (45 Miles) per hour. Operate at reduced speeds until engine is throughly warmed up. Avoid abrupt starts, stops and lugging of engine at any time.

After the vehicle has been driven 400 Km (250 Miles) occasional acceleration up to the governed or maximum recommended RPM is permissible and desirable.

Sustained high speed driving must be avoided until the vehicle has been driven at least 1600 Km (1000 Miles).

Do Not operate beyond maximum RPM at any time.

ENGINE EMERGENCY STARTING

CAUTION

The procedures below must be performed exactly as outlined, otherwise injury to the face, eyes, body, limbs and respiratory system could result from fire or acid due to battery explosion. Property damage could also result.

1. To prevent shorting of the system, remove metal rings or watches and do not allow metal tools to contact positive terminal of battery.

2. Place transmission in PARK or in NEUTRAL and set parking brake, in both vehicles.

3. Shut off lights, heater, air conditioner and any other electrical loads, in both vehicles.

4. Eye protection should be worn if available. If not available, shield eyes when near either battery.

5. Vehicle bodies or bumpers must not be in contact.

6. Connect jumper cable between POSITIVE posts of the CHARGED and DISCHARGED batteries.

7. Connect other cable to the NEGATIVE post of the CHARGED battery and to a good GROUND contact in the engine area; not to the NEGATIVE post of the DISCHARGED battery. Ground contact should be at least twenty inches away from DISCHARGED battery.

8. Reverse above procedure when removing the jumper cables.

IMPORTANT

If the battery is a Delco maintenance free type, do not attempt to jump start the vehicle, charge or test the battery if the indicator in the battery is bright or light yellow. Install a new battery.

VEHICLE OPERATION

ENGINE FUEL REQUIREMENTS (GASOLINE)

Your engine is designed to operate efficiently in normal operations on "Regular" grade fuels of at least 91 RON (Research Octane Number) or 86.5 anti-knock index designation. The latter figure is now generally posted on fuel dispensing pumps. It is recommended that the maximum octane rating used be no more than four octane numbers above the minimum of 91 octane. "Low Lead" fuel containing at least .13 gpl (.05 gpg) lead, or the equivalent additive, per liter (gallon) may be used.

Continuous use of gasoline which is completely free of lead, or other lubricating additives such as phosphorous, is not recommended. Prolonged use of such fuel can cause excessive exhaust valve seat wear resulting in loss of emission control, poor performance and possible engine failure. Use of a fuel which is to low in anti-knock quality will result in "spark knock". Since anti-knock quality of all "Regular" grade gasolines is not the same and factors such as altitude, terrain and air temperature affect operating efficiency, knocking may result even though you are using the grade of fuel recommended for your engine.

ENGINE FUEL AND LUBRICANT ADDITIVES

The following is the International Harvester Truck Division's policy on the use of fuel and lubricant supplement additives.

"It is the International Harvester Truck Division's policy to develop and build trucks that will operate satisfactorily on fuels and lubricant of good quality marketed by the petroleum industry. The Truck Division does not recommend the use of any supplementary fuel or lubricant additives. The vehicle warranty shall not apply to any unit which has been subjected to misuse, negligence or accident. Malfunctions attributable to neglect or failure to follow the manufacturer's fuel or lubricating recommendations may not be within the coverage of the warranty."

ENGINE GOVERNED SPEEDS

The governor has two functions: First, it provides the exact amount of fuel needed for idling position. Second, it overrides the throttle and shuts off fuel if engine rpm exceeds the maximum rated speed.

ENGINE SHUTDOWN

A basic rule of good engine operation concerns the importance of idling the engine from three to five minutes before shutting down. This few minutes idling allows the lubricating oil and water to carry heat away from the iron masses.

The larger the engine, the greater the need for this idling period and of course, the length of the idling period should somewhat follow the size of the engine in order to avoid seals or like features of an engine being damaged by rising heat.

To stop the engine turn the ignition switch to "OFF" position and pull out on engine fuel shut-off control (diesel only) until engine stops.

ENGINE SHUT-OFF LPG ENGINE

After the engine has completed its run and the engine is to be shut-off for an indefinite period of time, it will be necessary to close all tank valves and run the engine until the fuel is exhausted.

ENGINE STARTING

If your vehicle is equipped with push button starting system, turning key to the right, then pushing in on starting button starts the engine.

If your vehicle is equipped with ignition switch key starting system turning key to the extreme right engages the starting motor.

IMPORTANT

Depending on starting system, either release the push button or ignition switch key instantly after engine starts to avoid damage to the starting motor. If the engine does not start promptly, DO NOT OVERTAX THE STARTING MOTOR OR THE BATTERY. Do not use the starting motor longer than 30 seconds at a time.

Wait at least 15 seconds between attempts to start the engine to prevent heat (generated in the starting motor) from scorching the starting motor commutator.

CAUTION

DO NOT START OR RUN AN ENGINE WITHOUT VEHICLE BEING COMPLETELY VENTILATED AT ALL TIMES. Exhaust gas from all internal combustion engines contains posionous carbon monoxide gas which is odorless, tasteless, and colorless. When vehicle is started inside, keep garage doors wide open. This poisonous carbon monoxide gas will not only cause drowsiness, but could be fatal. Proper ventilation while operating vehicle must be adhered to.

VEHICLE OPERATION

GASOLINE ENGINE-AUTOMATIC CHOKE

Set parking brake and place transmission control in the neutral position.

If engine hasn't run for several hours and is cold, press the accelerator pedal once all the way to the floor for a moment and then release it. This sets the automatic choke to give the engine a "rich" fuel mixture for cold starting. If the engine has been stopped for only a short time and is still relatively warm, don't set the choke. Otherwise, you may flood a warm engine with too much gasoline and actually prevent it from starting. Just depress the accelerator pedal, about one-fourth of its downward travel and keep it there while starting the engine. Don't pump the accelerator pedal, you'll only flood the engine. If this should happen, however, the engine will usually start if the pedal is pushed and held all the way to the floor while operating the starter.

Depress the clutch pedal and keep it depressed until the engine is running.

After a cold engine starts to warm up and is running smoothly, tap accelerator pedal sharply with your foot to reduce fast idle speed.

GASOLINE ENGINE-MANUAL CHOKE

1. Set parking brake.

2. Place transmission control in the neutral position.

3. Depress accelerator once all the way to the floor and hold. Pull choke control out full distance and release accelerator. Do not use the choke when engine is warm.

4. Depress clutch pedal and keep it depressed until the engine is running.

5. Start Engine.

6. Immediately after engine starts adjust choke control for proper fast idle speed and mixture control. The frequent use of the choke control dilutes the crankcase oil. For this reason, we recommend a more frequent complete oil change in winter, using new oil of good quality.

7. Push the choke control all the way in as soon as the engine warms up and operation permits.

LPG ENGINE COLD

1. Slowly open only the vapor valve on one fuel tank. It is important that the vapor valve be opened slowly, otherwise the excess flow valve at the tank or in the line may be "slugged" or automatically closed. Approximately 50 seconds are required for the excess flow valve to relieve itself.

2. Press primer control on dash two or three times. A manual operated primer plunger is also provided on the converter for priming the engine under the hood.

3. Push in clutch pedal and hold in until after engine is started.

4. Start Engine. If the engine fails to start or makes a false start do not try starting again until the engine has come to a complete stop.

5. As soon as engine starts, press accelerator pedal slightly to pick up engine control. To press accelerator before engine starts will make starting more difficult.

6. After the engine warms up to normal operating temperature, slowly turn the liquid valve at tank on and the vapor valve off.

LPG ENGINE WARM

1. Slowly open the liquid valve on one tank only.

2. Do not use the primer control.

3. Start Engine, in the same manner as described in Items 4 and 5 of Cold Start Procedure.

ENGINE WARM UP

It is very important that any engine be warmed up before applying load.

The warm-up period provides time for the lubricating oil to establish a film between moving parts.

In colder areas where temperature is often below 0 deg. C (32 deg.F), the warm-up period for turbocharged engine is especially important. The cold external oil lines leading to the turbocharger will tend to slow oil flow until the oil warms up.

Slow oil flow to the turbocharger reduces the oil available for the bearing; therefore, before applying load or speed above 1000 rpm to the engine make sure to:

WARM UP THE ENGINE FOR A MINIMUM OF FIVE MINUTES AT OR BELOW 1000 RPM BEFORE APPLYING LOAD.

VEHICLE OPERATION

CAUTION

When parking your diesel vehicle the following procedures must be followed: Failure to follow these procedures, could result in an unattended vehicle moving, thus resulting in personal injury or property damage.

When parking your Diesel vehicle, do not leave transmission in gear; if vehicle rolls, engine could start by heat of compression. Use parking brake for parking on a grade, block wheels or turn to curb.

FRONT AXLE (4x4)

Pushing the control forward engages the front axle. Pulling the control backward disengages the front axle. Neutral position is locked between the engaged and disengaged position. When the front axle is engaged, a "RED" light on the instrument panel will glow to alert the operator.

CAUTION

To avoid personal injury or property damage pay strict attention to the following:

Should it be necessary to operate the rear wheels (with engine power) with the vehicle stationary and the rear wheels raised from the ground, first disengage the front axle; otherwise the driving front axle will pull the vehicle off its support.

Parking brakes should be applied when the transmission and transfer case have been left in the Neutral Position with the engine running or not running.

IMPORTANT

Do not keep the front axle engaged when operating on DRY, HARD surfaced roads EXCEPT where it is absolutely necessary to operate with the transfer case in low range. Operating on hard dry surfaces with both the front and rear axle engaged creates a build up of torque between the axles resulting in excessive tire wear and strain on the entire drive unit.

When necessary to operate with the transfer case in low range, the front axle drive must be engaged to avoid excessive torque load on the rear axle.

FRONT AXLE DISENGAGEMENT (4x4)

The torque build-up between the front and rear axle sometimes causes difficulty when disengagement of the front axle is attempted while the truck is in motion.

To disengage the front axle with the truck in motion, it is necessary to relieve the torque buildup between the front and rear axle by either slacking off abruptly on the accelerator and/or releasing the clutch while pressure is applied to the front axle control.

In some instances it may be necessary to stop the truck and move it slightly in the reverse direction before disengagement of the front axle can be completed.

FRONT AXLE ENGAGEMENT (4x4)

The front axle can be engaged with the truck in motion by pushing the front axle control forward to the "IN" position. It is not necessary to stop the truck or to disengage the clutch when engaging the front axle.

If difficulty is encountered in engaging the front axle when the truck is not in motion, it means the splines on the engaging clutch are not matched. Using forcing action or kicking the control will not make it engage but may damage the control linkage. Shift the transmission into low gear and roll the truck forward, keeping the pressure under control. When the splines are matched, it will engaged. It is easier to engage the front axle with the truck in motion.

With automatic transmission, it may be necessary to use a special procedure to shift out of neutral position in the transfer case. The input shaft to the transfer case must be stopped either by shifting between forward and reverse or by stopping the engine. Keep pressure on the transfer case lever as the input shaft approaches zero speed.

FRONT WHEEL LOCKING HUBS (4x4)

Locking hubs provide a means of controlling the engagement of the front wheels with the front drive axle. When engaged, full power is transmitted to both wheels. Disengagement with front axle nor driving allows the front wheels to "Free Wheel", and the axle shafts and differential gears to remain idle, saving unnecessary wear.

VEHICLE OPERATION

IMPORTANT

For the first 320 km (200 mi.) operate your new vehicle with locking hubs in "lock" position to assist in initial break in of the front driving axle.

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

BE SURE THAT BOTH HUBS are in either "FREE" position (TURN COUNTERCLOCK WISE TO FREE) or "LOCK" position (TURN CLOCKWISE TO LOCK). Arrow in center of controls must always point directly to one of the dots on the rim of the hub, controls "SEAT" when in position! You can feel the control "SEAT" itself when it is properly set. If arrow does not point to one of the dots, it will not seat. Both hubs must always be set the same!

IMPORTANT

USE FINGERS ONLY TO TURN CONTROLS. If controls do not turn freely with your fingers, move vehicle slightly either way in two-wheel drive, standard gear range, and try again. DO NOT FORCE CONTROLS WITH TOOLS.

WHEN TO USE "FREE" OR "LOCK" POSITION: Use "FREE" for all driving that does not require four wheel drive power and traction. Use "LOCK" whenever four-wheel drive is used.

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

POWER DIVIDER LOCK CONTROL
(For tandem drive axles)

The power divider lock control is used with vehicles equipped with dual real axles having inter-axle differentials.

For normal driving on hard surface roads, the control should be moved to the "out" (unlocked) position.

To transmit equal power to both rear axles when under heavy load and one or both wheels of the axle are slipping, the control should be moved to the "in" (locked) position. A green (PDL warning light on the instrument panel indicates the control is in locked position.

IMPORTANT

Move control to the "in" (locked) position at low speeds and never when wheels are slipping.

SHIFTING (Main and auxiliary transmission)

The auxiliary transmission, used in conjunction with the main transmission, provides additional gear ratios. The auxiliary transmission (in addition to the main transmission) must be placed in one of the driving positions before power can be transferred to the rear wheels.

The auxiliary transmission gear shifting is similar to the main transmission.

The operator can, after knowledge of his load and road conditions, manipulate the gear ratios of a main and auxiliary transmission to obtain the most efficient operation and road speed for his particular operation.

Selection of the "UD" (underdrive) gear in the auxiliary transmission gives a greater gear reduction than provided by the main transmission.

IMPORTANT

For auxiliary transmissions that have a deep low (numerically higher than 2.0: 1) underdrive gear ration the deep low gear should be operated or shifted only when the main transmission is in low gear. The deep low gear is intended only for starting the vehicle in motion when fully loaded or for off-highway use when moving less than 5 MPH (8.05 KPH) over rough terrain.

The selection of the "OD" (overdrive) gear in the auxiliary transmission provides a gear to permit increased road speeds in the various transmission ratios.

IMPORTANT

When auxiliary transmissions are use in combination with automatic transmissions a loaded vehicle should not be started with the auxiliary in the "OD" (overdrive) position. Auxiliary transmission ratio selections must be made only when vehicle is not in motion.

VEHICLE OPERATION

SHIFTING (Two-speed rear axle)

SHIFTING INTO THE LOW SPEED RATIO

1. On level grades or at high truck speeds:

   a. Keep the accelerator pedal depressed and push the control down.

   b. To complete the shift, release the accelerator pedal and then depress the accelerator again as quickly as possible. Do not operate the clutch.

2. On upgrades or at slow truck speeds:

   a. Keep the accelerator depressed and push the switch control down.

   b. To complete the shift, keep the accelerator depressed and disengage and re-engage the clutch as quickly as possible.

3. On downgrades against the engine:

   a. Release the accelerator pedal and push the switch control down.

   b. To complete the shift, press down on the accelerator pedal enough to synchronize the gears, then immediately release the accelerator. Do not operate the clutch.

SHIFTING INTO THE HIGH SPEED RATIO

1. On downgrades against the engine:

   a. Release the accelerator pedal and pull the switch control up.

   b. To complete the shift, disengage and reengage the clutch with the accelerator pedal released.

2. At any time except on downgrades against the engine:

   a. Keep the accelerator pedal depressed and pull the switch control up.

   b. Gradually release the accelerator to complete the shift. Do not depress the accelerator until the shift is completed.

SPLIT SHIFTING

To shift to the next higher gear in the transmission and at the same time from the high to the low speed axle, shift the transmission in the usual way and push the switch control down just before engaging the clutch.

To shift to the next lower gear in the transmission and at the same time from the low to the high speed axle, pull the switch control up and release the accelerator, then complete the transmission shift in the usual way.

Always park and start in low range.

STARTING A TURBOCHARGED TRUCK ON A GRADE

Under normal circumstances, when a driver is starting a load on a grade with either a naturally aspirated diesel engine or a gasoline engine, he begins to engage the clutch at which time the rpm starts to fall slightly and very quickly recovers as the vehicle begins moving.

The turbocharged diesel engines have a somewhat different feeling -once the clutch is engaged the rpm falls off significantly. This is due to the emission control device on the turbocharged engine which controls the fuel input during first gear acceleration. After the initial drop in speed, the engine will recover and accelerate in a normal manner. However, it is a different feeling and when the rpm falls off, the natural reaction is to disengage the clutch rapidly and try to bring up the rpm. Do not do this, for if you do, the cab will begin to buck and, in extreme cases, damage to the driveline components can result.

THE PROPER PROCEDURE SHOULD BE:

1. Set the trailer brakes, bring the rpm up slightly and begin to engage the clutch while, at the same time, releasing the trailer brakes.

2. As the rpm begins to fall off, DO NOT disengage the clutch. The rpm will quickly come back and the vehicle will rapidly accelerate up the grade.

TOWING INSTRUCTIONS

Before moving the towed vehicle, check for adequate road clearance of vehicle components.

Also before towing a disabled vehicle, be sure to fully release the parking brake. See Parking Brakes.

TOWING VEHICLE WITH FRONT WHEELS SUSPENDED

When it is necessary to tow a vehicle with the front wheels suspended, if at all possible, use a towing dolly to position rear wheels on, thus avoiding any unnecessary transmission or differential damage. If a towing dolly is not available, proceed as follows.

VEHICLE OPERATION

IMPORTANT

Vehicles with manual transmissions should not be towed even short distances without suspending rear wheels or removing the propeller shaft.

TOWING VEHICLE WITH REAR WHEELS SUSPENDED

Whenever possible, it is preferable to tow a disabled vehicle from the rear by raising the rear of the chassis and towing it backwards which will eliminate the preparations required when the rear drive wheels are on the ground. When towing a vehicle with rear of the chassis suspended, the front wheels must be locked in the straight ahead position.

Vehicles with manual shift must have at least one (1) pint of transmission lubricant drained from the case. This will prevent transmission lubricant from entering the clutch housing and lubricant saturating the clutch discs. Make sure that the transmission lubricant is replaced before the vehicle is put back into service.

Towing the vehicle with the front wheels on the ground also eliminates possible damage to the front bumper.

IMPORTANT

Full floating axles are axles where the axle shafts may be removed without disturbing the wheel and hub assemblies. On chassis with full floating axles, remove the axle shafts from all axles to be in contact with the road surface during the towing operation. The wheel hub ends must be covered to prevent loss of axle lubricant and entrance of contaminants.

If axle shafts are not removed, removal of rear propellar shafts will be required.

In the event the chassis is equipped with tandem axle and the vehicle is to be towed from the front, the forward rear axle may be raised to clear the road surface and secured to the frame by chains or "U" bolts, allowing only rear axle to contact road surface and axle shafts removed from rear axle assembly, Use extreme care in securing the chains or "U" bolts to avoid possible damage of brake lines, hoses or other components.

TRANSFER CASE

This control "ENGAGES" or "DISENGAGES" the front axle and selects the "HIGH" or "LOW" speed range of the transfer case.

CAUTION

When parking your 4 x 4 vehicle the following procedures must be followed:

Failure to follow these procedures, could result in an unattended vehicle moving, thus resulting in personal injury or property damage.

AUTOMATIC TRANSMISSION

1. Transfer case must be in gear.
2. Transmission must be in "PARK"

MANUAL TRANSMISSION

1. Transfer case must be in gear.
2. Transmission must be in gear.

It is also recommended the parking brake be "Set" at this time.

SHIFTING (Transfer Case)

The transfer case transmits power to the front driving axle for operation over rough terrain, steep grades or slippery surfaces (i.e;, mud, gravel, snow) where improved traction is required.

Low gear of the transfer case (if so equipped) should be engaged only when the vehicle is stopped or moving forward slowly. Low gear is intended for off-highway use only, where additional gear reduction is occasionally required to pull heavy loads.

IMPORTANT

The vehicle must not be operated with the transfer case in low gear on dry, flat, hard surface roads. Operating under these conditions may damage the power train.

VEHICLE MAINTENANCE

AXLE-REAR (With Locking Differential)

CAUTION

To avoid personal injury or property damage, pay strict attention to the following:

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

BODY-CAB

Frequent and regular washing will lengthen the life of your new vehicle's painted finish and bright metal trim.

WASHING: Wash your vehicle often with warm or cold water to remove dirt and preserve the original luster of the paint. Never wash the vehicle in the direct rays of the hot sun or when the sheet metal is hot to the touch, as this may cause streaks on the finish. Do not use hot water or strong soaps or detergents or wipe off dirt when the surface is dry as this will scratch the paint.

WAXING OR POLISHING VEHICLES: Prior to use of any wax or polish, vehicle must be thoroughly washed.

BRIGHT METAL CARE: Bright metal such as anodized aluminum, chrome and stainless steel, require the same washing as painted surfaces. A non-abrasive chrome cleaner may be used sparingly to clean the bright metal. Do not use steel wool. Use of automobile wax or polish on bright metal usually will restore the original brightness.

UPHOLSTERY CARE: Use a whisk broom and vacuum cleaner to remove loose dust and dirt from upholstery and floor. Vinyl and woven plastic upholstery can be washed with warm water and mild soap, wipe dry. If commercial cleaners are used, follow instructions supplied with cleaner.

BRAKES (Air)

AIR COMPRESSOR (Air Cleaner)

Some engines are equipped with air compressors that have an air cleaner mounted directly to the air compressor.

For servicing, refer to Engine Lubrication Section.

AIR RESERVOIR MOISTURE DRAINING

Moisture taken in with the air through the compressor inlet valves collects in the reservoirs and NECESSITATES DRAINING THE RESERVOIR DAILY IN COLD WEATHER AND ONCE A WEEK IN WARM WEATHER by opening the drain cock located either on the bottom of the tank or in the end of the tank. If in the end of the tank, there must be some air pressure in the system to assure proper drainage. Be sure to close the drain cocks after all moisture has been expelled.

The Automatic Reservoir 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.

BRAKE ANTILOCK SYSTEM

The brake antilock monitor (warning) light may be used to quickly trouble shoot the antilock system. The warning light will indicate to the operator or serviceman that the system is functioning properly or not.

Satisfactory System

A satisfactory antilock system is indicated each time the ignition key switch is turned to either "ON" or "RUN" position with the antilock warning light momentarily illuminating, followed by the light going out and remaining off. This indicates that the computer modules are receiving power and the solenoid valves are properly connected to the computer modules.

Warning Light Will Not Illuminate

No light when the ignition key switch is turned "ON" could be the result of no power to the antilock system or the light bulb is burned out. Check for bad fuse or light bulb.

Warning Light Remains On

If the warning light should remain "ON" a problem is indicated in the antilock control system. Should this condition occur the service brakes will function in the normal manner; however, the vehicle will not have the added safety and advantage of the antilock.

If the antilock warning light comes on and stays on, the antilock system should have an "Ignition Cycle Check" performed to determine if all or any computer modules and air control valves are operating satisfactorily. Refer to "Ignition Cycle Check".

VEHICLE MAINTENANCE

WARNING LIGHT ILLUMINATES WHEN VEHICLE IS OPERATED

As the vehicle is driven about 24 km (15 mph) the antilock warning light should remain "OFF". If the light should come "ON" and remain on above 24 km (15 mph), a wheel sensor problem may exist. Excessive spin on one drive wheel relative to the other on some axles may cause the monitor light to go "ON". To correct this condition, the ignition switch must be turned "OFF" and back "ON" to reset the system and correct the condition.

If wheel spin is not the cause of the light remaining on, one or more of the sensors could be the problem.

Most common problems found with the sensors are:

1. Vehicle brake hang-up and slow release of brakes (dragging brakes).

2. Loose-wheel bearings causing excessive exciter ring runout.

3. Insufficient voltage output of sensor or shorted sensor or sensor wires.

4. Improper installation of wheel and drum assemblies, could result in insufficient voltage output.

IMPORTANT

Do not rock the hub and drum when installing as the sensor may be pushed in too far. Do not forget to pull the sensor out to its maximum outward travel (away from center of vehicle) prior to installing the hub and drum assembly to assure that the sensor is properly adjusted.

5. Always check the sensor voltage output connector located at some point on the axle after performing any maintenance to brakes, wheel bearings or wheel seals. A volt-ohm meter can be used for sensor voltage output check at sensor connector by spinning the wheel about one revolution every two seconds. Voltage should not be lower than .3 volt.

IGNITION CYCLE ANTILOCK SYSTEM

To ignition cycle the antilock system, turn the ignition switch "ON" to "OFF" several times prior to starting the ignition cycle check. Then with at least 552 kPa (80 psi) air in system, apply the brakes and turn the ignition switch to "ON" position. This allows all air valves to exhaust a small amount of air. Continue to turn the ignition switch "ON" to "OFF" with the brakes applied until all computer modules and air control valves have been checked. An assistant will be required to listen for the exhaust of air at each axle air control valve.

BRAKE ADJUSTMENT

A regular schedule for periodic cleaning, lubrication, adjustment and inspection should be established, based on the type of vehicle operation. It is difficult to predetermine an exact maintenance interval (time or mileage) since vehicles will be used in a wide variety of operational applications and conditions.

Periodic checking of push rod travel or brake adjustment is essential for good braking. Push rod travel should be checked every 3,000 km (2,000 miles) to determine if adjustment is necessary. Push rod travel should be kept at a minimum without brakes dragging.

Inspect brake lining every 19,000 km (12,000 miles) or every 12 months; whichever occurs first. When brake lining or blocks are worn to within 1.6 mm (1/16") of rivets, brake lining must be replaced.

This inspection or adjustment should only be performed by qualified service personnel and must be in accordance with instructions provided by International Harvester Co.

Do not back off front brakes so that they are not as aggressive, letting the rear brakes do all the stopping of the vehicle. Do not overlook the brakes on the trailer either. Brake balance on trucks and tractor trailers is essential for good braking and minimize cycling of the antilock.

Too much lining-to-drum clearance will require more air to be delivered to each of the brake chambers since a longer stroke of the chamber is required. Improper brake adjustment on an axle (one brake group adjusted properly and the brake group on opposite side of vehicle backed off) will result in an antilock cycle since one brake group will tend to lock up or slow down more rapidly than the other. This cycling of the antilock will tend to increase the stopping distance of a vehicle.

VEHICLE MAINTENANCE

BRAKES HYDRAULIC

The vehicle may be equipped with either a single hydraulic brake system (codes 04011 or 04058) or split hydraulic system (codes 04044, 04055 or 04059) depending upon the front axle gross weight rating.

Code	Type System	Identification
04011	Single	A. One hydraulic fluid line from master cylinder which is under hood mounted on dash panel. B. Vehicles with frame mounted hydrovac. C. Vehicles with 5,000, 6,000 and 7,500 lb. front axles.
04058	Single	A. One hydraulic fluid line from master cylinder which is under hood mounted on dash panel. B. Vehicles with frame mounted hydrovac. C. Vehicles with 9,000 10,000 and 12,000 lb. front axles.
04055	Dual Power	A. Split hydraulic master cylinder with two compartment reservoir, two hydraulic fluid lines and is mounted on DPB booster. B. Dual Power Brake (DPB) booster with vacuum power chamber and a hydraulic power booster which receives hydraulic source from separate hydraulic pump (power steering). DPB booster is mounted under hood on dash panel. C. Vehicles w/5,000, 6,000 and 7,500 lb. front axles.
04044-04059	Hy-Power	A. Split hydraulic master cylinder with two compartment reservoir, two hydraulic brake fluid lines and mounted on the Hy-Power booster assembly. B. Hy-Power booster is a hydraulic assist system which receives hydraulic assist from separate hydraulic pump (power steering). It also has an electric power backup pump. It is under hood mounted on dash panel. C. Vehicles with 5,000 thru 12,000 lb. front axles.

BRAKES (HYDRAULIC)

The hydraulic brakes on some models are self-adjusting. The automatic brake adjuster maintains proper clearance between the brake shoe lining and drum during the service life of the lining.

The automatic brake adjuster operates when the brakes are applied while the vehicle is moving rearward. It should be noted, however, that the automatic adjustment feature does not eliminate the need for periodic inspection of the brake system (wheel cylinders, master cylinder, lines and hoses, etc.) or the replacement of worn or damaged linings or other parts.

Air Cleaner
Brake Vacuum Power Cylinder (Hydrovac)
Replace: Every 12,000 miles (19,000 kilometers)

Location: Adjacent to Hydrovac
inside left frame rail under cab.

VEHICLE MAINTENANCE

BRAKE PEDAL ADJUSTMENT Single Hydraulic System (Codes 04011 & 04058)

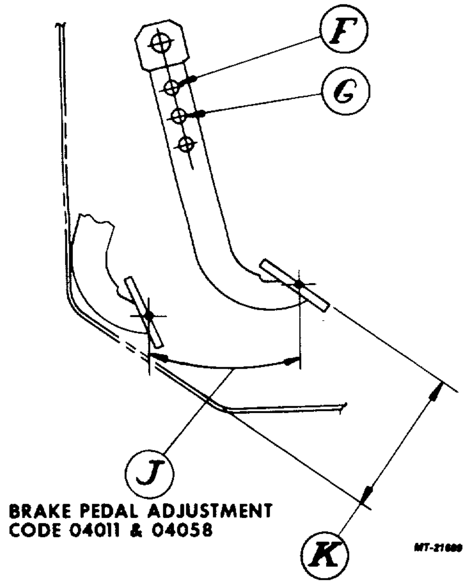
Reference letters for brake pedal adjustment.

F. Use this hole to attach clevis to pedal on 4x2 & 4x4 vehicles.

G. Use this hole to attach clevis to pedal on 6x4 vehicles.

Brake pedal should have pedal stroke "J" after pedal stop has been adjusted to obtain pedal height "K".

J.	226 mm (8.9")	4x2 & 4x4 vehicles
	230 mm (9.1")	6x4 vehicles
K.	201.5 mm (7.9")	4x2 & 4x4 vehicles
	206 mm (8.1")	6x4 vehicles



BRAKE PEDAL ADJUSTMENT
CODE 04011 & 04058

SPLIT HYDRAULIC SYSTEM (Codes 04044, 04055 and 04059)

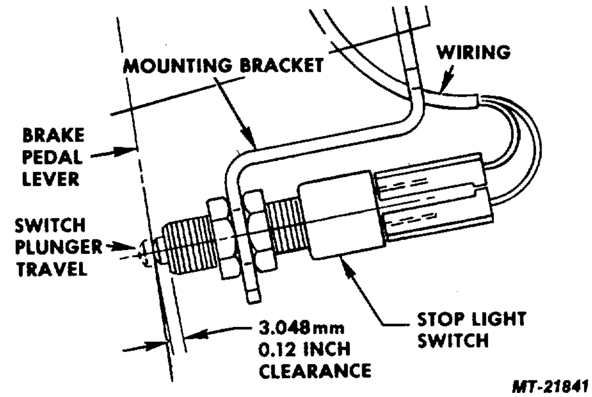
The brake pedal adjustment is at the booster control valve (push rod) and clevis. Proper pedal height (travel) will be obtained when the clevis is adjusted to 177.8 mm (7") between booster mounting surface and clevis center opening.

MASTER CYLINDER (Brake)

Fluid level should be 6.4 to 12.7 mm (1/4 to 1/2") from top of reservoir. Do not fill the master cylinder to the top of reservoir.

STOPLIGHT SWITCH ADJUSTMENT

The stoplight switch should be adjusted so that the clearance between the switch body (not plunger) and pedal lever is 3.048 mm (0.12"), when the brake pedal has been properly adjusted



SPECIAL FLUID PRECAUTIONS

CAUTION

The Hy-Power and Dual Power Brake Systems consist of two completely separate hydraulic systems operating with two different and incompatible fluids; power steering fluid and hydraulic brake fluid. Failure to observe precautions preventing the contamination of either system with fluid from the other will result in the swelling and deterioration of rubber parts leading to reduced brake performance and eventual failure.

To avoid fluid contamination, the following should be observed:

1. Use only fluids specified (or equivalent), and properly identified.

2. Add fluids only to the following locations:

   a. Power steering fluid to the power steering fluid pump reservoir.

   b. Brake fluid to the brake master cylinder.

VEHICLE MAINTENANCE

PARKING BRAKE (BURNISHING) (DRIVELINE TYPE)

The following burnishing procedure is required to be performed on new vehicles or whenever the parking brake lining and/or drum is replaced. Consult your dealer if you do not understand the parking brake burnishing procedure for your vehicle.

The procedure:

1. The vehicle must be loaded (near rated GVW)

2. With the parking brake released, turn the handle knob of the orchlen lever until a force is obtained to apply the brake (over center position of lever) which will result in the vehicle making a somewhat lighter than normal stop (3-5 feet per second) without wheel lock up.

3. Make ten (10) stops from 16 km/h (10 mph) on a dry hard surface road using only the parking brake to stop the vehicle.

4. After each stop, release the parking brake and drive the vehicle at 32 km/h (20 mph) for 4 km (2.5 mi.) to cool the brake.

5. Readjust parking brake linkage (between hand lever and brake assembly) and hand lever knob to suit your operational requirement considering load and road grades you are operating over.

CLUTCH (Pedal Free Travel)

When adjustment of the pedal free travel is necessary, it is extremely important that the work be properly performed; otherwise, early failure of the clutch will result and a costly clutch overhaul becomes necessary.

To avoid needless delay and expense, allow only competent and experienced servicemen to perform these operations.

COOLING SYSTEM

ANTIFREEZE

The cooling system of your new vehicle is filled at the factory with IH permanent-type antifreeze. IH permanent-type antifreeze may be added undiluted if protection below -29 deg. C (-20 deg. F) 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 container.

IMPORTANT

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.

CAUTION

When removing the pressure type cap from the radiator, perform the operation in three steps. 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.

IMPORTANT

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.

COOLANT HOSES

For proper care of coolant hoses, refer to "Cooling System Refill Capacities".

VEHICLE MAINTENANCE

COOLING SYSTEM FILLING (Gasoline Engine)

To eliminate air being trapped within the engine or heater, the following procedure should be followed when filling the engine coolant system.

1. Fill cooling system until coolant reaches bottom of radiator filler opening. Install radiator cap.

2. Set parking brake and start engine.

3. Allow engine to operate at a fast idle until engine reaches its normal operating temperature.

4. After engine reaches its normal operating temperature, trapped air will be expelled from system.

5. With engine still running, add sufficient coolant to bring level to approximately one inch below bottom of filler neck.

RADIATOR SHUTTERS

Automatic radiator shutters provide increased engine efficiency and economy as well as improved heater performance.

SHUTTERSTAT (With Air Filter)

The shutterstat, in conjunction with the power air cylinder, air filter and air pressure operate or close the shutter assembly as engine temperature decreases. Tension springs within the shutter assembly open the shutter as engine A temperature increases. The air filter element in the shutterstat should be removed and cleaned at least once a year.

THERMOSTAT

Your new truck is equipped at the factory with a high temperature thermostat.

Permanent type antifreeze must be used with high temperature thermostats.

WATER FILTER

TO REPLACE:

1. Remove water filter assembly by turning counterclockwise. Clean filter mounting pad.

2. Lubricate new gasket and place element in position on center tube. Hand tighten 1/2 to 3/4 turn after gasket first contacts base of mounting pad. Do not overtighten.

3. Start engine and check for leaks.

VEHICLE MAINTENANCE

ELECTRICAL

ALTERNATOR

IMPORTANT

Before connecting a fast charger, booster battery or installing a new battery, make sure that the ground polarities of the fast charger, booster battery or alternator (when installing a battery) are matched to the ground polarity of the vehicle battery. Improper usage of fast charger, hook-up of booster battery or installing battery can cause damage to the electrical system or to the alternator. Do not attempt to polarize the alternator.

ALTERNATOR BELT ADJUSTMENT

For proper belt deflection refer to Fan and Accessory Belt Adjustment under Engine.

BATTERY

The solution in each cell should be to the indicator level. When the solution is below this level, add distilled water, using a clean syringe. Acid or electrolyte should never be added except by skilled personnel.

Under no circumstances add any special battery "dopes", solutions or powders.

Test the specific gravity of the electrolyte in each cell with a hydrometer at least once a month. A hydrometer reading of 1.260 at 27 deg. C (80 deg F) indicates a full charge. Never allow the battery to fall below 1.225 which indicates half charged. A discharged battery will freeze at -7 deg. C (20 deg. F). A fully charged battery will withstand temperatures as low as -62 deg. C (-80 deg. F).

Battery cable terminals must be clean and tight. Use hot water and common baking soda for removing terminal corrosion and for cleaning the top of the battery. Brighten the contact surface with steel wool, apply a light coat of vaseline or chassis lubricant and reassemble. Be sure the terminals are clamped tightly and that battery is clamped securely in the battery box.

When working around the terminals and battery, use extra care to avoid shorting. A good practice is to insulate pliers and screwdrivers. DO NOT CHECK BATTERY CONDITION BY SHORTING (FLASHING) ACROSS TERMINALS.

CAUTION

To prevent severe injury to the eyes, face limbs and body, due to a fire or dangerous explosion from flames or sparks, it is imperative that flames or sparks be kept away from the vent openings of the battery. This is particularly true when jumper cables are being used.

In addition, inhaling of hydrogen gas produced in the normal operation of the battery could result in partial or permanent damage to the respiratory system.

WHEN INSPECTING BATTERY, NEVER SMOKE OR EXPOSE BATTERY TO SPARKS OR FLAMES, AS THE GAS MIXTURE IN EACH CELL OF THE BATTERY WHICH EXCAPES THROUGH THE HOLES IN THE VENT PLUGS CAN IGNITE, CAUSING AN INTERNAL EXPLOSION OF THE BATTERY.

Whenever disconnecting battery terminals, always disconnect GROUND TERMINAL FIRST. When reconnecting, always connect GROUND TERMINAL LAST.

ALWAYS WEAR EYE PROTECTION WHEN WORKING AROUND BATTERIES. Do not attempt to jump start a vehicle having a frozen battery, because the battery may rupture or explode. If a frozen battery is suspected, examine all fill vents on the battery. If ice can be seen, do not attempt to start with jumper cables as long as the battery remains frozen. Thaw out battery, fill with water and recharge. Failure to observe the above instructions could result in any or all of the aforementioned injuries.

CIRCUIT BREAKERS OR FUSES

The various electrical units are protected by either fuses or circuit breakers located under the instrument panel to the left of the driver.

A fuse panel for trailer connections is located on the cab behind the driver.

ENGINE INITIAL TIMING

To assure efficient operation of the engine the timing should be checked with a timing light attachment No. 1 (right front) spark plug on MV-404, MV-446, No. 1 left front spark plug on V-537 engines and No. 8 (right rear) spark plug on V-345 and V-392.

Refer to "Emission Control Information" label in the engine compartment for timing.

VEHICLE MAINTENANCE

HEADLIGHT REMOVAL

1. Remove the headlight rim retaining screw at the bottom of the headlight body and remove the rim.

2. Unhook the headlight retaining spring from the headlight retainer, or remove the headlight rim retaining screw.

3. Remove the sealed-beam unit from the headlight and disconnect the three-way connector at the rear. Hold the three-way connector firmly to avoid damage to the wiring. Remove the headlight retainer from the sealed beam unit.

All IH Dealers include in their service tools, equipment scientifically developed for aiming headlight beams. The use of this equipment will result in maximum illumination for night driving and assure that the headlight aiming does not conflict with existing laws and regulations. It is good practice to avail yourself of this service when a sealed-beam unit has been replaced or the headlight beam pattern does not give adequate illumination.

PARKING LIGHTS

The parking lights are equipped with ordinary filament bulbs. Should it become necessary to replace either a parking light lens or bulb, remove the lens retaining screws, replace the necessary parts and reassemble.

SPARK PLUGS-GASOLINE ENGINES

For spark plug change intervals, refer to Emissions Manual.

VEHICLE MAINTENANCE

ENGINE

CRANKCASE VENTILATION SYSTEM

For servicing intervals refer to Emissions Manual.

DIPSTICK-OIL LEVEL

Keep oil level as near the high level mark as possible. Never operate an engine with oil level below low level mark.

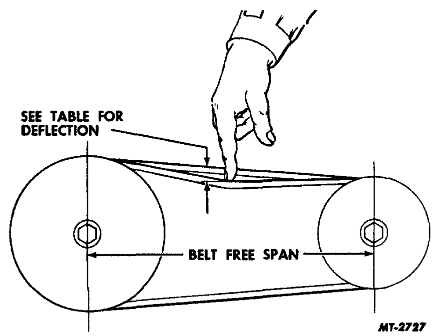
When checking the oil level, the dipstick must be withdrawn and wiped clean, then inserted all the way and again withdrawn for a true reading .

Never check the oil level with engine running or immediately after engine shutdown as an inaccurate reading will be obtained.

Use only a good grade and proper viscosity engine oil.

The lubricating oil in a diesel engine becomes dark in color after short periods of engine operation. This discoloration is not harmful to engine parts as long as the oil and oil filter element change periods are performed at regular intervals .

FAN AND ACCESSORY BELT ADJUSTMENT



Conventional "V " belts are used on the engine to drive the fan and various accessories. Belt tensions are as follows:

BELT WIDTH	DEFLECTION PER .3 METER (1 Ft.) OF SPAN
12.7 mm (1/2")	10.3 mm (13/32")
17.5 mm (11/16")	10.3 mm (13/32")
19.1 mm (3/4")	11.2 mm (7/16")
22.2 mm (7/8")	12.7 mm (1/2")
25.4 mm (1")	14.3 mm (9/16")

OIL FILTER-ENGINE Gasoline

Procedure for servicing the spin-on type oil filter is as follows:

1. Remove oil filter assembly by turning counterclockwise with the hands or a suitable tool. Clean filter mounting pad.
2. Coat the gasket on the new filter with a film of grease.
3. Place the new filter in position on the center tube. Hand tighten ½ to ¾ of a turn after gasket first contacts base of mounting pad.
4. Start engine and run for at least five minutes to warm oil and check for leaks. Also check engine oil level.

FUEL SYSTEM AIR CLEANER (Gasoline Engines)

The dry type air cleaner utilizes a special paper element which is sealed at the outlet end so that all air drawn into the engine must enter through the element. There is no oil reservoir used in this type of filter, hence the reference to "dry type".

Connections between the filter and engine must be kept tight to prevent entry of dirt laden air

For servicing intervals refer to Emissions Manual.

CARBURETOR REDUNDANT THROTTLE CLOSING LINKAGE

In the event the throttle return spring becomes disconnected at either end, the carburetor redundant throttle closing linkage will return throttle linkage to the idle position. Vehicles may be driven in this condition; however, increased accelerator pedal effort will be required. When this occurs, carburetor redundant throttle closing linkage should be reloaded as soon as possible following the instructions outlined.

CAUTION

Whenever throttle return spring is disconnected at either end, the throttle linkage at the carburetor will snap to the closed position under a spring force sufficient to cause possible personal in jury. It is essential, to prevent personal injury, that all instructions be followed in the stated order; and hands be kept clear of carburetor throttle linkage when connecting or disconnecting the throttle return spring.

VEHICLE MAINTENANCE

If throttle return spring has been disconnected or removed, the carburetor linkage will be unloaded as shown in Fig. 1.

Loading the linkage (Fig. 2) is accomplished by rotating throttle lever to wide open throttle (clockwise) and by moving accelerator control rod to the right. Do not rotate throttle lever directly, since it will snap to the closed position. Then attach throttle return spring to trip lever. Secure opposite end of throttle return spring to retainer located at thermostat housing. Slowly return accelerator control lever to idle position. Linkage is not loaded (Fig. 3).

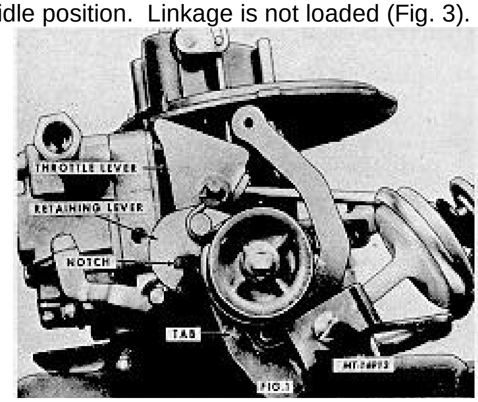


Fig. 1

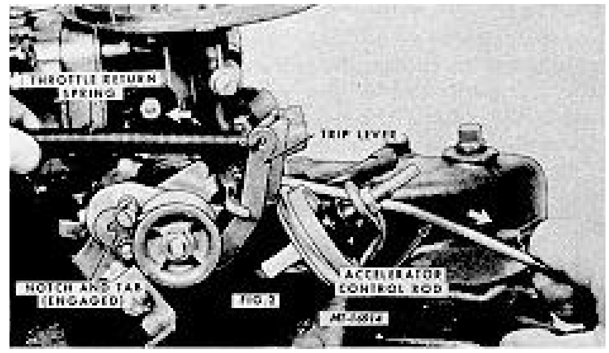


Fig. 2

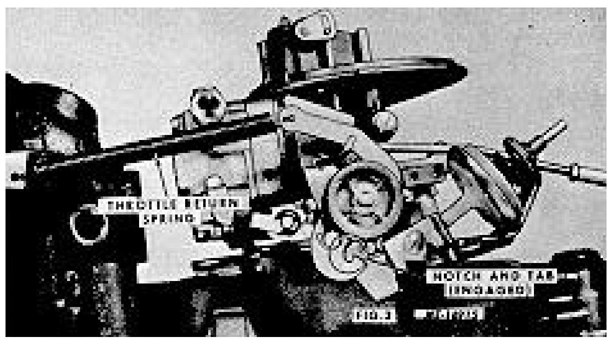


Fig. 3

ENGINE IDLE-CARBURETOR

ADJUSTMENT (Gasoline Engine)

The engine idling speed can be increased by turning the carburetor throttle stop screw "inward", or decreased by turning the throttle stop screw "outward".

FUEL FILTER (Gasoline Engine)

The gasoline fuel filter is located in the carburetor fuel inlet line. For servicing intervals refer to Emissions Manual.

FUEL FILTER (LPG Engine)

The fuel lock-strainer assembly should be drained occasionally and blown out. If strainer should become clogged, close valve on tank and allow engine to run until line and strainer are clear of gas. Stop engine and remove drain plug at bottom of strainer.

CAUTION

To prevent personal injury, property dam age or fatality, do not blow strainer out while engine is running, vehicle is close to fire or parked inside of a building.

VEHICLE MAINTENANCE

FUEL TANK (Gasoline Engine)

As fuel is consumed, air is drawn through the vent into the fuel tank. Under certain climatic conditions, with a quick drop in temperature and the vehicle inoperative, moisture may accumulate in the fuel tank. Therefore, keep the fuel tank filled, as much as practical, to avoid moisture accumulation.

FUEL TANK LPG

LPG chassis should be operated on one tank at a time. If both tanks are used simultaneously, the fuel will bleed into the tank having the lowest pressure and temperature. When the fuel tank being used becomes exhausted of fuel, the operator will notice a reduction in power. The operator will then stop the vehicle, close the liquid valve on the tank being used, and slowly open the liquid valve on the opposite tank.

CAUTION

To prevent severe personal injury, property damage or fatality never light matches near any type fuel tank, because the air within a radius of several feet is permeated with a highly explosive vapor. Keep the filler spout or nozzle in contact with the metal of the tank to avoid the possibility of an electric spark igniting the fuel.

STEERING

POWER STEERING PUMP BELT TENSION

For proper belt deflection refer to Fan and Accessory Belt Adjustment under Engine.

POWER STEERING PUMP FLUID RESERVOIR

The fluid level in the reservoir must be maintained to the proper level on the dipstick type indicator attached to the filler cap.

POWER STEERING OIL RESERVOIR FILTER (If Equipped)

Remove reservoir cover and filter element. Clean inside of reservoir with a lint-free cloth. Install new filter element and replace cover. Refer to the lubrication instructions.

TIRES

TIRE BALANCE

Front wheel shimmy, wandering and cupped tires are caused by an out-of-balance condition of one or both front tires. If the tires are changed because of a flat tire or to equalize wear, it is advised that they be checked for balance before operating the truck.

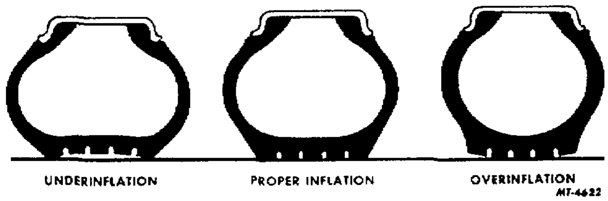
VEHICLE MAINTENANCE

TIRE INFLATION

Inflation pressures should be checked when tires are cool, using an accurate tire pressure .gauge. Check pressures at regular intervals.

CAUTION

Bleeding the air from hot tires is dangerous and should not be attempted. While the pressure will be reduced, an increase in temperature of the tire will take place as soon as driving is resumed and tire failure will occur. Tire failure could result in bodily harm or property damage in the event of an accident.



UNDERINFLATION

Too little air pressure increases deflection, causes the tread to wipe and scuff over the road, results in extra strain on the tire, and increases the changes for bruising.

PROPER INFLATION

Maintaining the proper air pressure provides maximum road contact and results in increased tire life.

OVERINFLATION

Overinflation reduces tire deflection and tire contact area, causing the tire to ride on the crown, and results in rapid wear in the center of the tread.

CAUTION

Tires used on multipiece rims should be assembled and inflated only by experienced personnel. Bodily injury may be incurred with improper assembly or inflation techniques.

TIRE MATCHING

DUAL TIRES

Use care in matching dual tires. Tires which differ more than 6.4mm (¼ in.) in diameter or 19.1 mm (¾ in.) in circumference should not be mounted on the same dual wheel. Should it become necessary to mount two tires of unequal size on the same dual wheel, place the larger or less worn tire on the outside.

DRIVE AXLES

Tires of the same size and specifications must be installed on both front and rear driving axles of the vehicle. If different size tires are used when vehicle is operated with both the front and rear axles engaged, a torque build-up between the axles, caused by the different diameter tires, will result in excessive tire wear and strain on the entire drive unit. This method of tire mounting will also cause high axle lubricant temperatures which may lead to premature axle failure.

TIRE MIXING
RADIAL AND BIAS PLY TIRES

It is recommended that for best overall performance that only bias or only radial tires be used on a vehicle. However, different heavy truck tires may be used per the following:

Bias or radial tires may be used on either axle of two-axle vehicles if the vehicle has dual rear wheels, or is equipped with wide base single tires.

Either bias or radial tires may be used on the steering axle of vehicles with three or more axles.

Never mix different tire sizes or constructions on the same axle.

Never mix bias and radial tires in a tandem drive axle combination.

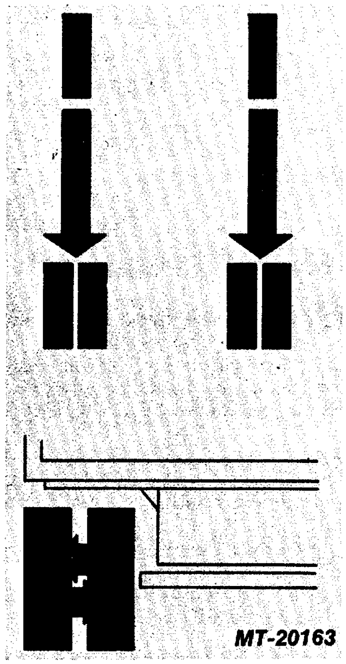
TIRE ROTATION
ROTATION IS ALWAYS ADVISABLE:

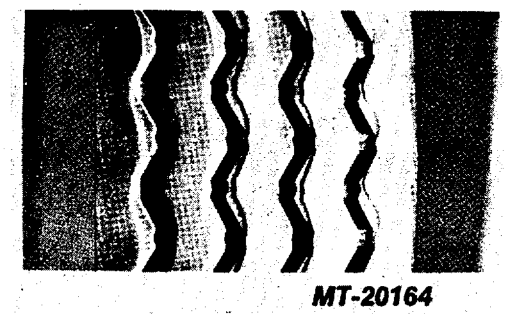
1. If front (steering) axle tires become irregularly worn, move to rear or trailer position.
2. In a dual assembly, if one tire wears much faster than its mate, reverse position of tires.

ROTATION MAY BE ADVISABLE:

1. If rib-type tires are used in all wheel positions: FRONT (STEERING) AXLE-Install new tires in front wheel positions. When worn to no less than 3.175 mm (1/8 in.) remaining groove depth, move to any other position. REAR AND TRAILER AXLES Tires must be removed when worn to no less than 1.588 mm (1/16 in.) remaining original groove depth. However, tires identified by the word "regroovable" molded on the side wall can be regrooved.

2. If rib type tire is used on front axle and lug type on rear axle positions: FRONT (STEERING) AXLE-Install new tires in front wheel positions. When worn to 3.175 mm (1/8 in.) remaining groove depth, they must be removed and can be moved to trailer positions. REAR AND TRAILER AXLES Tires must be removed when worn to 1.588 mm (1/16 in.) remaining original groove depth. However, tires identified with the word "regroovable" molded on the side wall can be regrooved.





CIRCUMFERENTIAL TREAD CHANNELING

A type of irregular wear which can occur on any tire but which is more prevalent on radial tires, is sometimes called "erosion wear", "freerolling wear" or "river wear". It is characterized by a fast-wearing channel adjacent to one or both sides of the groove.

This type of wear is found most typically on any free-rolling position. Tires on drive positions can also generate this condition but due to the faster rate of wear and the torque being transmitted through these tires, the wear is worn away as fast as it develops and is very rarely observed.

Wear of this type will generally not detract from the overall mileage that the tire can give, if it is caught and corrected before it progresses to an advanced state. Tires with this condition should be moved to drive positions where it can be smoothed out.

CAUTION

To prevent bodily harm the following points must be strictly adhered to when mounting radial tires on wheels.

1. Before mounting radial tires make certain that heavy duty rims or approved rims for radial tires are being used. It may be necessary to contact your wheel and rim distributor to determine if rims are approved for radial tires.
2. If a tube is to be used make sure special radial tire tubes are used because of the increased flexing of the side walls on radial tires.
3. Never use soap when mounting radial tires, an approved lubricant by the tire manufacturer or water can be used as an aid for mounting tires.

TRANSMISSION

Air Filter

The transmission air filter having a replaceable element is located on the left side of the transmission and filters the air require to operate the transmission air shift cylinder. Moisture should be drained from the filter and the element changed at regular pre-established intervals. Refer to Lubrication Chart and Instructions.

INSTRUCTIONS FOR CHANGING THE AIR FILTER ELEMENT

1. Remove drain plug to blow off air pressure and collected moisture.

VEHICLE MAINTENANCE

2. Remove retaining nut and gasket from cover.
3. Remove filter case by tapping lightly on case.
4. Remove the used filter element.
5. Wash filter case and internal parts in cleaning solution and air dry.
6. Check the cover gasket. Replace if necessary.
7. Install spring, washer, gasket, support cup and new filter element over filter case stud and into case.
8. Install filter case and assembled components to filter cover. Hold in position and install retaining nut and gasket. Tighten the nut securely.
9. Install drain plug and tighten securely.
10. Raise the air pressure and check for leaks.

OIL FILTER

If your vehicle is equipped with a transmission oil filter, it has a replaceable element. See Lubrication Section for servicing.

U-BOLTS

1. After the chassis has been operating under load for 1600 km (1000 miles), or six months whichever comes first, the U-bolt nuts must be retorqued.
2. The U-Bolt nuts thereafter should then be retorqued every 58,000 km (36,000 miles).
3. The U-Bolt (joint) should be cleaned and free of corrosion as in a new or as-new condition .

U-BOLT NUTS

U-Bolt Dia. (NOM)	Torque N•m	Torque Lbs. Ft.
½	88-109	65-80
5/8	176-217	130-160
¾	271-325	200-240
7/8	305-573	225-275
1	441-543	325-400

WHEELS

Wheel Alignment

To guard against excessive tire wear, have the front wheel alignment inspected occasionally by your IH Dealer for tow-in, camber and axle caster.

WHEEL-CAST

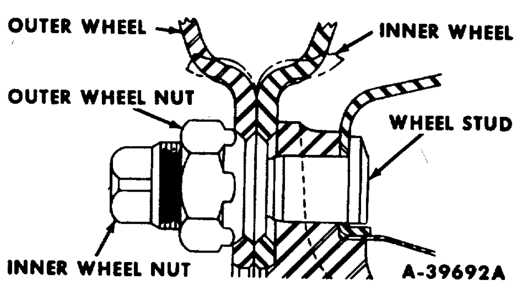
On cast type wheels, the rim clamp nuts should be inspected at regular intervals to see that they are tight. The rim and tire alignment, in relation to the wheel, should also be inspected to be sure that the tire is running true. Keep the rim clamp bolts tight. Refer to torque chart for nut size and torque.

RIM AND CLAMP NUT TORQUE

Bolt Size	Torque Newton Meters
½-13	108-122 N•m (80-90 ft. lbs.)
5/8-11	217-237 N•m (160-175 ft. lbs.)
¾-10	237-258 N•m (175-190 ft. lbs.)

WHEELS-DISC (Dual Wheel Nut)

1. Mounting faces of the hub, wheel and nut must be free from dirt or excess paint. Mounting faces which have been damaged from wear or abuse must be repaired or replaced.
2. Right hand threads are used on the right hand side of the vehicle and left hand threads on the left side.
3. Tighten the single wheel nuts alternately.
4. Tighten the wheel mounting stud nuts to 608-675 N•m (450-500 ft. lbs.) torque.
5. On dual wheels loosen the outer nuts before attempting to tighten the inner nuts. Tighten inner nuts to 675 N•m (500 ft. lbs.) torque and outer nuts to 608 N•m (450 ft. lbs.) torque. Always tighten the inner nuts 68 N•m (50 ft. lbs.) more than the outer nuts and never let the outer nuts get below 540 N•m (400 ft. lbs.).



WHEELS-DISC (Flanged Nut)

1. Mounting faces of the hub, wheel and nut must be free from dirt or excess paint. Mounting faces which have been damaged from wear or abuse must be repaired or replaced.
2. Right hand threads are used on both sides of the vehicle when the flanged type nuts are used.
3. Tighten flanged wheel mounting stud nuts to 540 N•m (400 ft. lbs.).

It is good practice to recheck lug nut torque of any wheel installation after the first 80 km (50 mi.). The seating of parts may allow the torque to drop off. If the torque has dropped off, retorque and check again after another 80 km (50 mi.). If torque has dropped off a second time, recheck closely for a flush fit to hub or brake drum; look for any type of interference and correct. Once the proper torque is retained after the initial installation, it is advisable to periodically check the torque at regular maintenance intervals.

CAUTION

When mounting "NEVER" hammer on a fully or partially inflated assembly.

To prevent possible bodily injury or fatality, these Safety Precautions listed below must be strictly observed.

CAUTIONS

1. Always deflate tires completely before removing locks or side rings.
2. Always inspect and clean all parts before assembly.
3. Always inflate tires in safety cage.
4. Always use a "clip-on" air chuck with remote valve to inflate tires.
5. Never mix parts of different types or size.
6. Never use cracked, bent or badly rusted parts.
7. Never reinflate flat tire on vehicle--use the spare.
8. Never add air until certain each side or lock ring is fully seated.
9. Caution must be observed when selecting the proper replacement part, an incorrect fit is dangerous. The side ring, locking ring and base must all fit correctly.
10. Do not heat or weld aluminum wheels in an attempt to straighten or repair severe road damage. The special alloy used in these wheels is heat-treated, and uncontrolled heating from welding torch affects the properties of the material.
11. To avoid possible corrosive affects to aluminum wheels, use only a slight amount of water and neutral soap (similar to Ivory Snow, Dreft, etc. -no detergents) when mounting tires. Do not use commercial rubber lubricants.
12. Do not stand unprotected in front of side ring when inflating tire. If no protection device is available, stand wheel and tire close to a solid wall with side ring facing the wall. Inflate tire from side opposite ring. If no solid wall is available, place tire and wheel on floor with side ring next to floor (down) and inflate from above keeping body AWAY from directly in front of or above tire at all times.
13. Inflate tire until tire beads are firmly seated against rim flanges. Never inflate above 40 psi to seat beads. Completely deflate tire by removing valve core; then reinflate tire to recommended pressure.
14. When installing new front or rear rims, the size and material of new rims must be equivalent or the same as specified by the ORIGINAL MANUFACTURER. Installation of larger than recommended rims can include severe overstress of axle and brake components which could result in serious personal injury in the event of component fatigue.
15. When mounting "NEVER" hammer on a fully or partially inflated assembly.

VEHICLE MAINTENANCE

TIRE LOAD AND INFLATION CHART

(For Trucks, Buses and Trailers in Normal Highway Service)

Tire Size Designations: Tube Type	Tubeless	* / **	40 / 45	45 / 50	50 / 55	55 / 60	60 / 65	65 / 70	70 / 75	75 / 80	80 / 85	85 / 90	90 / 95	95 / 100	100 / 105	105 / 110	110 / 115	115 / 120
			Tire Load Limits at Various Cold Inflation Pressures															
	8-19.5	D	1850	1990	2110C	2230	2350	2460D										
		S			2110	2270	2410C	2540	2680	2800D								
7.00x20		D	1840	1980	2100	2220	2340	2450D										
		S			2100	2260	2390	2530	2670	2790D								
7.50x20	8-22.5	D	2070	2220	2350	2490	2620	2750D	2870	2990	3100E	3210	3320	3430F	3540	3640G		
		S			2360	2530	2680	2840	2990	3140D	3270	3410	3530E	3660	3780	3910	4040	4150G
8.25x20	9-22.5	D	2460	2640	2800	2960	3120	3270	3410	3550E	3690	3820	3950F	4070	4200	4320G		
		S			2800	3010	3190	3370	3560	3730	3890	4050E	4210	4350	4500F	4640	4790	4920G
9.00x20	10-22.5	D		3120	3310	3510	3690	3870	4040E	4200	4360	4520F	4670	4820	4970G			
		S				3560	3770	4000	4210	4410	4610E	4790	4970	5150F	5320	5490	5670G	
10.00x20	11-22.5	D			3760	3970	4180	4380	4580	4760F	4950	5120	5300G	5470	5630	5800H		
		S					4290	4530	4770	4990	5220	5430F	5640	5840	6040G	6240	6430	6610H
10.00x22	11-24.5	D			4000	4230	4450	4660	4870	5070F	5260	5450	5640G	5820	6000	6170H		
		S					4560	4820	5070	5310	5550	5780F	6000	6210	6430G	6630	6840	7030H
11.00x20	12-24.5	D			4100	4330	4560	4780	4990	5190F	5390	5590	5780G	5960	6150	6320H		
		S					4670	4940	5200	5450	5690	5020F	6140	6370	6570G	6790	7010	7200H
11.00x22	12-24.5	D			4350	4600	4840	5080	5300	5520F	5730	5940	6140G	6330	6530	6720H		
		S					4960	5240	5520	5790	6040	6290F	6530	6770	7000G	7220	7440	7660H
11.00x24		D			4620	4890	5140	5390	5630	5860F	6090	6310	6520G	6730	6930	7130H		
		S					5270	5570	5860	6140	6420	6680F	6940	7190	7430G	7670	7900	8130H
12.00x20		D				4930	5190	5440	5680	5910	6140G	6360	6580	6790H	7000	7200J		
		S						5620	5920	6200	6480	6740	7000G	7250	7500	7740H	7980	8210J
12.00x24		D				5550	5840	6120	6390	6650	6910G	7160	7410	7640H	7870	8100J		
		S						6330	6660	6980	7280	7580	7880G	8160	8450	8710H	8970	9230J
	15-22.5	D		5000E	5320	5620	5910F	6200	6480	6740G	7000	7250	7500H					
		S				5680E	6040	6390	6720F	7040	7360	7660G	7950	8240	8520H			
	16.5-22.5	D		5800	6170	6520	6860	7190	7520	7820	8120H							
		S				6590	7010	7410	7790	8170	8540	8890	9230H					
	18-22.5	D		6430	6850	7230	7610G	7980	8330	8680H	9010	9340	9650J					
		S				7310	7780	8220	8650G	9070	9470	9860H	10240	10610	10970J			

For applicable load limits for other than normal highway service, for other size designations and for size designations with suffixes such as "ML" consult the tire manufacturer

* Cold Inflation Pressure for Bias Tires.

** Cold Inflation Pressure for Radial Tires. Radial Tires have an "R" in the Size Designation; examples 10.00R20.

SAFETY CHECKS AND PRECAUTIONS

Every effort has been made to assure that your new vehicle has been engineered and manufactured to provide continued trouble free service. Materials selected to manufacture the many parts which make up the vehicle undergo exhaustive test and research to make certain that acceptable, safe service life is realized.

There is, however, an area in which the vehicle owner plays an important part and which determines in a large measure the extent of continued, safe, trouble free service to be realized from the owner's investment in the vehicle. This has to do with the responsibility which rests with the owner in seeing that the vehicle receives proper care through following the periodic lubricating procedures and arranging the regular inspection intervals to assure that parts that normally deteriorate are replaced or repaired. In addition, ask your IH Dealer to make an inspection of your vehicle at least once a year.

A good, general vehicle check by an experienced serviceman will give you assurance that your vehicle is still in a safe condition.

The lubrication intervals present a good opportunity to inspect the vehicle, and we suggest that the following points be checked at these intervals.

AXLE-FRONT

Maintaining proper front axle alignment specifications is of great importance and should only be performed by a qualified mechanic.

Check to assure that axle mounting U-bolt nuts, attaching or mounting bolts and nuts are securely tightened.

Regularly check front axle for damaged, binding or worn parts, and adequate lubrication.

AXLE-REAR

Check to assure that axle mounting U-bolt nuts, attaching or mounting bolts and nuts are securely tightened.

Regularly check rear axle for damaged, binding or worn parts.

BRAKE-SYSTEM

Brake Lining Adjustment: Always maintain proper lining adjustment.

Brake Lining Inspection: Every 12,000 miles or 12 months, whichever occurs first, have brake linings inspected for wear. Where vehicles are used in severe service or in considerable stop-and-go service, more frequent inspections should be scheduled.

On a periodic basis or at least once a year inspect entire brake system for:

1. Brake controls (refer to Rubber Parts).
2. Condition of drums, brake chambers and slack adjusters.
3. Air leaks.
4. Hose or pipes for rust, damage, deterioration.
5. Operation of service and parking brakes.

IMPORTANT

Some parts, such as air brake chamber diaphragm, should be inspected once a year or every 80,000 km (50,000 mi.) and replaced if considered unserviceable for further use.

CAB

Defrosters: Operate defroster controls to determine if sufficient air is being directed against windshield.

Door Latches: Check latches for positive closing, latching and locking.

Glass: Check for cracked, broken, scratched or dirty glass including rear view mirrors.

Seats: Be sure manually operated seats are firmly engaged to avoid forward or rearward movement when starting or stopping.

Seat Belts: Check the entire seat belt assembly for wear and proper operation. Make certain anchor mountings are tight.

In addition to the above, check condition of cab mounting brackets, sheet metal, rubber mountings and safety prop when equipped.

CLUTCH

Maintain specified clutch pedal adjustment.

Regularly inspect clutch control linkage for tightness.

SAFETY CHECKS AND PRECAUTIONS

COOLING

CAUTION

Misuse, misapplication or modification of radiator cooling fans can result in serious personal injury and property damage. The following safety recommendations should be adhered to when servicing radiator cooling fans.

1. Extreme caution must be exercised when working on vehicles equipped with an Automatic Fan Clutch. The fan clutch is controlled by a temperature control switch which starts the fan in motion only after the engine coolant reaches a predetermined temperature.

   Service personnel should never reach or permit objects to come within the radius of the fan blade while the engine is running, but the fan blade is not in motion.
2. Do not operate the engine with a fan which has been bent, mutilated, modified or in any way damaged.
3. Do not operate the engine if the fan makes physical contact or strikes against any other engine accessory while in operation.
4. Do not rebalance a fan.
5. Insure that all fan mounting bolts are installed at the specified torque.
6. Install fans such that the word "front" stamped on the fan hub faces toward the radiator.
7. Perform all required maintenance on the subassembly to which the fan is attached (i.e., water pump or fan drive, etc.).
8. Take special care not to make modifications which will increase the operating speed of the fan.
9. Do not install a fan on an engine for which the fan has not been approved. Likewise, install a subassembly to which the fan is attached (water pump, fan drive, etc.) only if approved for use on the engine.
10. If the fan contains any plastic or rubber component, have the fan inspected by a qualified mechanic after exposure to excessively high temperatures (above 250° F ambient temperature).
11. Replace the fan if there appear to be indications of excessive corrosion or erosion in the fan.

ELECTRICAL

Horn: Occasionally blow the horn (air or electric) for satisfactory operation.

Instruments: Check operation of all instruments and gauges.

Lights: Be sure lights, regardless of type or where they are located, will illuminate at all times.

Wiring: Replace loose, weathered, cracked or broken wires to safeguard against breakdown on the road or possible shorts.

EXHAUST SYSTEM

Inspect heat shields for proper installation or location. Maintain exhaust system (mufflers, exhaust pipes, tail pipes, joints) integrity to assure no exhaust fumes can enter cab area.

CAUTION

Be assured that no fuel lines, brake lines, hoses or electrical wiring is contacting the exhaust system as this can result in the following.

FUEL LINES: Personal injury or property damage is a high probability, should a fire occur due to fuel leakage being ignited by an external ignition source.

BRAKE LINES: A defective or ruptured brake line can allow a loss of braking ability to stop the vehicle; thus a vehicle crash could result with property damage or severe personal injury being incurred.

HOSES: Bodily harm from steam or hot water can result from broken heater or radiator hoses. Also deteriorated steering gear hoses could result in property damage or personal injury should the vehicle crash due to loss of steering gear fluid.

ELECTRICAL WIRING: Shorts in the electrical wiring, such as the headlights, horn, electric windshield wipers, etc. could result in a fire or stalled vehicle with resultant bodily injury.

SAFETY CHECKS AND PRECAUTIONS

FRAME

Because International chassis are manufactured with frame rails of either cold rolled steel, heat-treated steel or aluminum alloy, each must be handled in a specific manner to assure maximum service life.

Specific instructions are published, concerning proper repair of frame rails and can be obtained from your nearest Dealer.

FUEL SYSTEM

Frequently check throttle linkage for proper operation.

Inspect condition of fuel tanks, fuel lines, clips and routing.

LPG

Safety precautions in the handling of butane-propane cannot be over-emphasized. There are state, county or city laws, ordinance, and fire regulations covering the utility ordinance, and fire regulations on this subject must be adhered to in addition to the safety rules given below.

Where local rules are more stringent than those given below, the local rules are to be given priority.

These rules apply to servicing any vehicle or engine using liquefied petroleum gas (butane-propane) for engine fuel regardless of the nature of the work to be performed.

1. Select a location for servicing this vehicle where there wll be good air circulation. This is to avoid accumulation of gas-air mixtures in and about the vehicle caused by undetected leaks.
2. Such location should be as far as possible from steam cleaners, hot water cleaner, hot dip tanks, etc., and any other device operating with open flame.
3. Shut off the main valves at the fuel tanks and allow the motor to run. This is to exhaust all fuel in the system from the tank to the engine. In the event the vehicle is disabled and the engine is inoperative, shut the valve at the tank. Bleed the fuel system of propane gas outside of the building before towing the unit into the shop.
4. "DANGER" signs should be placed on either side of the vehicle. There is to be no smoking in the vicinity. No work is to be performed on this vehicle or no others in a nearby zone involving open flames such as cutting or welding, grinding, chiseling, or any similar operation which may produce sparks.
5. In order to avoid possible accumulations of explosive gas-air mixtures, these vehicles, whenever possible, should be removed from the shop at the end of the working day.
6. A fire extinguisher (dry powder or carbon dioxide) should be removed from its regular location and placed adjacent to the mechanic's working area-handy for immediate use. When LPG ignites, it should be allowed to burn until, if possible, the source of fuel is shut off. Extinguishing the fire before this is accomplished, can result in dangerous accumulations of gas which might cause a more serious flash or explosion.
7. After completing service work and before starting the engine, raise the hood to allow air to circulate around the engine to remove any possible gas accumulation.
8. Never use LPG from the fuel tanks on these vehicles for cleaning parts, blowing of horns, inflating tires, cleaning out the cab or other uses for which it is not intended and by which it is out of control.

   This is mentioned because inspections have revealed that operators have used it as a substitute for solvents and compressed air, not realizing the extreme danger of this practice.
9. Whenever the nature of service work requires any operation on the fuel system, the following should be observed.
   a. All threaded connections should be treated with an insoluble lubricant. (permatex or aviation gasket maker.) Replace worn or defective fittings.
   b. After connecting up the fuel system check it for leaks. NO LEAKS ARE PERMISIBLE. Odorants which are strong smelling compounds (a smell similar to spoiled cabbage) are added LP-Gas, as warning agents, to indicate leakage of even small quantities of gas.
   c. A lather of soap brushed on with a soft brush will indicate the presence of leaks which are dangerous and wasteful. Never use open flame to check for leakage.

SAFETY CHECKS AND PRECAUTIONS

CAUTION

Pay particular attention to short lengths of rubber hose used anywhere in the piping system to relieve stress and vibration.

10. NO WORK WHATEVER IS TO BE PERFORMED ON THE FUEL TANKS OF LIQUIFIED PETROLEUM GAS FUELED VEHICLES. Any necessary work should be performed by qualified concerns who normally service such containers and are familiar with local regulations and inspection and test after any repairs are made.
11. Vehicles of this type which have been involved in an accident should not be brought into the shop for repair until the shop foreman has checked the fuel tanks and fuel systems for possible leaks.
12. It is important to remember that all LPG systems are pressurized. Make certain the tank valves are tightly closed and all fuel exhausted from the lines before starting any repair work on the fuel system.

PROPELLER SHAFT

At the regular lubrication interval, check universal joints for wear.

Should propeller shaft vibrations occur, stop the vehicle immediately to avoid possible hazardous consequences or damage to other components.

RUBBER PARTS

Rubber parts are subject to deterioration. Brake components should be considered for periodic replacement once each year based upon the severity and length of service. Usually careful inspection by experienced mechanics will disclose the need for attention.

SPRINGS

Maintain specified torque on spring U-bolt nuts.

Periodically check condition of spring leaves for evidence of fatigue, bending or breakage.

STEERING

Be alert to any change (feel) in steering when driving. This change or feel would include increased steering efforts, unusual sounds when turning, excessive wheel play or pulling to either side.

Check tie rod and drag link end clamp bolts. They must be tight. Ask your service mechanic to examine the steering mechanism. Minor adjustments could head off further problems.

Check power steering system for leaks or hose chaffing. Repair at once.

Maintain proper steering gear and power steering pump lubricant levels.

Regularly inspect all steering linkage, particularly for body-to-chassis clearance.

IMPORTANT

If any of the above are evident, contact qualified steering personnel at once.

SUSPENSIONS

Check condition of suspension mounting brackets or bushings.

Suspension alignment must be maintained at all times.

TOW HOOKS

Front and rear tow hooks should be inspected for damage or a loose mounting. This is of great importance, particularly on vehicles used in operations where the tow hooks are frequently required.

TRANSMISSION

Check fluid level and shift linkage for proper operation.

IMPORTANT

If vehicle starts in any gear other than "Neutral" or "Park" the safety switch is malfunctioning.

SAFETY CHECKS AND PRECAUTIONS

WHEELS

Check condition of and maintain recommended torque on wheel and rim mounting bolts and nuts

Check condition of tires for abnormal wear patterns, and proper inflation pressures. Cut or broken tire casing must be repaired.

CAUTION

Mounting and demounting of tires should only be performed by personnel utilizing necessary safety procedures and equipment.

Wheel bearings must be properly packed and adjusted at regular intervals. This is especially important if operating in deep sand, mud, or water.

WHEEL-DISC (Flanged Nut)

1. Mounting faces of the hub, wheel and nut must be free from dirt or excess paint. Mounting faces which have been damaged from wear or abuse must be repaired or replaced.

2. Right hand threads are used on both sides of the vehicle when the flanged type nuts are used.

3. Tighten flanged wheel mounting stud nuts to 540 N•m (400 ft. lbs.).

It is good practice to recheck lug nut torque of any wheel installation after the first 80 km (50 mi.). The seating of parts may allow the torque to drop off. If the torque has dropped off, retorque and check again after another 80 km (50 mi.). If torque has dropped off a second time, recheck closely for a flush fit to hub or brake drum; look for any type of interference and correct. Once the proper torque is retained after the initial installation, it is advisable to periodically check the torque at regular maintenance intervals.

LUBRICATION

GENERAL INSTRUCTIONS

New vehicles are properly lubricated at the factory and before they are delivered. After the vehicle is placed in operation, regular lubrication intervals, as outlined, should be followed. Thorough lubrication at definite intervals will add greatly to the service life of the vehicle and will reduce overall operating expense.

The interval between lubrication periods and oil changes depends entirely upon operating conditions, loads carried, speeds and road and weather conditions. 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 HOURS OF OPERATION.

Only lubricants of the best quality such as IH oil and lubricants, having proper body or viscosity, should be used. The use of inferior products will reduce the service life of the vehicle or result in failure of its components.

The International Harvester Company Truck Group recommends the use of its regular IH oil and lubricants available through your IH truck dealer.

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.

IMPORTANT

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 is 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, miles or kilometers.

LUBRICATION

ENGINE LUBRICANT SPECIFICATIONS

GASOLINE ENGINES

Temperature	Straight Viscosity Grade	Multi Viscosity Grade
20 to 120 F (-7 to 49 C)	SAE 30	SAE-10W-30,10W-40,20W-40,20W-30
0 to 90 F (-18 to 32 C)	SAE 20W	SAE-10W-30,10W-40,20W-40,20W-30
-10 to 70 F (-23 to 21 C)	SAE 10W	SAE 10W-30, 10W-40
Below -10 F (23 C)	SAE	5W-20, 5W-30

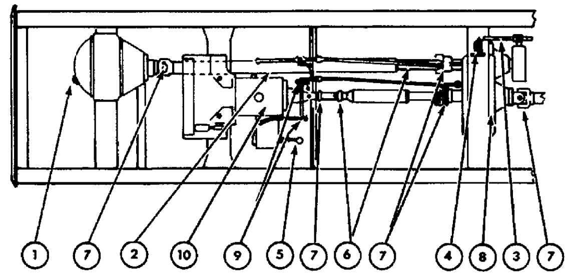
Use engine oils meeting service classification "SE" or "CC" (MIL-L-46152).

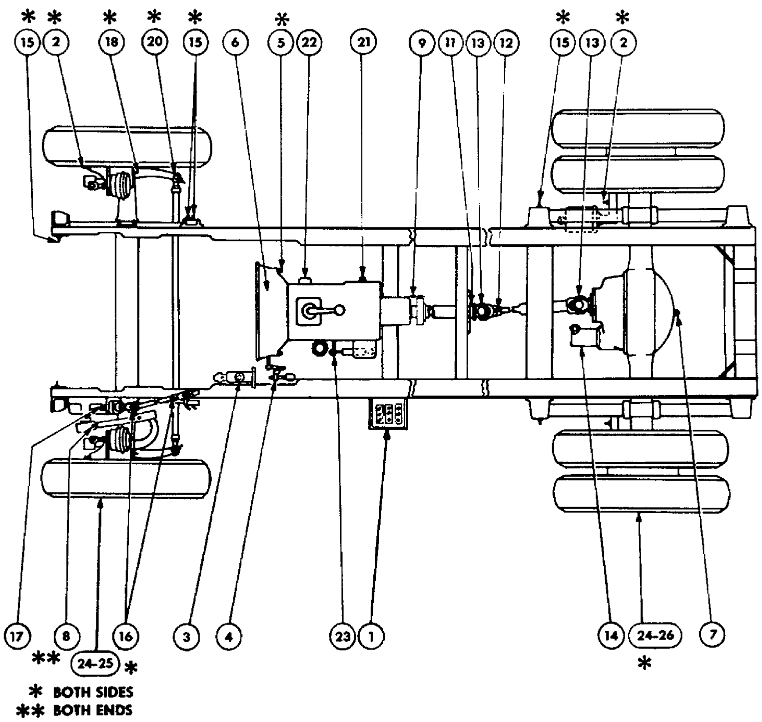
IMPORTANT

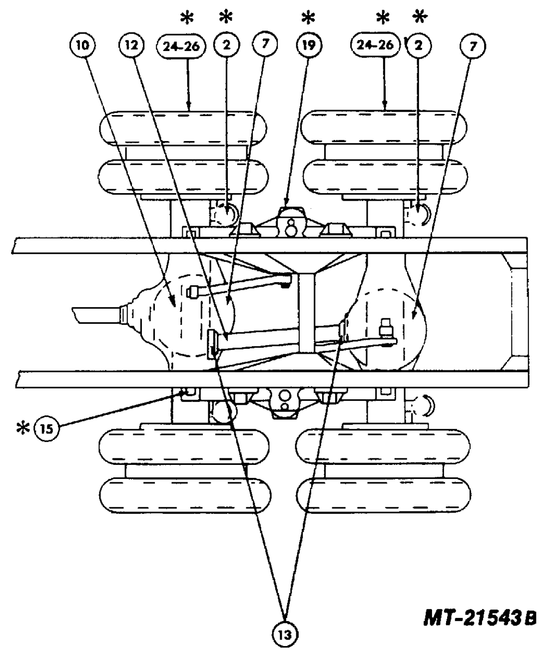
When a universal engine oil (SE-CD) is preferred, the engine oil must have passed the Volvo B-20 cam and tappet test and contain a minimum 0.1% alkyl zinc. IH #1 engine oil meets this requirement.

(For Caterpillar, Cummins, Detroit Diesel, IH DT-466, 9.0 liter and D-150-170-190 engines, refer to separate Operator's Manual).

LUBRICATION







LUBRICATION

KEY NOS.			LUBRICATION INTERVALS				
4x2	4x4	Description	Operation	Months	Miles	Kilometers	Use
NI	NI	Air Cleaner (Chassis Mounted) Engine	Clean or Replace	SEE SPECIAL INSTRUCTIONS "A"			For Engine Mounted Air Cleaner See Engine Emission Control Manual
NI	NI	Air Cleaner (Air Compressor)	Clean or Replace	5	16000	26000	
1	SAME	Battery (With Caps)	Check Water Level	Monthly	4000	6000	Soft Water
1	SAME	Battery Posts	Clean	When Corrosion Appears			Grease After Cleaning
2	SAME	Brake Camshafts and Slack Adjusters	Lubricate	5	16000	26000	IH 251 HEP Grease or Equivalent NLGI #2
3	SAME	Brake Master Cylinder	Check Level	Monthly	4000	6000	Super Heavy Duty "Dot" 3"
NI	NI	Brake Pedal to Brake Valve Linkage	Lubricate	5	24000	38000	Light Weight Engine Oil
NI	NI	Clutch Master Cylinder (RH Drive)	Check Level	Monthly	4000	6000	Super Heavy Duty "Dot 3"
4	SAME	Clutch Pedal Linkage	Lubricate	Monthly	4000	6000	Light Weight Engine Oil
5	SAME	Clutch Relay and Release Fork Shaft	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
6	SAME	Clutch Release Sleeve, Bearing, Fork	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
NI	NI	Clutch Slave Cylinder Yoke (Pin RH Drive)	Lubricate	Monthly	4000	6000	Light Weight Engine Oil
NI	NI	Coolant Level	Check Level	At Each Fuel Stop			Soft Water and Antifreeze
7	1	Differential (Front or Rear Axles)	Check Level	Monthly	4000	6000	See Special Instructions "B"
			Change Lubricant	15	24000	38000	See Special Instructions "B"
NI	NI	Door Check, Hinges, Latches, Strikers	Lubricate	5	4000	6000	Light Weight Engine Oil
8	SAME	Drag Link	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
		Engine Crankcase (Oil)	Check Level	Daily			
			Change	See Engine Emission Control Manual for Service Interval. See Engine Lubrication Chart for Specified Lubricant.			
		Engine Oil Filter	Replace	See Engine Emission Control Manual for Service Interval.			
		Fuel Filters	Replace	See Engine Emission Control Manual for Service Interval.			
NA	2	Front Driving Axle Shift Linkage	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
NI	NI	Hood Tilt Linkage	Lubricate	Monthly	4000	6000	Light Weight Engine Oil
9	3	Parking Brake Linkage	Lubricate	Monthly	4000	6000	Light Weight Engine Oil
NA	4	Parking Brake Relay Lever	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
NI	NI	Power Steering Pump Filter Element	Replace	20	20000	32000	
NA	5	Power Take Off Shift Control	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
10	SAME	Power Divider Lock Yoke Pin	Lubricate	Monthly	4000	6000	Light Weight Engine Oil
11	NI	Prop Shaft Center Bearing	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
12	6	Prop Shaft Slip Joint	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
13	7	Prop Shaft U-Joint	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2

LUBRICATION

KEY NOS.		LUBRICATION INTERVALS					
4x2	4x4	Description	Operation	Months	Miles	Kilometers	Use
14	NA	Shift Motor (Two Speed Axle)	Check Level	Monthly	4000	6000	See Special Instructions "C"
15	SAME	Spring Pins	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
16	SAME	Steering Column	Lubricate	5	16000	26000	IH 251 HEP Grease or Equivalent NLGI #2
17	SAME	Steering Gear (Manual)	Check Level	Monthly	4000	6000	See Special Instructions "K"
NI	NI	Steering Gear (Power) Reservoir	Check Level	5	16000	26000	See Special Instructions "J"
18	SAME	Steering Knuckles	Lubricate	5	16000	26000	IH 251 HEP Grease or Equivalent NLGI #2
19	SAME	Suspension Connecting Tube Bearing	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
20	NI	Tie Rods	Lubricate	5	16000	26000	IH 251 HEP Grease or Equivalent NLGI #2
NA	8	Transfer Case	Check Level	Monthly	4000	6000	See Special Instructions "D"
			Change Lubricant	5	16000	26000	See Special Instructions "D"
NA	9	Transfer Case Shift Linkage	Lubricate	Monthly	4000	6000	IH 251 HEP Grease or Equivalent NLGI #2
21	10	Transmission (Auto)	Check Level	Monthly	4000	6000	Dexron Automatic Transmission Fluid
			Change Lubricant	5	16000	26000	Dexron Automatic Transmission Fluid
21	10	Transmission (Fuller) Main and Aux.	Check Level	Monthly	4000	6000	See Special Instructions "E"
			Change (Initial Fill)	--	5000	8000	See Special Instructions "E"
			Change (Thereafter)	--	32000	51000	See Special Instructions "E"
21	10	Transmission	Check Level	Monthly			See Special Instructions "E"
		(New Process)	Change Lubricant	Every 5 months			See Special Instructions "E"
21	10	Transmission (I.H.)	Check Level	Monthly			See Special Instructions "G"
		(T-498, T-499 Only)	Change Lubricant	Every 5 months			See Special Instructions "G"
21	10	Transmission (Spicer) Main and Aux.	Check Level	Monthly	4000	6000	See Special Instructions "F"
			Change (Initial Fill)	--	4000	6000	See Special Instructions "F"
			Change (Thereafter)	--	12000	19000	See Special Instructions "F"
21	10	Transmission (Clark)	Check Level	Monthly	4000	6000	See Special Instructions "H"
			Change (Initial Fill)	--	1000	1609	See Special Instructions "H"
			Change (Thereafter)	5	24000	38000	See Special Instructions "H"
22	SAME	Transmission Air and Oil Filter	Change	5	16000	26000	
23	SAME	Transmission Air Cylinder Linkage	Lubricate	Monthly	4000	6000	See Special Instructions "C"
NI	NI	Water Filter	Replace	5	12000	19000	
24	SAME	Wheel Bearings (Grease)	Repack	5	32000	51000	IH 251 HEP Grease or Equivalent NLGI #2
25	SAME	Wheel Bearings (Oil) Front	Check Level	Monthly	4000	6000	SAE30 Heavy Duty Engine Oil or Rear Axle
			Change Lubricant	5	16000	26000	Gear Lubricant
26	SAME	Wheel Bearings (Oil) Rear	Check Level	Monthly	4000	6000	See Special Instructions "B"
			Change Lubricant	5	16000	26000	See Special Instructions "B"

LUBRICATION
SPECIAL INSTRUCTIONS

A. Under 240,000 Km (150,000 miles): Clean element when air restriction exceeds 51 cm (20 in.) of water or 3.8 cm (1.5 in.) of mercury

Air Pressure Cleaning: Compressed air can be used to blow out the element from the clean air side out.

Washing Procedure: Filter element can be washed with any good non-sudsing, household detergent. Use warm water 49-60 deg. C (120-140 deg. F). Flush filter with gentle stream until drain water is clean. Air dry element before using. Also inspect after every cleaning for damage or rupture. Wipe all internal parts clean before reassembling. Replace gasket regularly.

REPLACE: 240,000 Km (150,000 miles)

B. SAE 85W-140 gear lubricant or SP type lubricant SAE-90 viscosity year around, meeting MIL-L-2105B specification (SP must not contain zinc). For abnormally high temperature severe service (hot climate off highway operation where vehicle is in low speed heavy hauling for prolonged periods), use SAE-140. For trac-lok rear axles, add 20CC (2/3 ounce) of IH-LS additive for each .47 liter (pint) of SP lubricant, at every 10,000 miles, 16,000 kilometers of operation.

C. SAE10W Engine Oil for temperatures 18 deg. C (0 deg. F) and up. For temperatures below 18 deg. C (0 deg. F) use three parts of SAE10W engine oil to one part kerosene. The mixture can safely be used in temperatures up to 0 deg. C (32 deg. F).

D. *Use straight mineral oil SAE90 for temperatures -18 deg. C (0 deg. F) and up. Use SAE80 for temperatures* below -18 deg. C (0 deg. F). Special Recommendations: Where temperature is consistently below -18 deg. C (0 deg. F) and where parked vehicles are exposed to unusual cold for long periods, use SAE75. Where temperatures are consistently above 32 deg. C (90 deg. F) or unusually hot, use SAE140 straight mineral oil.

E. **FULLER-NEW PROCESS**	Engine Oil (SE, CC, CD)	SAE30	Below	-12 deg. C (+10 deg. F)
		SAE40,50	Above	-12 deg. C (+10 deg. F)
	Mineral Gear Oil	SAE80	Below	-12 deg. C (+10 deg. F)
	(Rust and Oxidation Inhibited)	SAE90	Above	-12 deg. C (+10 deg. F)
F. **SPICER**	Engine Oil (SE, CC, CD)	SAE30	Below	-18 deg. C (0 deg. F)
		SAE30,40,50	Above	-18 deg. C (0 deg. F)
G. **IH**	Engine Oil (SE, CC, CD)	SAE5W20 or 10W40	Below	-18 deg. C (0 deg. F)
		SAE20, 20W30 or any of the above	Above	0 deg. C (+32 deg. F)
		SAE30, 10W40, 20W40	Above	32 deg. C (90 deg. F)
	Add eight (8) ounces of zinc additive to a clean fill of lubricant any overhaul or complete transmission replacement.			
H. **CLARK**	Gear Lubricant	SAE80,90	Above	-7 deg. C (+20 deg. F)
	Engine Oil	SAE50	Above	-7 deg. C (+20 deg. F)
	Mineral Oil	SAE80,90	Above	-7 deg. C (+20 deg. F)
	Gear Lubricant	SAE80,90		-29 to 16 deg. C (-20 deg. F to +60 deg. F)
	Engine Oil	SAE30		-29 to 16 deg. C (-20 deg. F to +60 deg. F)
	Mineral Oil	SAE80,90		-29 to 16 deg. C (-20 deg. F to +60 deg. F)
	Mineral Oil	SAE75	Below	-18 deg. C (0 deg. F)

J. Saginaw Gears: IH Power Steering Fluid (1 Quart Can No. 990625-C1).

Sheppard Gears: 10W-40 Engine Oil Only.

Ross Gears: 1600-2100 IH Power Steering Fluid (1 Quart Can No. 990625-C1).
2200-2600 10W-40 Engine Oil.

K. Manual Gears:

Gemmer and Ross - SAE-90 SP Type Lubricant, meeting MIL 2105B Specification.

Saginaw - IH 251 HEP Grease or equivalent NLGI #2.

UNIT REFILL CAPACITIES

AIR CONDITIONER REFRIGERANT CAPACITY

Kg.	Lb.	Oz.
2.04	4	8

AXLE FRONT

Model	Code	Liters	Pints
FA-64	02064	8	17
FA-78	02078	8	17
FA-79	02079	8	17

AXLE REAR

		Forward			Rear	
Note No.	Model	Code	Liters	Pints	Liters	Pints
	RA-29	14029	6	13		
	RA-30	14030	5	11		
	RA-39	14039	6	13		
	RA-42	14042	11	23		
1	RA-44	14044	11	23		
1	RA-47	14047	15	32		
1	RA-57	14057	18	38		
	RA-72	14072	20	42		
	RA-186	14186	10	21		
	RA-187	14187	6	13		
	RA-192	14192	13	27		
	RA-197	14197	14	30		
	RA-199	14199	9	19		
1	RA-277	14277	18	38		
	RA-292	14292	13	27		
	RA-298	14298	18	38		
4	RA-333	14333	16	34	15	32
1-4	RA-351	14351	10	21	11	23
1-4	RA-355	14355	10	21	11	23
4	RA-399	14399	16	34	13	27
1-4	RA-467	14467	20	42	16	34
1-4	RA-472	14472	12	25	11	23
4	RA-474	14474	22	46	18	38
3	RA-496	14496	15	32	14	30

NOTES

(1) Add .47 Liters, One (1) Pint of this total at Pinion Cage Plug.
(2) Add .94 Liters, Two (2) Pints of Fwd. Rear Axle Total at Fwd. Filler Hole.
Add .94 Liters, Two (2) Pints to Selecto-Torq thru Hole in Side of Case.
(3) Add .94 Liters, Two (2) Pints of Fwd. Rear Axle Total at Interaxle Diff.
(4) Add .47 Liters, One (1) Pint of Fwd. Rear Axle Total at Interaxle Diff.

UNIT REFILL CAPACITIES

COOLING SYSTEM

Engine Model		Liters	Quarts
V-345		21	22
V-392		22	23
MV-404		25	26
MV-446		32	34
9.0 Liter		40	42
DT-466	(1800, 1900, 2100 Series)	35	37
	(All Others)	51	54
6V-53		40	42
6-71N		49	52
6V-92		57	60
6V-92		*59	62
8V-71		59	62
8V-71		*68	71
V-537	(2100 Series)	35	37
	(All Others)	51	54
PT-270		49	52
NTC-230		51	54
NTC-250		51	54
NTC-290		58	61
CAT-3208	(1800, 1900, 2100 Series)	38	40
	(All Others)	63	67

Capacities listed above are for standard cooling radiators (with heater, add 1.9 Liters (2 Qts.). Trucks with increased capacity radiators add additional coolant to bring level about one inch below top of the radiator surge tank.

The only coolants which are recommended for use in IH cooling systems are those which contain an ethylene glycol base. Other base coolants are generally detrimental to our rubber hoses, especially to those made of silicone rubber. A general guide to type of rubber is based on color. Silicone hoses are made in "COLOR" while other rubber hoses are "BLACK". If coolants used are not of ethylene glycol base, this may affect your engine warranty.

* With Cooler

IMPORTANT

Anti-freeze formulated with methoxy propanol or propolene glycol is not recommended for use with IH engines due to a reaction with engine internal seals, coolant hoses and potential fire hazard due to lower flash points than ethylene glycol type antifreeze.

UNIT REFILL CAPACITIES

CRANKCASE AND OIL FILTERS (ENGINE)

	Oil Pan Only		Oil Pan & Engine (Full Flow Filter)	
	Liters	Quarts	Liters	Quarts
V-345 (Not 4x4)	8	8	9	9
V-345 (4x4)	7	7	8	8
V-392 (Not 4x4)	8	8	9	9
V-392 (4x4)	7	7	8	8
MV-404	8	8	9	9
MV-446	8	8	9	9
9.0 Liter	11	12	13	14
DT-466	17	18	21	22
V-537	14	15	15	16
6V-53	22	23	24	25
6-71N	22	23	24	25
6V-92	17	18	19	20
8V-71	22	23	24	25
PT-270	27	28	30	32
NTC-230	27	28	30	32
NTC-290	27	28	30	32
CAT-3208	11	12	12	13
CAT-3406	28	30	34	36

Bypass Filter Capacity:

Luberfiner 750	13 Liters	14 Quarts
IH (Fleetguard)	11 Liters	12 Quarts

STEERING GEAR

Model	Code	Kg.	Lbs.	Oz.
S-57	05057	624	1	6
S-58	05058	624	1	6
S-165	05165	510	1	2

Power Steering Gears: Fill Power Steering Pump Reservoir To Indicator Level

UNIT REFILL CAPACITIES

TRANSMISSION

Model	Code		Liters	Pints
T-17	13017		3	6
T-18	13018		3.5	7
T-128	13128		13	27
T-129	13129		12	25
T-194	13194		12	25
T-196	13196		12	25
T-197	13197		13	27
T-316	13316		13	27
T-348	13348		10	21
T-422	13422	Fwd	3	6
		Rear	5	11
T-425	13425		4	8
T-448	13448		6	13
T-451	13451		13	27
T-454	13454		13	27
T-456	13456		20	42
T-459	13459		13	27
T-462	13462		13	27
T-463	13463		12	25
* T-464	13464		15	32
* T-465	13465		15	32
T-467	13467		13	27
T-468	13468		13	27
T-470	13470		13	27
T-471	13471		12	25
T-473	13473		12	25
T-495	13495		6	13
T-496	13496		6	13
T-672	13672		8	17
T-673	13673		8	17
T-674	13674		8	17
T-681	13681		12	25
T-683	13683		18	38
T-696	13696		4	8
T-697	13697		4	8
T-698	13698		6	13
T-699	13699		6	13

* Capacity listed is initial fill. After oil has been circulated, add additional oil as required to bring level to full mark on dipstick. Capacities can vary with optional cooling system.

UNIT REFILL CAPACITIES

TRANSMISSION (AUXILIARY)

Model	Code	Liters	Pints
AT-522	13522	4	8
AT-536	13536	5	11
AT-540	13540	6	13
AT-552	13552	6	13
AT-554	13554	7	15
AT-601	13601	6	12

TRANSFER CASE

Model	Code	Liters	Pints
TC-155	13155	2	4
TC-163	13163	3	6
TC-170	13170	3	6
TC-177	13177	5	11

ABBREVIATIONS OF METRIC TERMS

Volume
cm^3 = cubic centimeter
1 = liter

Velocity
km/h = kilometers per hour

Torque
N.m = Newton Meter

Length
m = meter
mm = millimeter
cm = centimeter
km = kilometer

Power
kw = kilowatts

Temperature
c = celsius

Pressure
kPa = kilopascal

Mass
g = gram
kg = kilogram
gpl = grams per liter
gpg = grams per gallon

SPECIFICATIONS

ENGINE-GASOLINE

IH Model	V-345/V-345LPG	V-392	MV-404	MV-446	V-537
Number of Cylinders	8	8	8	8	8
Bore	9.8 cm (3-7/8")	10.5 cm (4-1/8")	10.5 cm (4.125")	10.5 cm (4.124")	11.8 cm (4.625")
Stroke	9.3 cm (3-21/32")	9.3 cm (3-21/32")	9.5 cm (3.740")	10.6 cm (4.180")	10.2 cm (4")
Piston Replacement	5658 cm^3 (345 cu.in.)	6429 cm^3 (392 cu.in.)	6558 cm^3 (399.9 cu.in.)	7329 cm^3 (446.9 cu.in.)	8800 cm^3 (537 cu.in.)
Maximum Recommended Speed RPM	3,800	3,600	3,600	3,600	3,400
Firing Order	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2	1-2-7-3-4-5-6-8	1-2-7-3-4-5-6-8	1-8-7-3-6-5-4-2
Horsepower (AMA)	36.1 kw (48.1 hp)	40.8 kw (54.4 hp)	40.9 kw (54.5 hp)	40.9 kw (54.5 hp)	51.0 kw (68.5 hp)

(AMA horsepower rating is based on the bore of the engine and is no index to actual engine power. It is required in some states for licensing purposes.)

ELECTRICAL

Electrical System - 12 Volts	Negative ground
Spark Plug Gap	LPG Engine .51 mm (.020") Gasoline Engine .76 mm (.030")
Distributor Contact Point Gap (NOT ELECTRONIC IGNITION)	LPG Engine .41 mm (.016") New Points .5 mm (.019") Gasoline Engine Reset .41 mm (.016")
Distributor Cam Angle Dwell (NOT ELECTRONIC IGNITION)	V-345 Gas and Propane - 28 - 32 Degrees V-537-24-34 Degrees
Air Gap, Trigger Wheel-To-Sensor (ELECTRONIC IGNITION)	.20 mm (.008")

ENGINE INITIAL TIMING AND IDLE RPM.
Refer to "Emission Control Information" label in the engine compartment for timing, RPM and Fuel Mixture Specs.

(For Caterpillar, Cummins, Detroit Diesel, IH DT-466, 9.0 liter and D-150-170-190 engines, refer to separate Operator's Manual).

EXTERIOR NOISE EMISSIONS

THE WARRANTY

The International Harvester Co. warrants to the first person who purchases this vehicle for purposes other than resale and to each subsequent purchaser that this vehicle was designed, built and equipped to conform at the time of sale to such first purchaser with all applicable U.S. EPA Noise Control Regulations.

This warranty is not limited to any particular part, component or system of the vehicle. Defects in the design, assembly or in any part, component or system of the vehicle which, at the time of sale to such first purchaser, cause noise emission levels to exceed federal standards are covered by this warranty for the life of the vehicle.

TAMPERING WITH NOISE CONTROL SYSTEM PROHIBITED

Federal law prohibits the following acts or the causing thereof; (1) The removal or rendering inoperative by any person other than for purposes of maintenance repair, or replacement, of any device or element of design incorporated into any new vehicle for the purpose of noise control prior to its sale or delivery to the ultimate purchaser or while it is in use, or (2) The use of the vehicle after such device or element of design has been removed or rendered inoperative by any person. Among those acts presumed to constitute tampering are the acts listed as follows: A. Air Intake System: Removal of air cleaner, intake silencer, or piping. B. Acoustical Shielding (Body): Removal of wheel wellsplash shields, cab shields, or acoustical (underhood) insulation. C. Cooling System: 1. Removal or rendering inoperative the fan clutch. 2. Removal of fan shrouds. D. Engine and Drive Line System: 1. Removal or rendering engine speed governor inoperative so as to allow engine speed to exceed manufacturer specifications. 2. Removal of engine block shield, oil sump shield, or transmission enclosures. E. Exhaust System: Removal or rendering inoperative exhaust system components including muffler, resonator, or tailpipe.

INSTRUCTIONS FOR PROPER MAINTENANCE

In order to comply with federal exterior noise regulations, your vehicle may be equipped with the following noise items. Depending upon the vehicle configuration, it may incorporate all or some of the following five groups.

To avoid abnormal changes in vehicle sound level, it is necessary for the owner to perform inspections and necessary maintenance at the intervals shown in the following maintenance schedules, and record on the inspection verification forms provided.

Air Intake System:

A. Air intake silencer a metal ring or canister mounted between the air cleaner and the engine air intake should be checked for proper installation.

B. Air Cleaner if remote mounted to dash panel, should be inspected and its location should not be altered. Do not alter inlet and outlet piping.

Body:

A. Wheel well - Splash shields, cab shields and underhood insulation should be inspected for deterioration, dislocation, and orientation.

Cooling System:

A. Check fan for damage to blades, replace if necessary with manufacturer recommended parts. Inspect for fan to shroud interference, and any damage to shroud such as cracks, holes and buckling of metal.

B. Fan ratio should not be changed and fan spacer dimensions and position should not be altered.

C. Inspect for proper operation of fan clutch making sure that the fan is disengaged when cooling of engine is not required.

EXTERIOR NOISE EMISSIONS

D. Check for proper operation of radiator shutters, if provided. Shutters should be open during normal operating temperatures.

Engine and Driveline System:

A. Engine sump cover - Inspect for cracks, holes and visible signs of deterioration. Sump cover should be mechanically isolated to be effective. Check for grounding. Maintain exact location of sump cover and check sealing at edges.

B. Transmission enclosure - Inspect for cracks, holes and tears. Clean any deposits such as oil, dirt and stones.

C. Throttle delay devices should be checked and, if necessary, adjust as per manufacturers' recommendations.

D. Engine valve covers and block covers are made to damp out engine mechanical noise and, if needed to be replaced, should be replaced by recommended parts. Check for mechanical isolations.

Exhaust System:

A. Inspect for leaks at various joint connections and tighten clamps. Make visual inspection for cracks or holes in muffler and tailpipe. Always replace with manufacturer recommended parts. Tailpipe elbow orientation must not be changed from standard position as originally received.

EXTERIOR NOISE EMISSIONS
MAINTENCANCE INTERVALS

KILOMETERS, MILEAGE, MONTHS or OPERATION HOURS, WHICHEVER OCCURS FIRST
(Kilometers and Mileage in Thousands)

MAINTENANCE INSPECTIONS	KM	6	13	19	38	58	77	96
	MILES	4	8	12	24	36	48	60
	MOS.	5	10	15	30	45	60	75
	HOURS	125	250	375	750	1125	1500	1875
AIR INTAKE SYSTEM:								
Silencer					I		I	
Piping					I		I	
Clamps					I		I	
BODY:								
Splash Shields				I	I	I	I	I
Cab Shields			I	I	I	I	I	I
Under Hood Insulation				I	I	I	I	I
COOLING SYSTEM:								
Fan Damage		I		I	I	I	I	I
Fan Clutch Operation		I		I	I	I	I	I
Shroud Damage		I		I	I	I	I	I
Shroud Interference		I		I	I	I	I	I
Shutter Operation		I		I	I	I	I	I

MAINTENANCE INSPECTION	KM	6	13	19	38	58	77	96
	MILES	4	8	12	24	36	48	60
	MOS.	5	10	15	30	45	60	75
	HOURS	125	250	375	750	1125	1500	1875
ENGINE and DRIVELINE:								
Oil Sump Cover		I			I		I	
Valve Covers		I			I		I	
Block Covers		I			I		I	
Throttle Delays		I			I		I	
Governor		I			I		I	
Manifold Condition		I			I		I	
Manifold Gaskets		I			I		I	
Transmission Enclosure		I			I	I	I	I
EXHAUST SYSTEM:								
Exhaust Flange Bolts		I			I		I	
Exhaust Flange Gaskets		I			I		I	
Exhaust Pipe Condition		I			I		I	
Muffler Condition						I		
Resonator Condition		I				I		
Tailpipe Condition		I				I		
Tailpipe Orientation		I			I		I	
Flexpipe Condition		I				I		
Clamps		I			I		I	

EXTERIOR NOISE EMISSIONS

VERIFICATION OF INSPECTIONS

CHASSIS MODEL ______________ VEHICLE IDENTIFICATION NO. ______________

FIRST INSPECTION

MILES __________ Km __________ Hours __________ Months __________

PERFORMED BY: SERVICE MANAGER ______ DEALER ______ DATE ______ CITY ______ STATE ______

APPROVED BY: OWNER ______ DATE ______ STREET ______ CITY ______ STATE ______

SECOND INSPECTION

MILES __________ Km __________ Hours __________ Months __________

PERFORMED BY: SERVICE MANAGER ______ DEALER ______ DATE ______ CITY ______ STATE ______

APPROVED BY: OWNER ______ DATE ______ STREET ______ CITY ______ STATE ______

THIRD INSPECTION

MILES __________ Km __________ Hours __________ Months __________

PERFORMED BY: SERVICE MANAGER ______ DEALER ______ DATE ______ CITY ______ STATE ______

APPROVED BY: OWNER ______ DATE ______ STREET ______ CITY ______ STATE ______

EXTERIOR NOISE EMISSIONS

VERIFICATION OF INSPECTIONS

CHASSIS MODEL ______________ VEHICLE IDENTIFICATION NO. ______________

FOURTH INSPECTION

MILES __________ Km ____________ Hours __________ Months __________

PERFORMED BY: ______________ SERVICE MANAGER ________ DEALER ________ DATE ________ CITY ________ STATE

APPROVED BY: ______________ OWNER ________ DATE ________ STREET ________ CITY ________ STATE

FIFTH INSPECTION

MILES __________ Km ____________ Hours __________ Months __________

PERFORMED BY: ______________ SERVICE MANAGER ________ DEALER ________ DATE ________ CITY ________ STATE

APPROVED BY: ______________ OWNER ________ DATE ________ STREET ________ CITY ________ STATE

SIXTH INSPECTION

MILES __________ Km ____________ Hours __________ Months __________

PERFORMED BY: ______________ SERVICE MANAGER ________ DEALER ________ DATE ________ CITY ________ STATE

APPROVED BY: ______________ OWNER ________ DATE ________ STREET ________ CITY ________ STATE

SEVENTH INSPECTION

MILES __________ Km ____________ Hours __________ Months __________

PERFORMED BY: ______________ SERVICE MANAGER ________ DEALER ________ DATE ________ CITY ________ STATE

APPROVED BY: ______________ OWNER ________ DATE ________ STREET ________ CITY ________ STATE

CIRCUIT DIAGRAMS

BULB CHART

BULB APPLICATION	WATTS OR CANDLEPOWER	TRADE NO.
HEADLIGHT:		
UPPER BEAM	60WATTS	7002 RH DR / 6014
LOWER BEAM	45 WATTS RH DR / 50 WATTS LH DR	
FRONT TURN	32	1156
SIDE MARKER	2	1895
PARK	3	181
STOP-TURN/TAIL-LICENSE	32/3	1157
BACK-UP	32	1156
IDENTIFICATION-CLEARANCE	3	168
FLOOD LIGHT	12	561
MIRROR LIGHT	2	1895
CLUSTER:		
ILLUMINATION	2	194
INDICATOR	2	194
WARNING	2	194
INFORMATION	2	194
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
INSTR PANEL CONTROLS	0.50	**
ASHTRAY	0.50	**
DOME	12	211-2
RADIO	0.75	1892
HEATER & A/C CONTROLS	3	168
AUTOMATIC XMSN COTROLS	1	53

** PURCHASED LIGHT ASSEMBLY
(REF G.E. BULB NO. 2162D)

DESCRIPTION	SIZE	TYPE	LOCATION
TRAILER AUX	—	—	FUSE BLOCK
TRAILER MARKER	15A	FUSE *	AT REAR
TRAILER STOP	20A	FUSE *	CAB
TRAILER TAIL	15A	FUSE *	JUNCTION
TRAILER RT TURN	10 A	FUSE *	BLOCKS
TRAILER L TURN	10A	FUSE *	
LIGHT SWITCH FBC/BUS	18GA	GN FUSE LINK	LIGHT SWITCH
KEY SWITCH IGN BUS BAR	14GA	BN FUSE LINK	AMMETER
FUSE BLOCK BAT BUS BAR	14 GA	BNFUSE LINK	AMMETER
IGNITION FBC/BUS	20GA	OR FUSE LINK	KEY SWITCH
INSTRUMENT FBC/BUS	20 GA	OR FUSE LINK	KEY SWITCH

FUSE, CIRCUIT BREAKER & FUSIBLE LINK CHART

* CIRCUIT BREAKER OPTIONAL

DESCRIPTION	SIZE	TYPE	LOCATION
HOURMETER	4A	FUSE	GAUGES BUS & FBC
ETHER START	4A	FUSE *	FUEL/ETHER
HAZARD LIGHTS	20A	FUSE	TURN/HAZARD
TURN LIGHTS	20A	FUSE	
DOME LIGHTS	15 A	FUSE *	HORN/DOME
CIGAR LTR (FBC/BUS)	15 A	FUSE *	
HORN	15 A	FUSE *	
STOP LIGHTS	30A	FUSE *	STOP/TRL MKR
TRAILER MARKER	30 A	FUSE *	
FLOOD LIGHTS	30A	FUSE *	
TAIL LIGHTS	20A	FUSE *	(15A FBC/BUS)
CL/ID LIGHTS	20A	FUSE *	TAIL/CAB MKR
PARK MARKER LTS	20A	FUSE *	
MIRROR LIGHTS	20A	FUSE *	
MKR LIGHTS (FBC/BUS)	15A	FUSE *	MARKER
TRL MKR LIGHT REL	15A	FUSE *	MARKER
INSTR PANEL LIGHTS	4A	FUSE *	PANEL
CLUSTER PANEL LTS	4A	FUSE *	
ASHTRAY LIGHTS	4A	FUSE *	
HTR & A/C CONT ILLUM	4A	FUSE *	
XMSN & ENG OIL TEMP GAUGE ILLUM	4A	FUSE *	
RADIO	4A	FUSE *	RADIO
HEATER ONLY	20A	FUSE *	HEATER & A/C
HTR & A/C-EXCEPT HIGH POSITION	20A	FUSE *	
2 SPEED AXLE	20A	FUSE *	2 SPEED
SUBMERGED FUEL PUMP	4A	FUSE *	FUEL/ETHER-BUS FUEL PUMP-TRUCK
BACK-UP LIGHTS	15A	FUSE *	BACK-UP/ ANTILOCK
ANTILOCK SYSTEMS	15A	FUSE *	
HTR & A/C HIGH POSITION	30A	CIRCUIT BKR	HEATER & A/C
KYSOR ENGINE SHUTDOWN	10A	IN-LINE FUSE	ABOVE KYSOR SW, LWR FRT LT
2 FUSES	6A	IN-LINE FUSE	SIDE OF CAB
HEADLIGHTS	15A	CIR BKR	INSIDE LIGHT SW
WINDSHEILD WIPER & WASHER	6A	CIR BKR	REAR OF WIPER SWITCH
HI-POWER PUMP (CONVENTIONAL ONLY)	50A	CIR BKR	RELAY MTG BRKT
HIGH POWER PUMP FBC/BUS	50A	CIR BKR	DASH PANEL (ENG SIDE)
CIGAR LIGHTER (CONVENTIONAL ONLY)	18 GA	GN FUSE LINK	LIGHT SWITCH
HEADLIGHT FEED	16 GA	BK FUSE LINK	AT START MOTOR SOL
CAB FEED (CONVENTIONAL ONLY)	12 GA	DK BL FUSE LINK	AT START MOTOR SOL
GENERATOR FBC/BUS	20 GA	OR FUSE LINK	KEY SWITCH
HOURMETER	5A	IN-LINE FUSE	UNDER FUSE BLOCK - TRUCK
ETHER START	5A	IN-LINE FUSE	LWR EDGE INST PNL - TRUCK

FUSE IDENT SHOWN AS ON FUSE BLOCK
FUSE BLOCK MTG ON INSIDE CAB-UPPER LEFT SIDE OF DASH-CONVENTIONAL-LH DR
FUSE BLOCK MTG ON INSIDE COWL-CENTER OF INSTR PANEL - FBC/BUS
FUSE BLOCK MTG ON INSIDE CAB-UPPER RIGHT SIDE OF DASH-CONVENTIONAL - RH DR

MT-23290

BULB AND FUSE CHART

CIRCUIT DIAGRAMS

SYMBOLS

- —11-16— TYPICAL WIRING
- —1 GA— BATTERY CABLE
- REFERENCE WIRING
- – –11-16– – ALTERNATE WIRING
- RESISTANCE OR RESISTOR
- RESISTANCE OR RESISTOR-VARIABLE
- FUSIBLE LINK
- SPLICE
- OR FIXED CONTACT OR COMPONENT INTERNAL CONNECTION
- OPEN SWITCH
- CLOSED SWITCH
- 15 CIRCUIT BREAKER W/AMP IDENTIFIER
- 15 INLINE FUSE W/AMP IDENTIFIER
- 15 FUSE PANEL CLIP W/MALE BLADE TERMINALS & FUSE W/ AMP IDENTIFIER
- MALE TERMINAL
- FEMALE TERMINAL
- SINGLE BODY INLINE CONNECTOR
- MULTIPLE TERMINAL INLINE CONNECTOR
- —11-16— EXTERNAL GROUND
- CASE GROUND
- TERMINAL OR CONNECTOR CAVITY
- INCANDESCENT LAMP
- ELECTROMAGNETIC COIL
- THERMAL CUTOUT (FLASHER)
- DIODE

WIRE COLOR CODES

BK-BLACK	RD-RED
BN-BROWN	GN-GREEN
YL-YELLOW	WH-WHITE
BL-BLUE	OR-ORANGE

KEY

11A-16 BK

- CABLE COLOR
- CABLE GAUGE
- CIRCUIT NUMBER

NOTES

1-MULTIPLE CONNECTORS AT ELECTRICAL EQUIPMENT VIEWED FROM CABLE INSERTION END UNLESS OTHERWISE SPECIFIED.

MT-21942

Definition Of Symbols

All Models

CIRCUIT DIAGRAMS

CIRCUIT NUMBERS & DESCRIPTION

1	GENERATOR (FIELD)
2	GENERATOR (CHARGE)
6	REGULATOR, VOLT (FIELD RELAY)
7	REGULATOR, VOLT (CHARGE)
11	GROUND
14	MAIN FEED
15	KEY SWITCH
16	IGNITION
17	STARTING CONTROL
18	GLOW PLUG, PRE HEATER
19	FUEL SHUT-OFF
21	ETHER
23	MAGNETIC FAN
24	EXHAUST BRAKE
28	INSTRUMENT
29	ENG WATER TEMP
30	ENG OIL TEMP
31	TRANS OIL TEMP
32	AXLE OIL TEMP
33	ENG OIL LEVEL
34	WATER LEVEL
35	ENG OIL PRESSURE
36	FUEL LEVEL
37	FUEL PUMP
42	FRT AXLE WARNING
43	P.D. LOCK WARNING
44	BRAKE SYSTEM WARNING
48	TACHOMETER
50	LIGHT SWITCH

51	DIMMER SWITCH
52	HEAD LIGHT - HI-BEAM
53	HEAD LIGHT - LO-BEAM
54	PARKING LIGHTS
55	DIR. SIGNAL SWITCH
56	DIR. SIGNAL LIGHTS - LEFT
57	DIR. SIGNAL LIGHTS - RIGHT
58	CLEAR., IDENT., & MARKER LIGHTS
60	HAZARD SWITCH
62	PANEL LIGHTS
63	DOME &/OR COURTESY LIGHTS
68	TAIL LIGHT
70	STOP LIGHT
71	BACK-UP LIGHT
72	TRAILER
75	HEATER
76	DEFROSTER
77	AIR CONDITIONER
78	HEATED MIRROR
80	ACCESSORY FEED
82	WINDSHIELD WIPER
84	CIGAR LIGHTER
85	HORN
86	RADIO
87	WINDSHIELD WASHER
88	HOURMETER
90	HY-POWER BRAKES
92	TRANSMISSION
93	AXLE SHIFT
94	WHEELLOCK (ANTI SKID BRAKES)
95	EXHAUST EMISSION

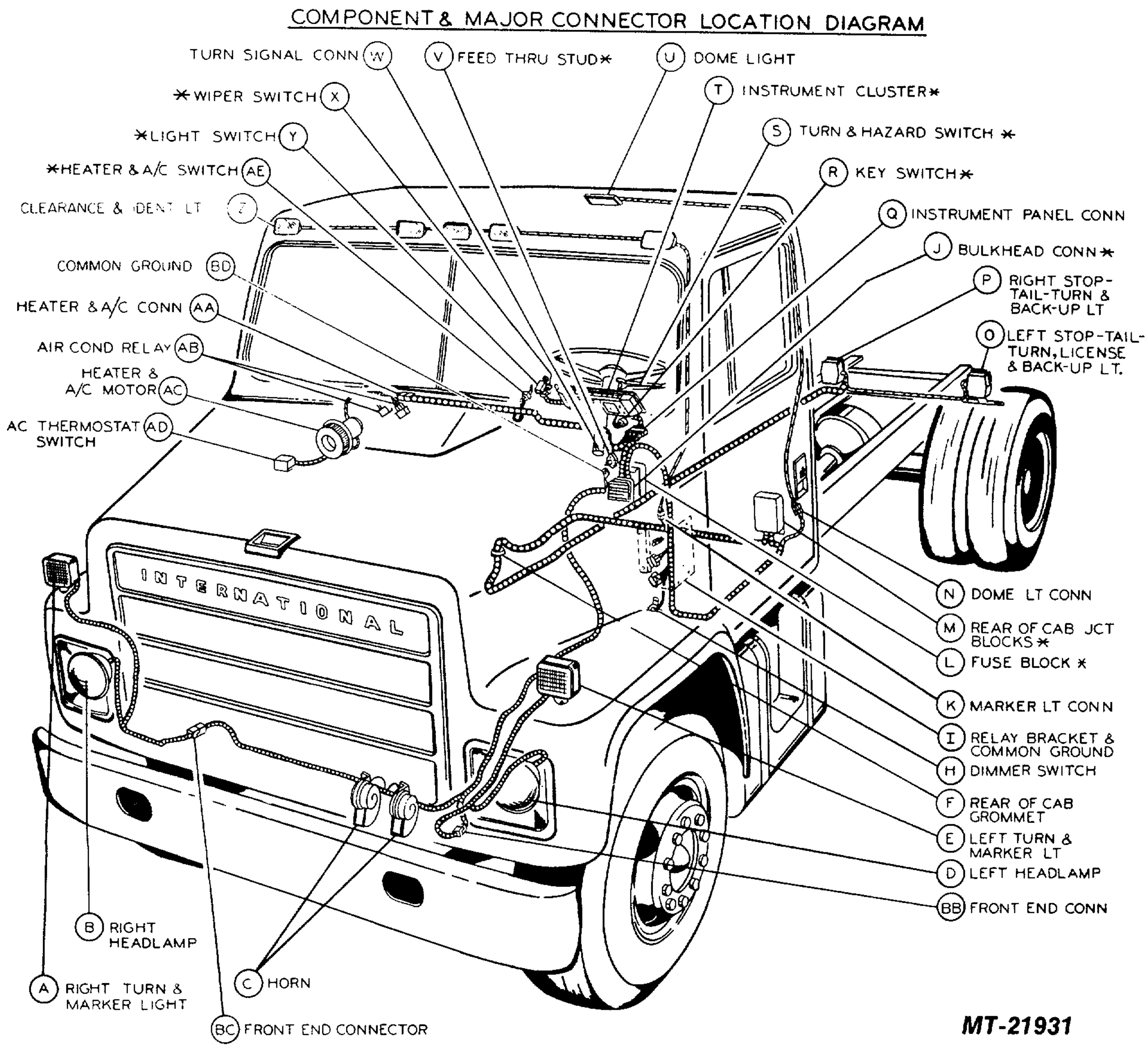
CIRCUIT NUMBERS MAY REQUIRE SUFFIC LETTER IDENTIFICATION WHEREVER BRANCHES OF THE MAIN CIRCUIT ARE ENCOUNTERED.

MT-23291

Circuit Numbers And Description

All Models

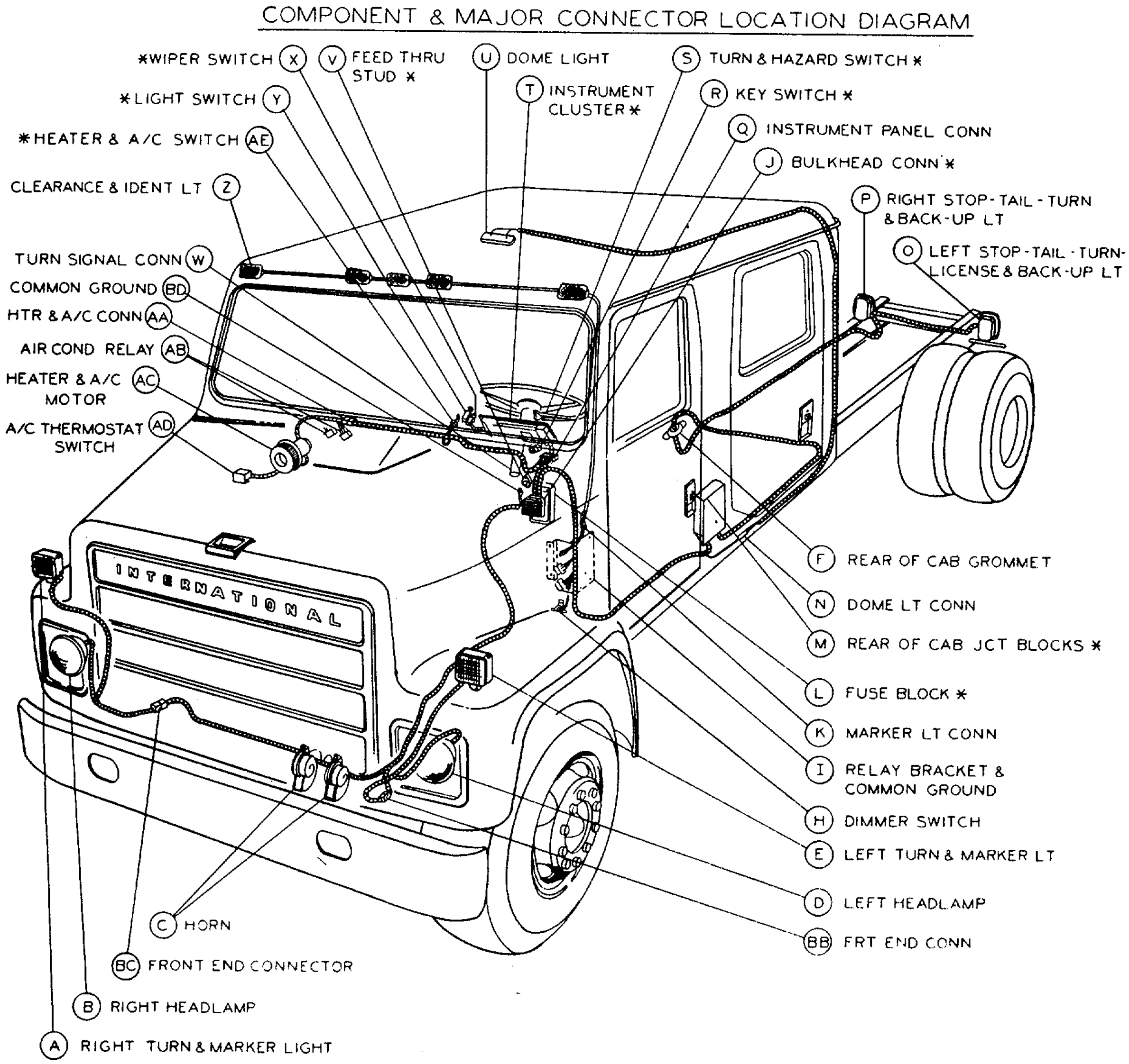
CIRCUIT DIAGRAMS



Component And Major Connector Location (On Chassis)

1600 thru 1900 Models

CIRCUIT DIAGRAMS

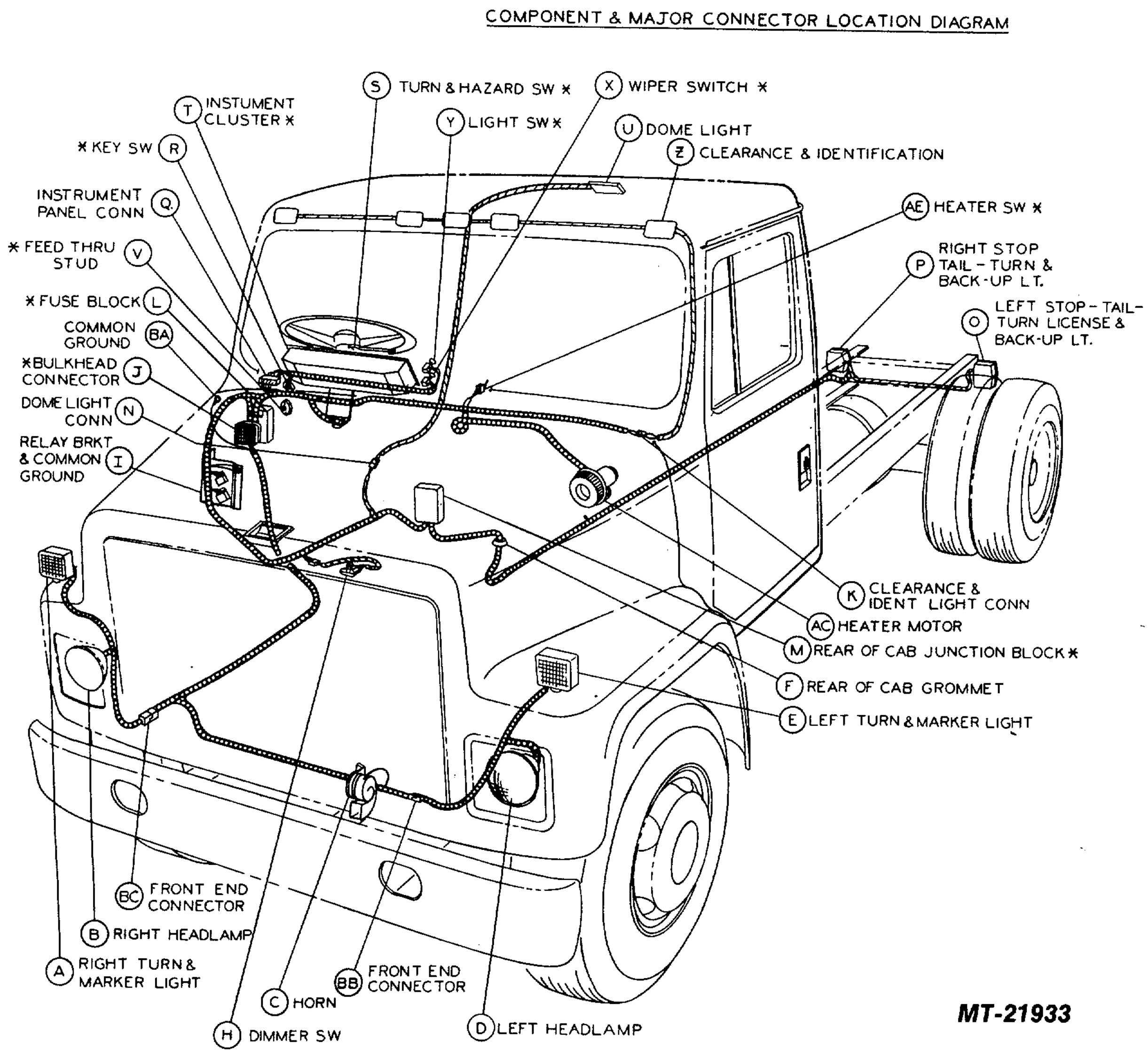


MT-21934

Component And Major Connector Location (On Chassis)

1700 thru 1900 w/Travel Crew Cab

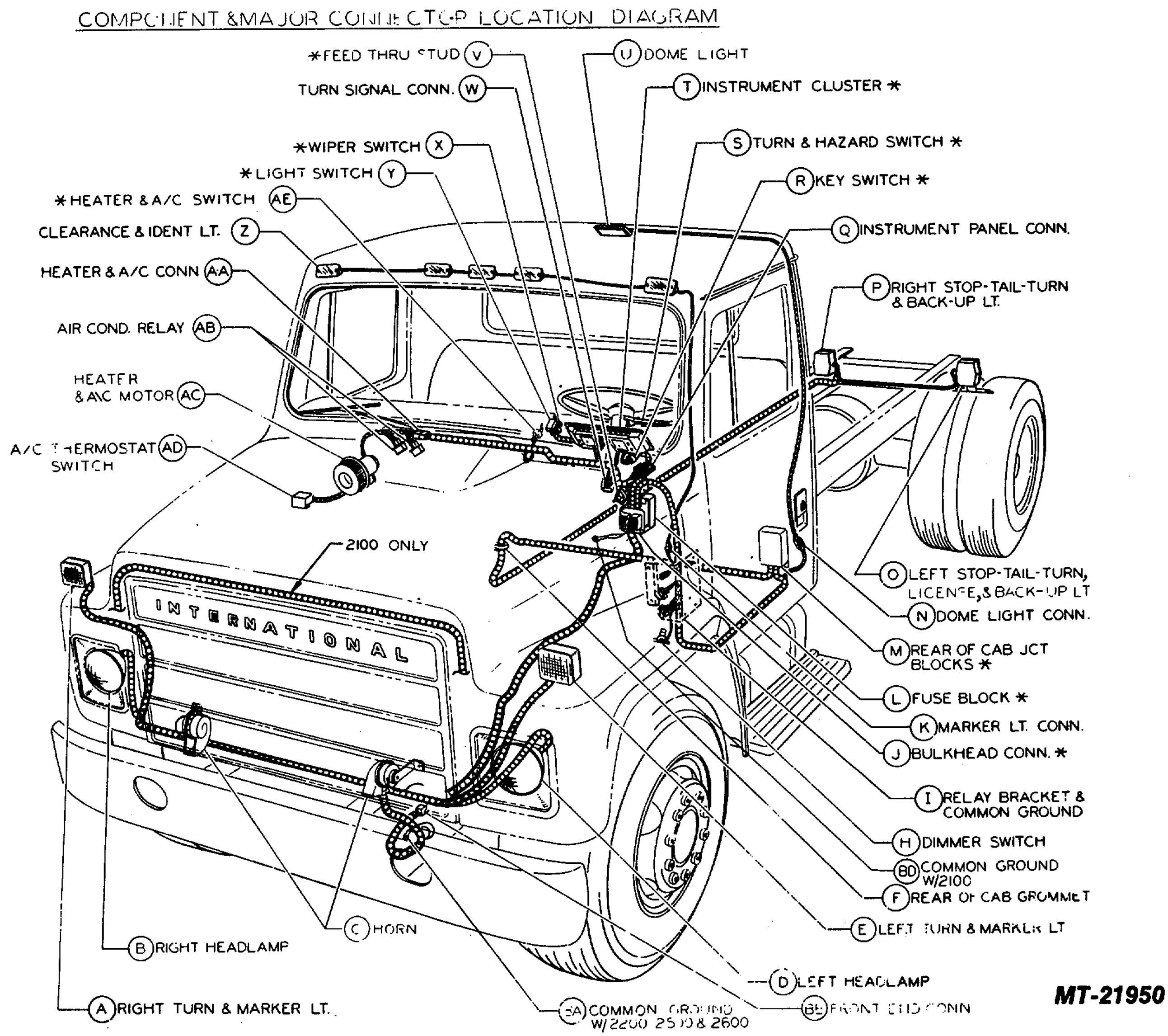
CIRCUIT DIAGRAMS



Component And Major Connector Location (On Chassis)

1700 thru 1900 Right Hand Drive Models

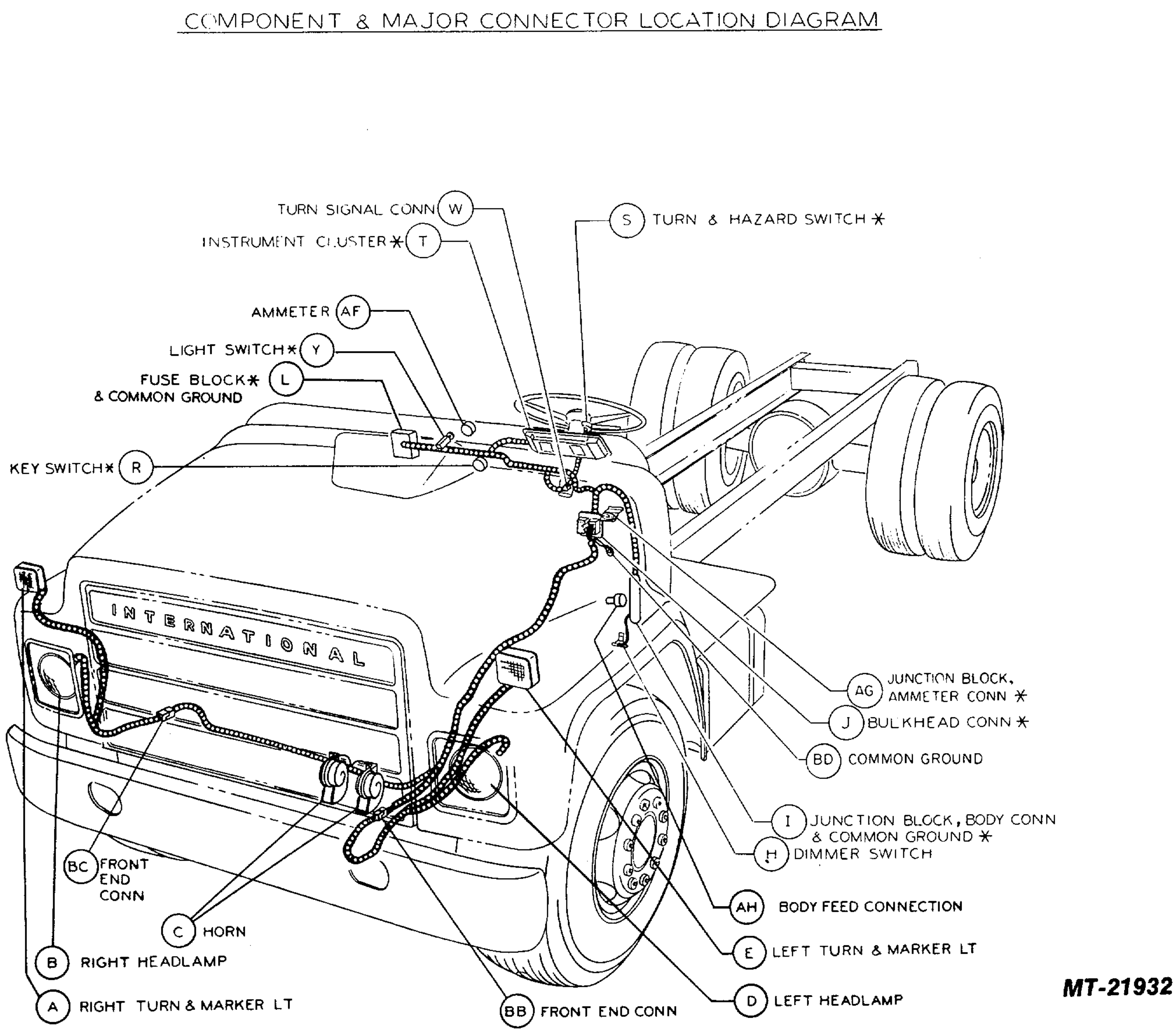
CIRCUIT DIAGRAMS



Component And Major Connector Location (On Chassis)

2100-2200-2500-2600 Models

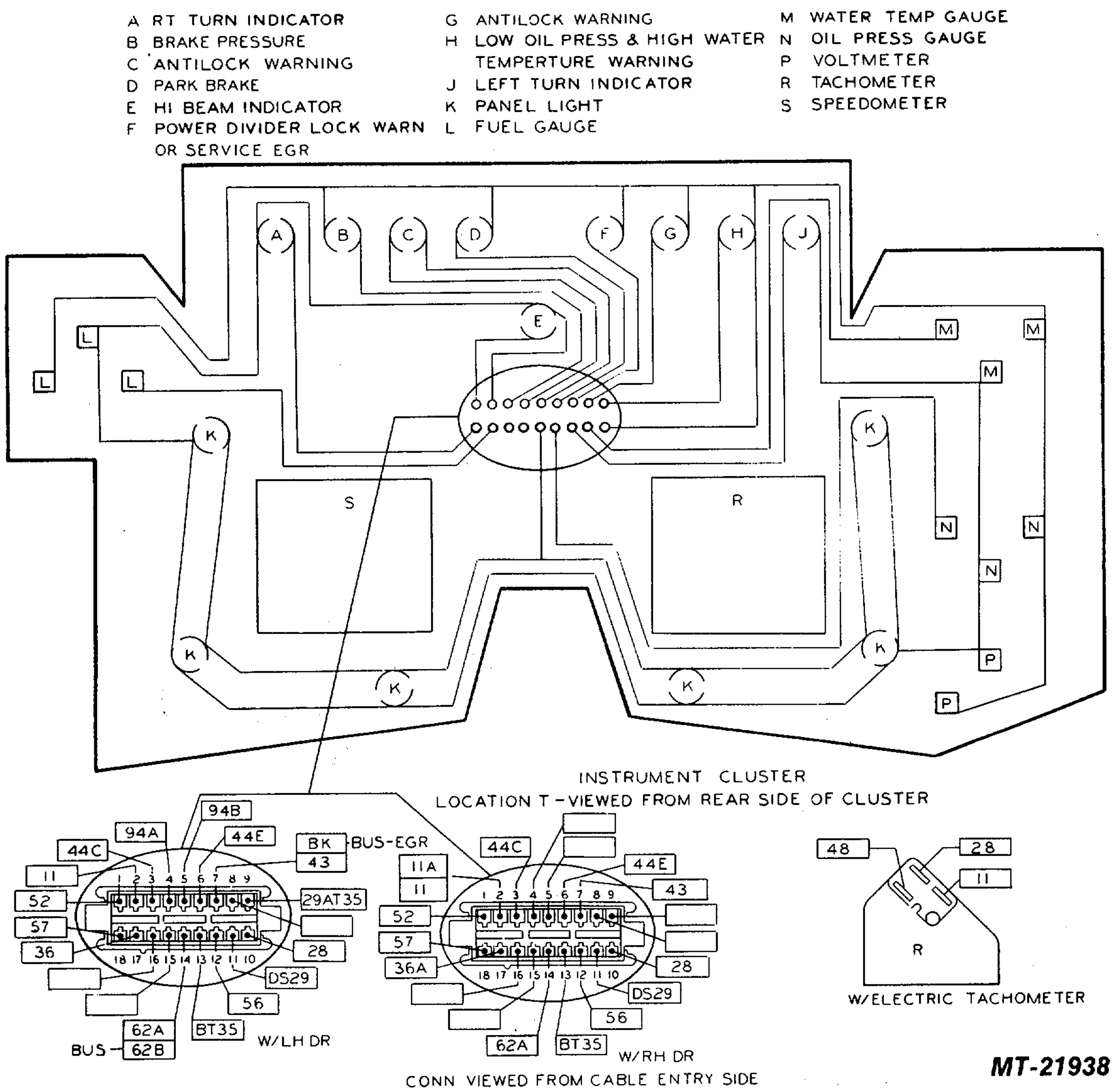
CIRCUIT DIAGRAMS



Component And Major Connector Location (On Chassis)

FBC/BUS Model

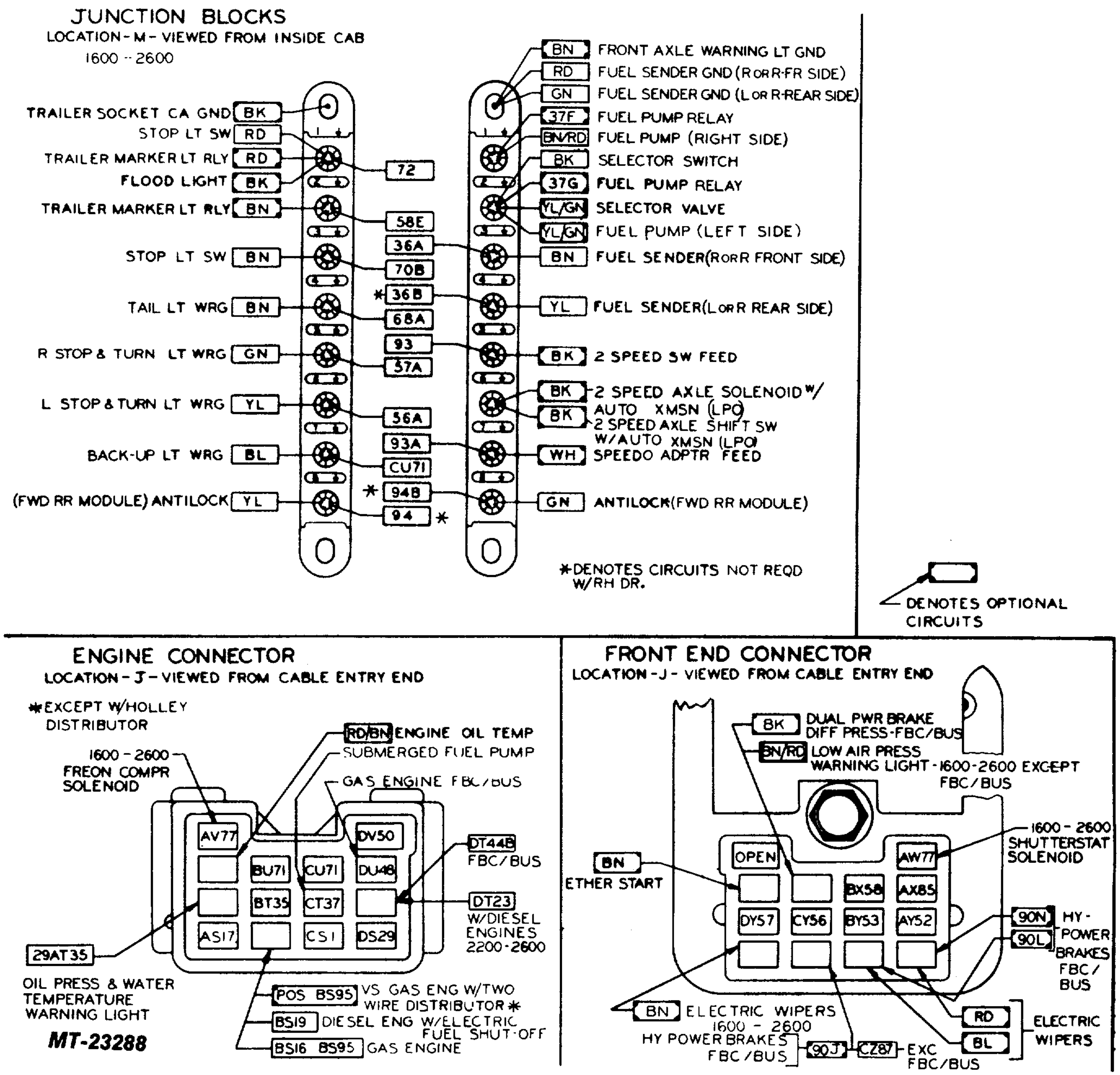
CIRCUIT DIAGRAMS



Component And Major Connectors (Use In Conjunction With Page 3)

Instrument Cluster

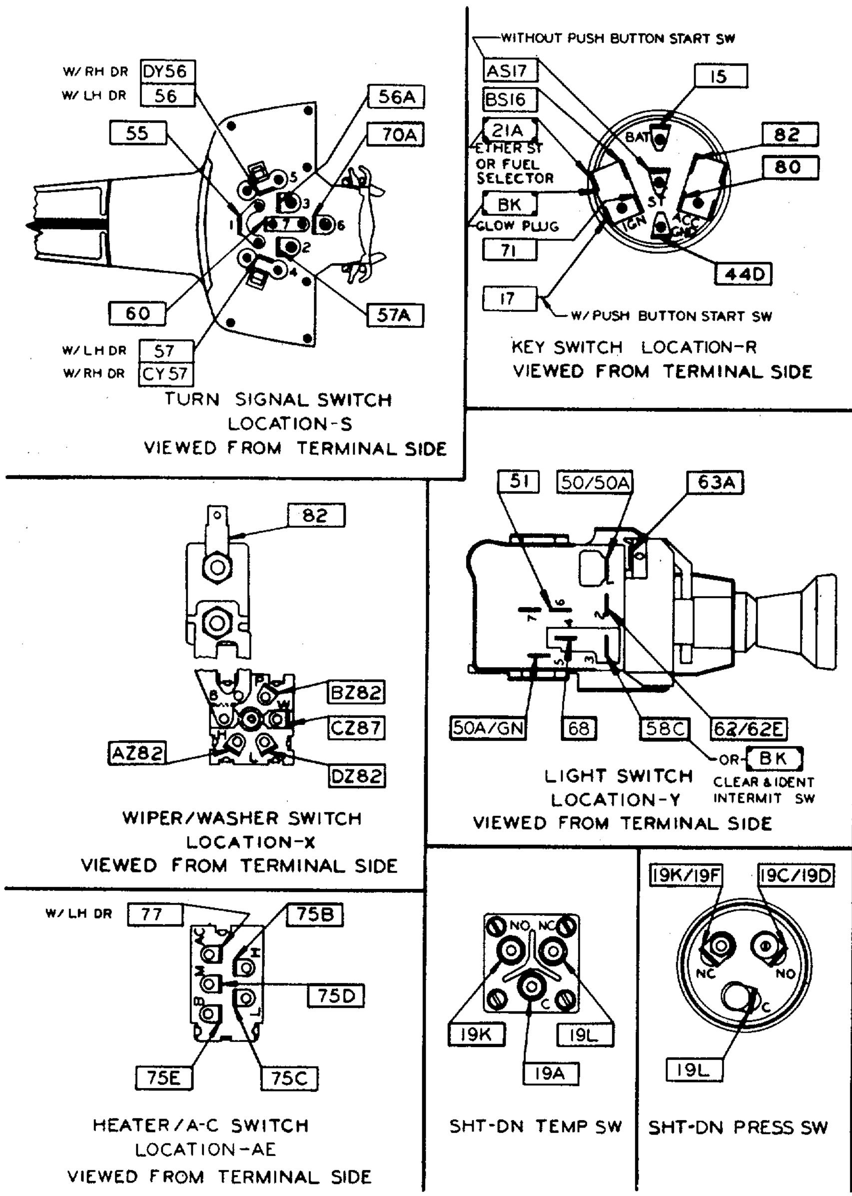
CIRCUIT DIAGRAMS



Component And Major Connectors (Use In Conjunction With Page 3)

Junction Blocks - Engine Connector - Front End Connector

CIRCUIT DIAGRAMS



SWITCH CONTACT CHART

SWITCH	POSITION	CONTACTS CLOSED	CONTACTS OPEN
TURN SIGNAL & HAZARD	OFF (NORMAL)	2,3 & 6	1,4,5 & 7
	LEFT TURN & LANE CHANGE	1,3 & 5 2 & 6	4 & 7
	RIGHT TURN & LANE CHANGE	1,2 & 4 3 & 6	5 & 7
	HAZARD	2,3,4,5 & 7	1 & 6
HEAD LIGHT	OFF-(KNOB IN & TURNED C.W.)	2,3&4	0,1,5,6 & 7
	PARK LIGHTS (KNOB IN 1ST POS.)	1 & 7 2,3,4&5	0 & 6
	HEAD LIGHTS (KNOB IN 2ND POS.)	1 & 6 2,3,4&5	0 & 7
	DOME-(KNOB IN & TURN C.C.W.)	0 TO GND 3,4 & 2	1,5,6 & 7
	PANEL-(2ND POS. TURN C.C.W. TO LOCK)	0 TO GND 1 & 6 2,3,4&5	7
KEY	OFF	NONE	ALL
	START	BAT-ST-IGN GND-CASE	ACC
	IGNITION	BAT-IGN-ACC	ST-GND
	ACCESSORY	BAT-ACC	ST-IGN-GND
HEATER & A/C	OFF	NONE	ALL
	LOW	BAT-L-A/C	M-H
	MED	BAT-M-A/C	L-H
	HIGH	BAT-H-A/C	L-M
WIPER/ WASHER	PARK	BAT-P	W-L-H
	LOW	BAT-L	W-P-H
	HIGH	BAT-H	W-P-L
	WASHER (KNOB IN)	BAT-W	L-M-H
SHT-DN TEMP	NORMAL (BELOW 204°)	C-NC	C-NO
	ALARM (204°-210°)	C-NC C-NO	NONE
	SHUT-DOWN (ABOVE 210°)	C-NO	C-NC
SHT-DN PRESS	ENG OFF	C-NC	C-NO
	NORMAL	C-NO	C-NC
	ALARM (7 OR 11 P.S.I.)	C-NO C-NC	NONE
	SHUT-DOWN (3 OR 6 P.S.I.)	C-NC	C-NO

MT-23285

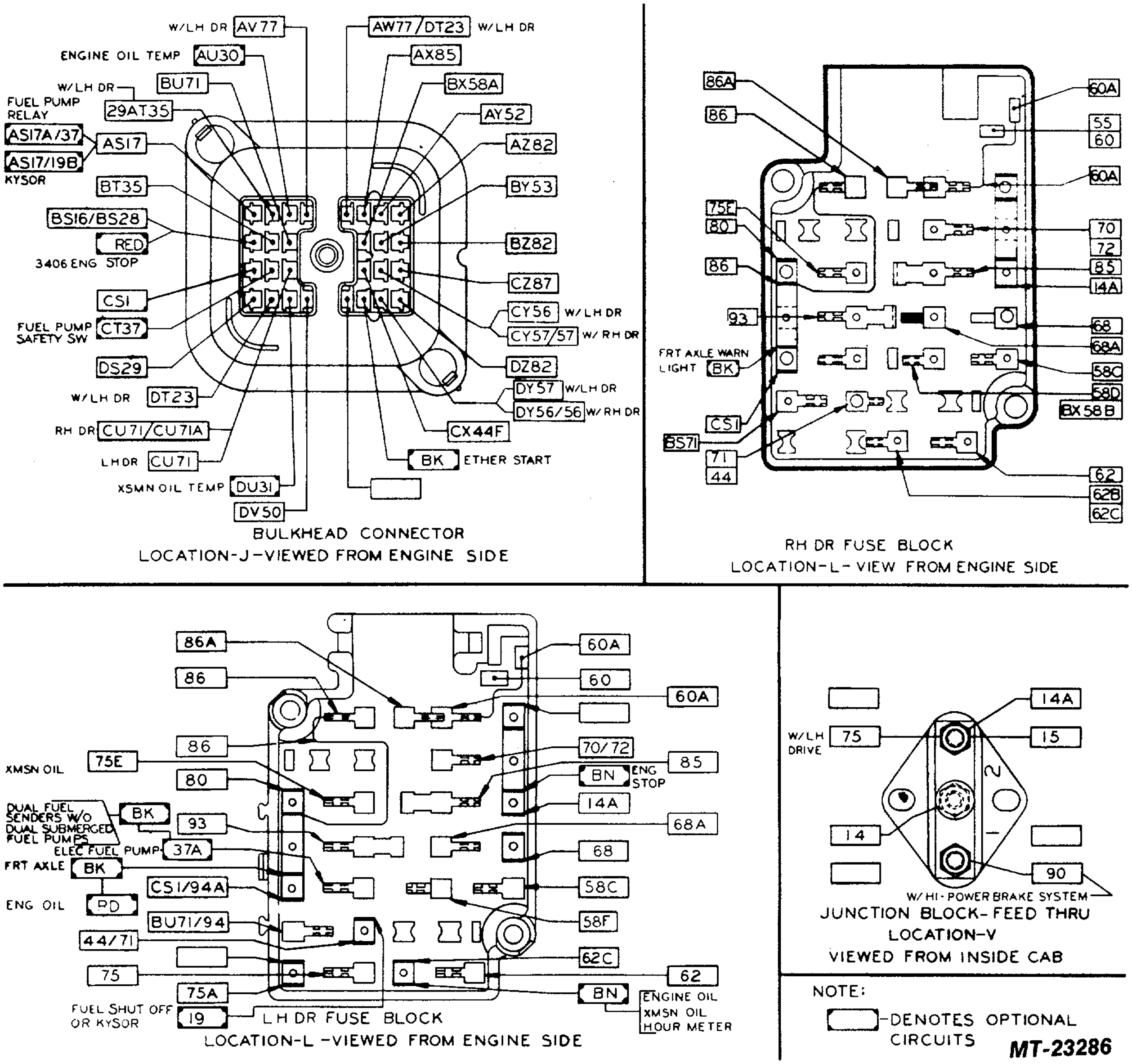
NOTE:
▭ DENOTES OPTIONAL CIRCUITS

Turn Signal Switch - Key Switch - Windshield Wiper/Washer Switch

Light Switch - Heater/Air Conditioner Switch - Shut Down Temperature Switch

Shutdown Pressure Switch

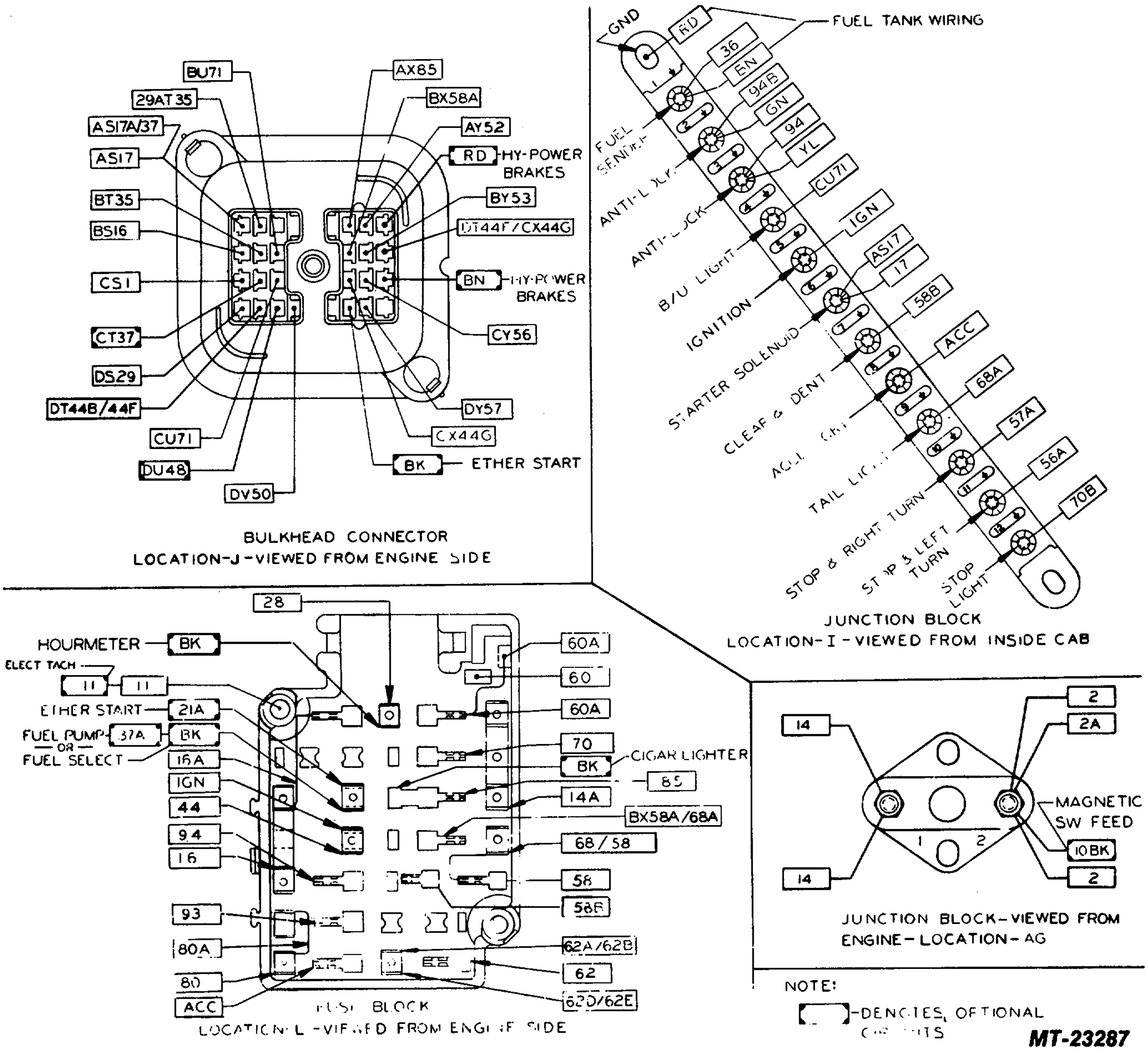
CIRCUIT DIAGRAMS



Component And Major Connectors (Use In Conjunction With Page 3) (Now Schoolbus)

Bulkhead Connector - Fuse Blocks - Junction Block

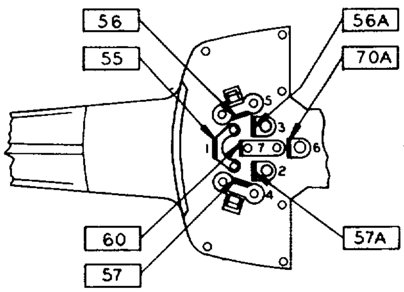
CIRCUIT DIAGRAMS



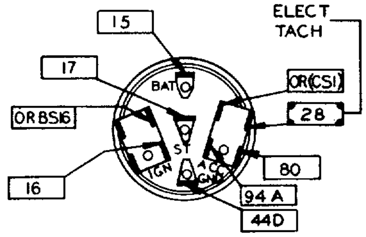
Component And Major Connectors (Use In Conjunction With Page 3) (Schoolbus)

Bulkhead Connector - Fuse Block - Junction Block

CIRCUIT DIAGRAMS



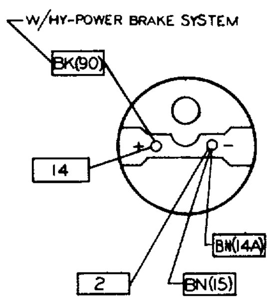
TURN SIGNAL SWITCH
LOCATION-S
VIEWED FROM TERMINAL SIDE



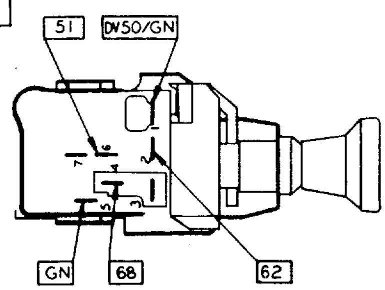
KEY SWITCH
LOCATION-R
VIEWED FROM TERMINAL SIDE

SWITCH CONTACT CHART

SWITCH	POSITION	CONTACTS CLOSED	CONTACTS OPEN
TURN SIGNAL & HAZARD	OFF (NORMAL)	2,3 & 6	1,4,5 & 7
	LEFT TURN & LANE CHANGE	1,3 & 5 2 & 6	4 & 7
	RIGHT TURN & LANE CHANGE	1,2 & 4 3 & 6	5 & 7
	HAZARD	2,3,4,5 & 7	1 & 6
HEAD LIGHT	OFF-(KNOB IN- & TURNED C.W.)	2,3&4	0,1,5,6 & 7
	PARK LIGHTS (KNOB IN- 1 ST POS.)	1 & 7 2,3,4&5	0 & 6
	HEAD LIGHTS (KNOB IN- 2 ND POS.)	1 & 6 2,3,4&5	0 & 7
	DOME-(KNOB IN & TURN C.C.W.)	0 TO GND 3,4 & 2	1,5,6 & 7
	PANEL-(2ND-POS. TURN-C.C.W. TO LOCK)	0 TO GND 1 & 6 2 3 4&5	7
KEY	OFF	NONE	ALL
	START	BAT-ST-IGN GND-CASE	ACC
	IGNITION	BAT-IGN-ACC	ST-GND
	ACCESSORY	BAT-ACC	ST-IGN-GND



AMMETER
LOCATION -AF
VIEWED FROM TERMINAL SIDE



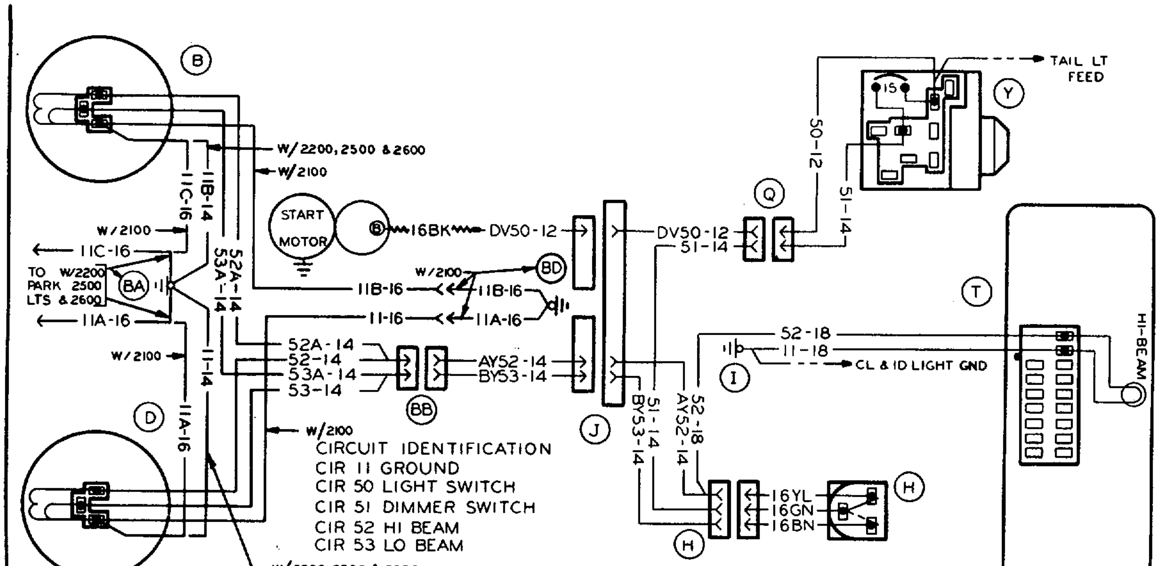
LIGHT SWITCH
LOCATION-Y
VIEWED FROM TERMINAL SIDE

MT-23289

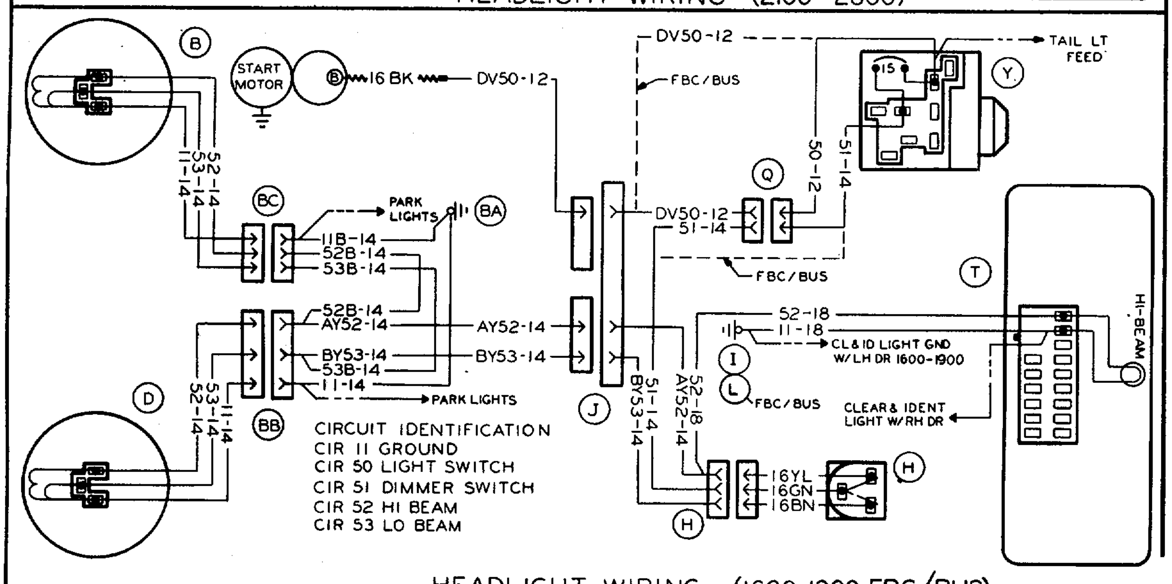
Component And Major Connectors (Use In Conjunction With Page 3) (Schoolbus)

Turn Signal Switch - Key Switch - Ammeter - Light Switch

CIRCUIT DIAGRAMS



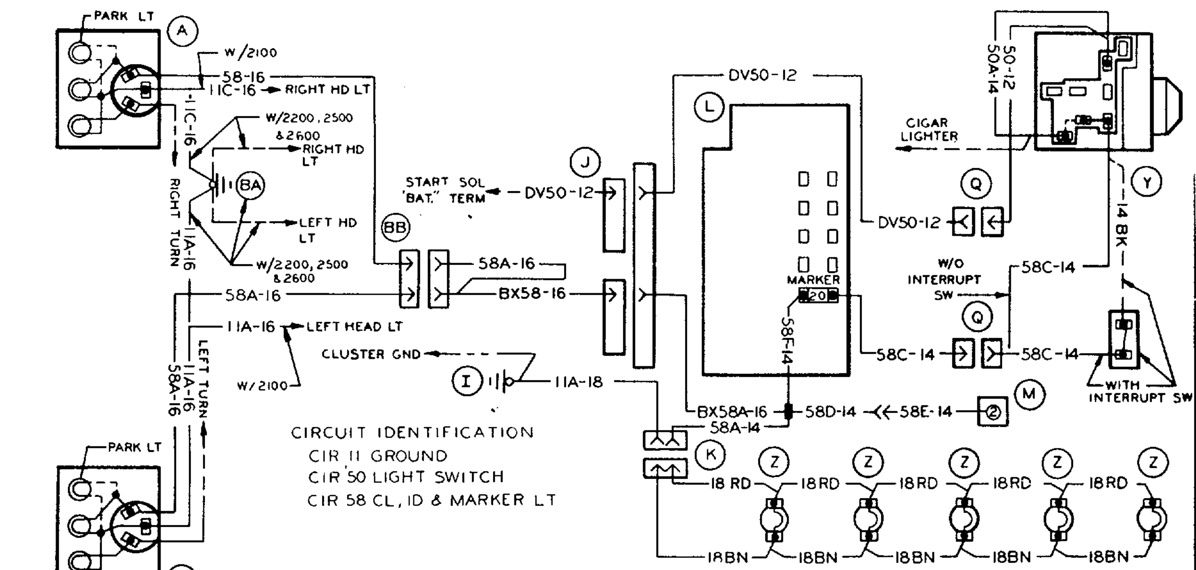
HEADLIGHT WIRING (2100-2600)



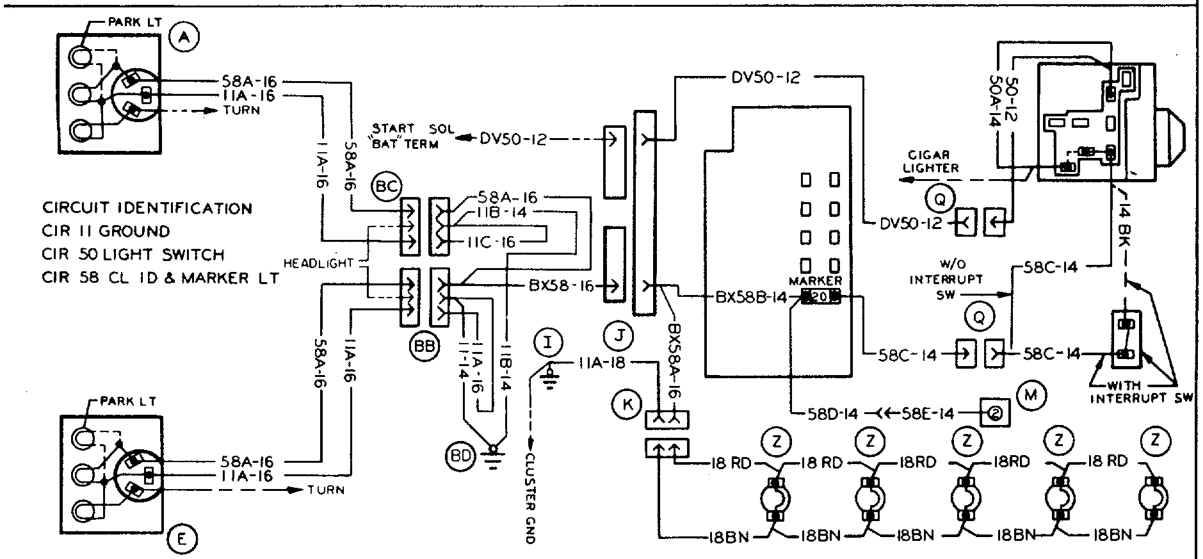
HEADLIGHT WIRING (1600-1900,FBC/BUS)

MT-21944

CIRCUIT DIAGRAMS



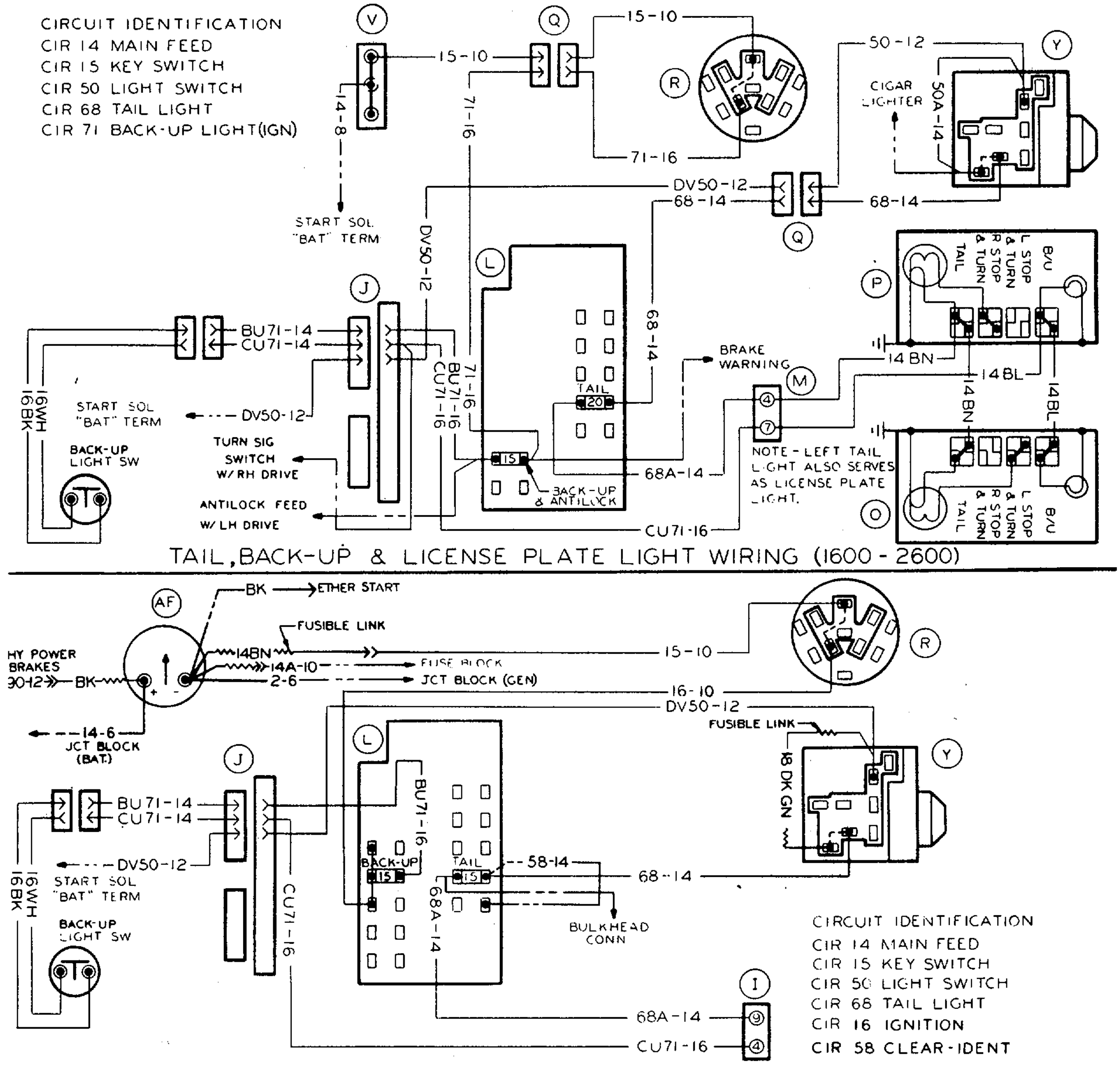
CLEARANCE - IDENTIFICATION - PARK & MARKER LT WIRING 2100 - 2600



CLEARANCE - IDENTIFICATION - PARK & MARKER LT WIRING 1600 1900 RH DR

MT-21945

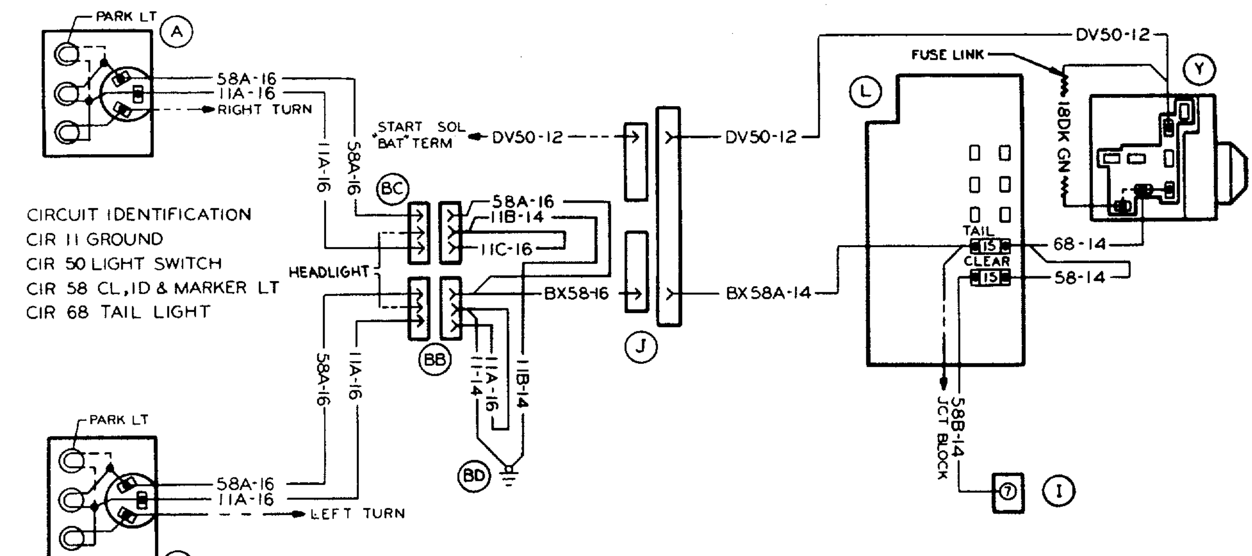
CIRCUIT DIAGRAMS



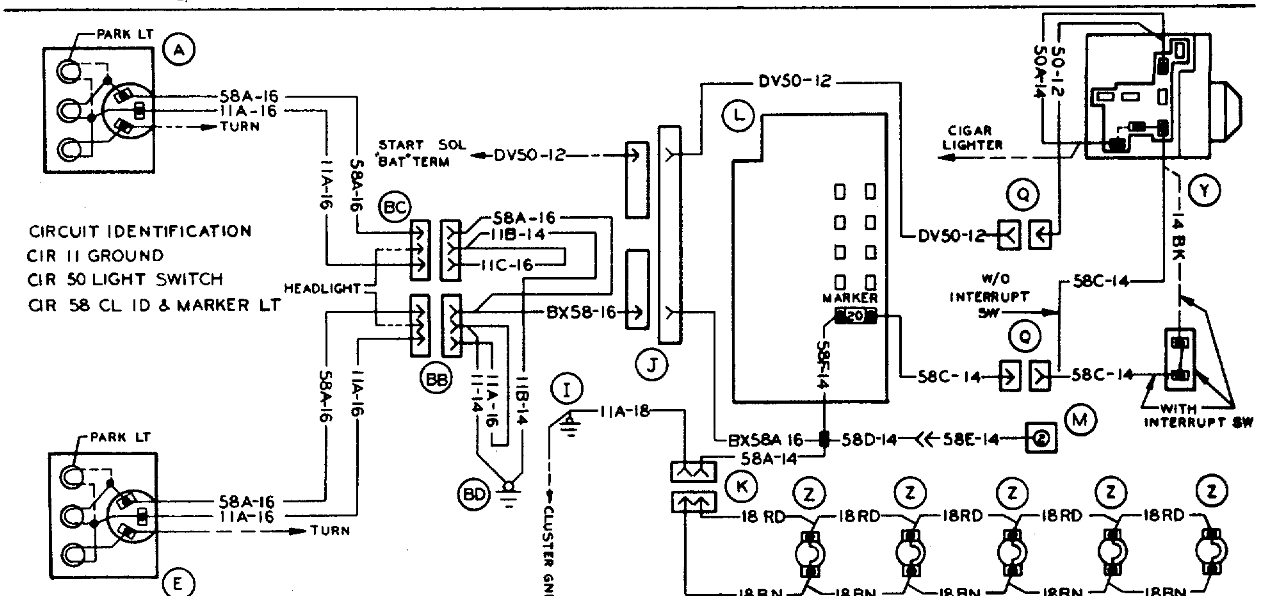
TAIL, BACK-UP & LICENSE PLATE LIGHT WIRING (1600 - 2600)

TAIL, BACK-UP & LICENSE PLATE LIGHT WIRING (FBC / BUS) **MT-23293**

CIRCUIT DIAGRAMS



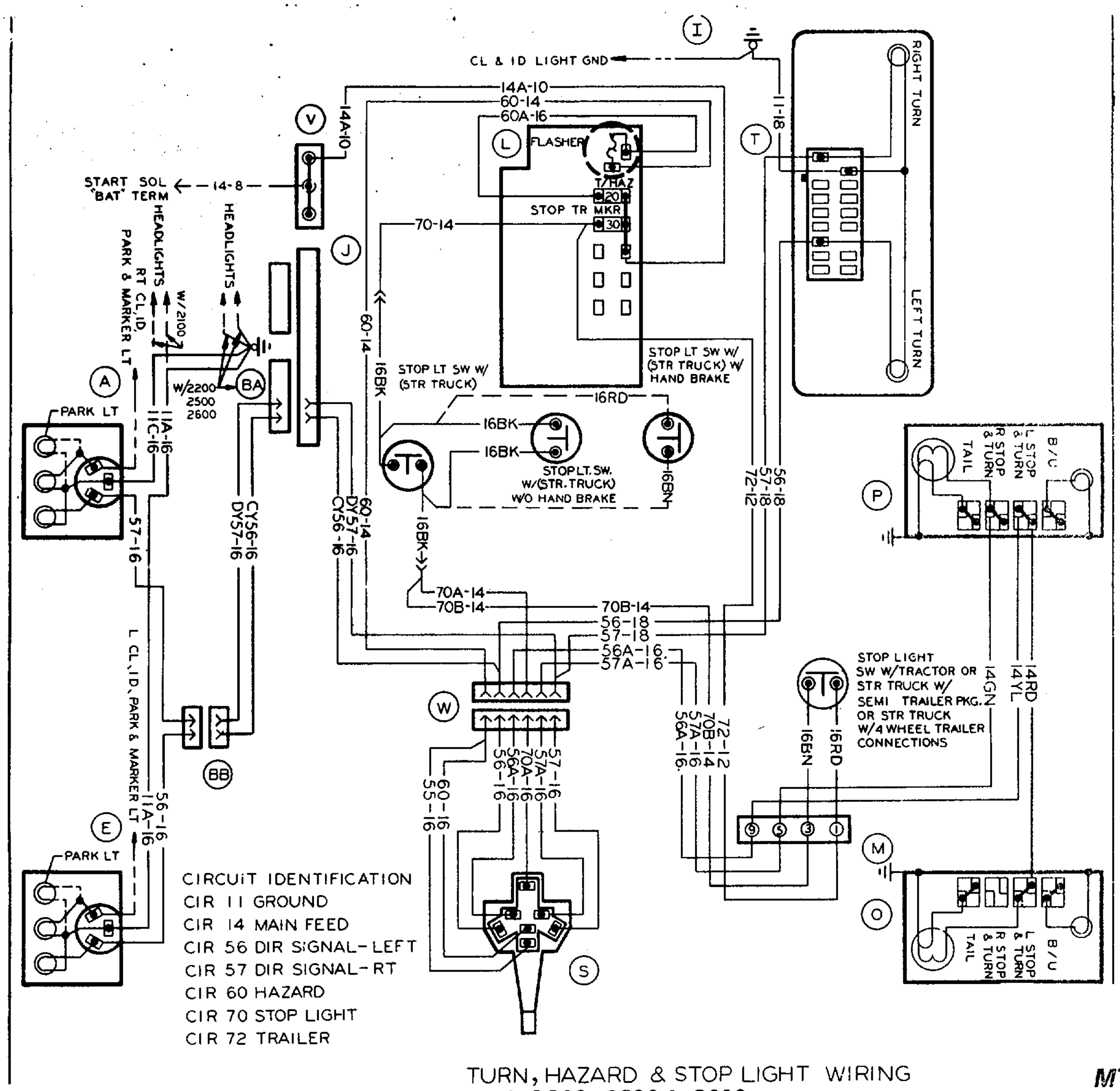
PARK & MARKER LIGHT WIRING FBC/BUS



MT-23292

CLEARANCE – IDENTIFICATION – PARK & MARKER LT WIRING 1600-1900 LH DR

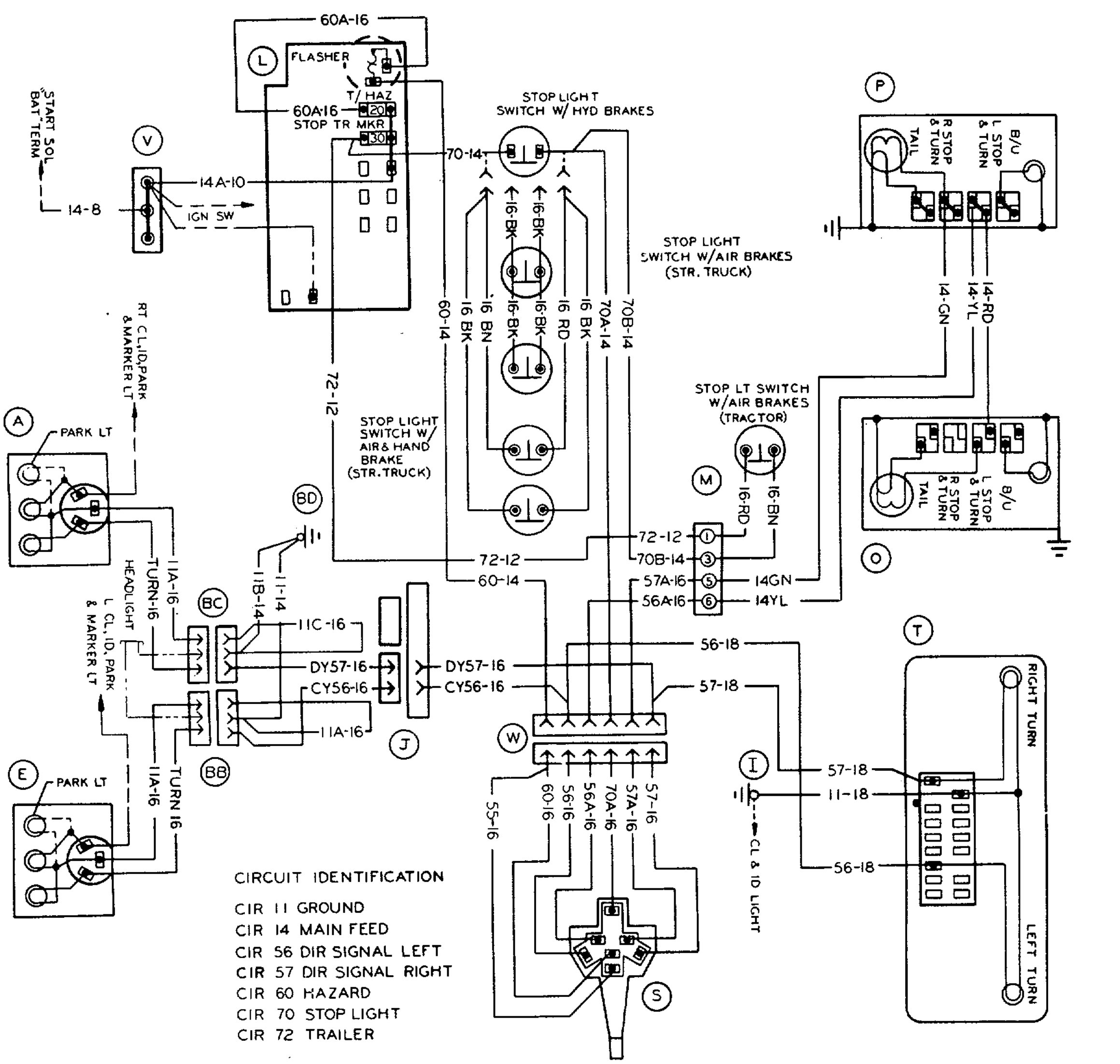
CIRCUIT DIAGRAMS



TURN, HAZARD & STOP LIGHT WIRING
2100, 2200, 2500 & 2600

MT-21948

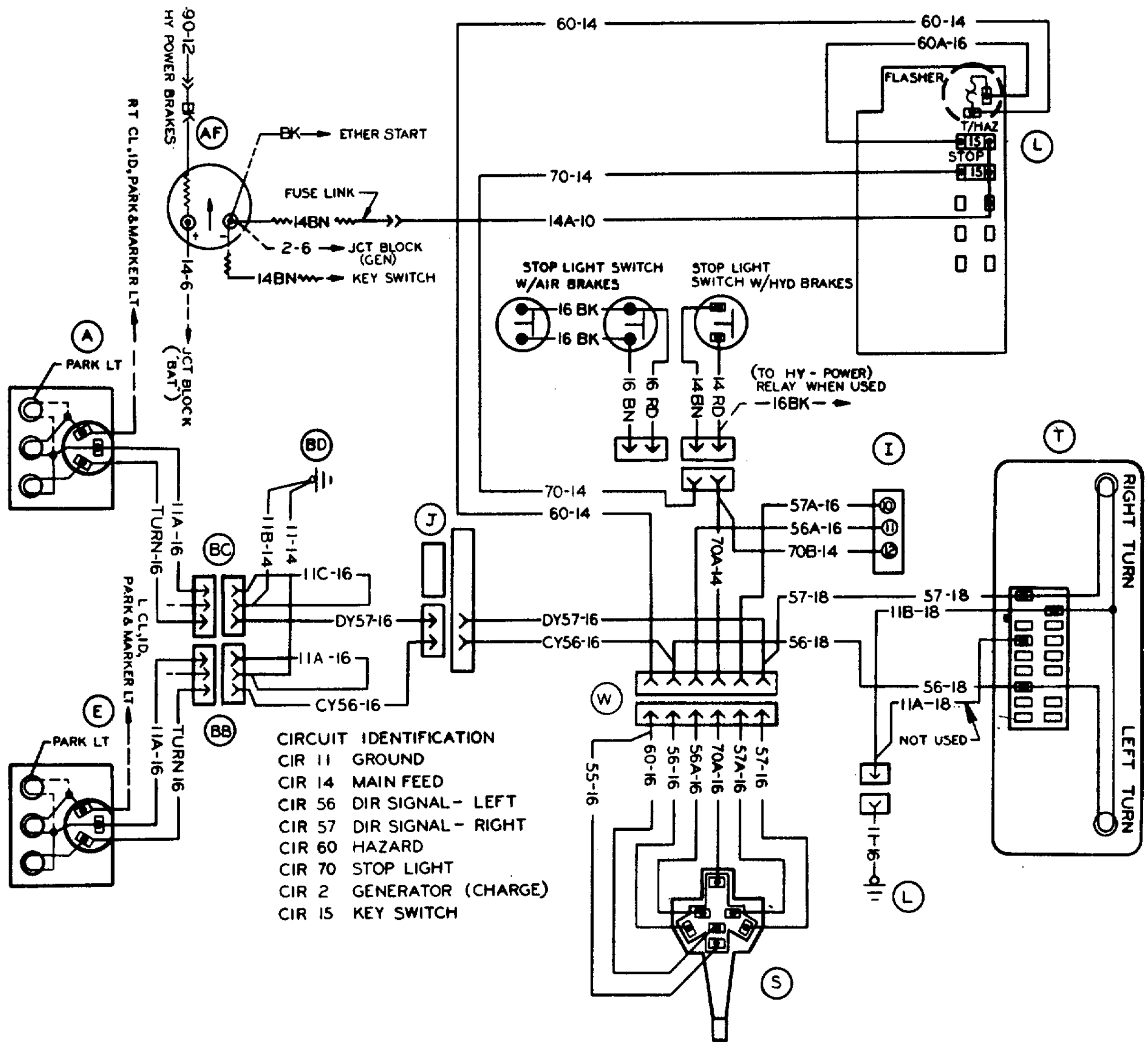
CIRCUIT DIAGRAMS



TURN HAZARD & STOP LIGHT WIRING LH DR 1600,1700, 1800 & 1900

MT-21949

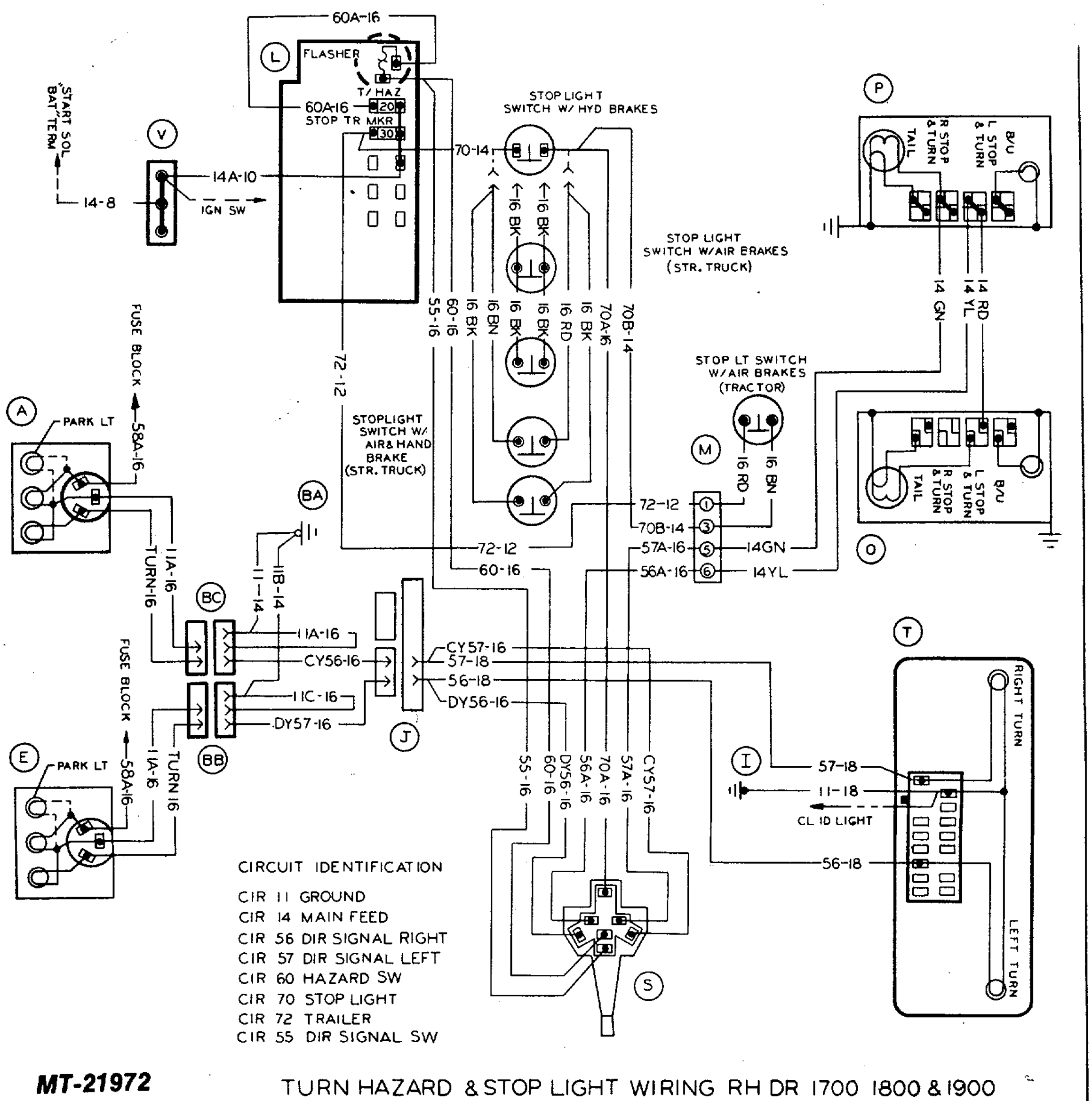
CIRCUIT DIAGRAMS



MT-23294

TURN HAZARD & STOP LIGHT WIRING - FBC/BUS

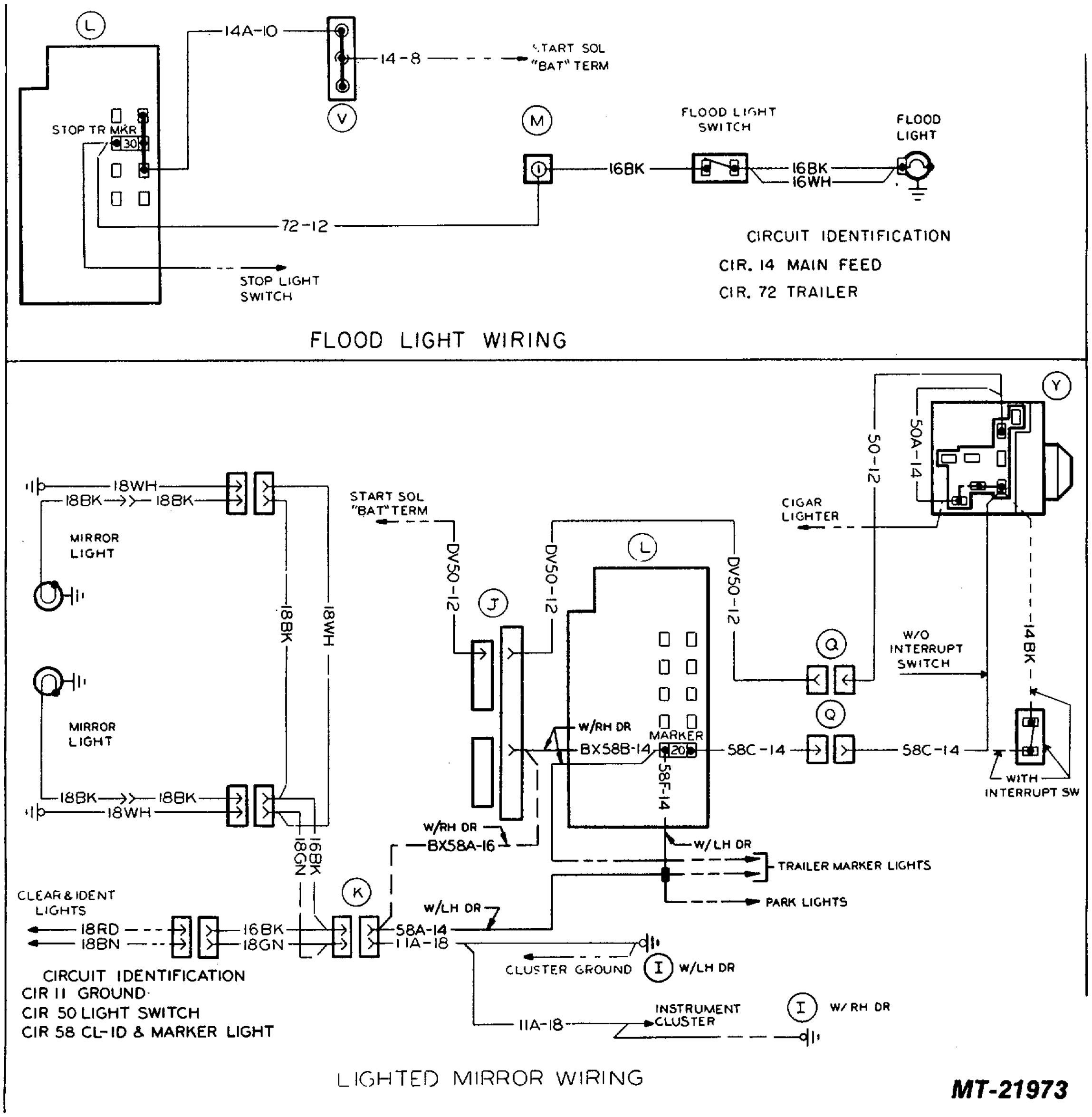
CIRCUIT DIAGRAMS



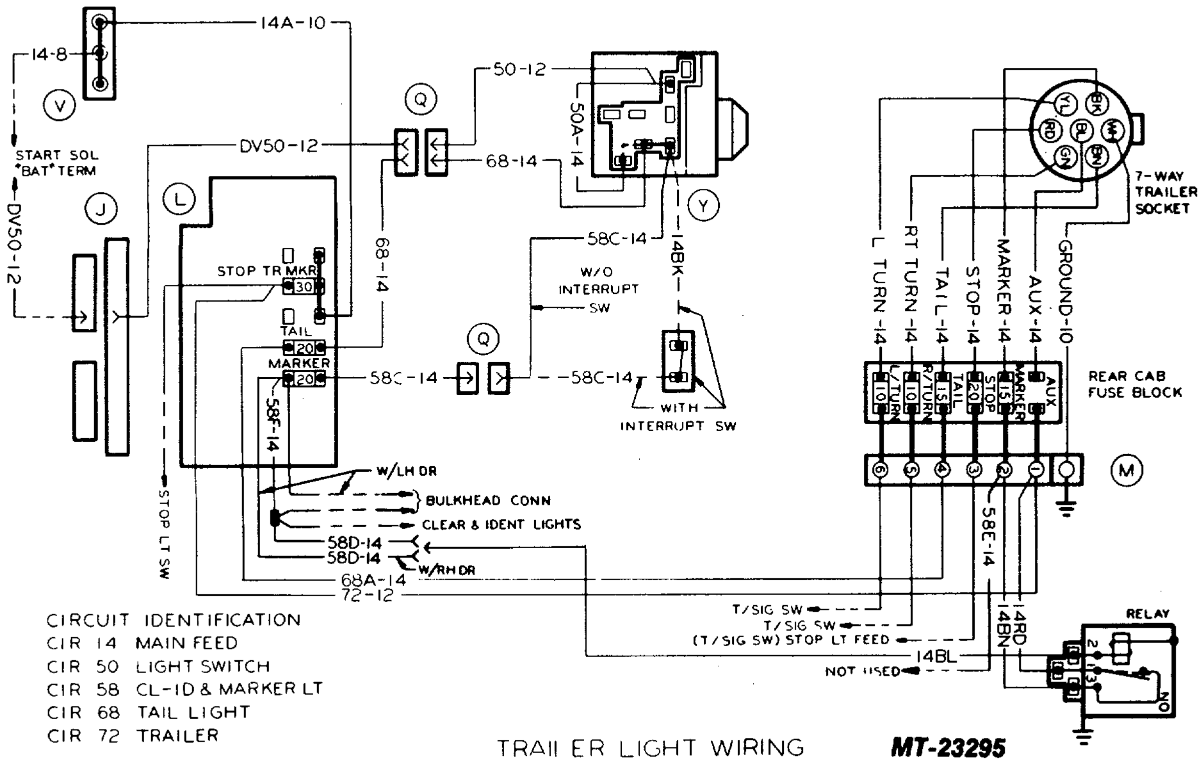
MT-21972

TURN HAZARD & STOP LIGHT WIRING RH DR 1700 1800 & 1900

CIRCUIT DIAGRAMS



CIRCUIT DIAGRAMS



CIRCUIT IDENTIFICATION

CIR 14 MAIN FEED

CIR 50 LIGHT SWITCH

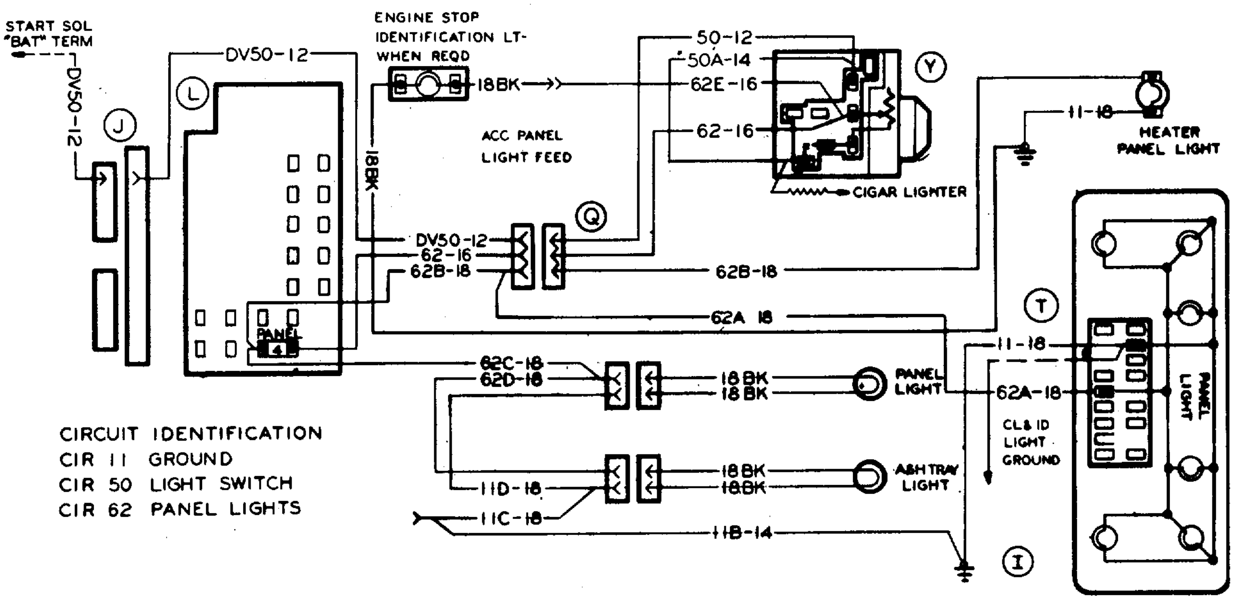
CIR 58 CL-ID & MARKER LT

CIR 68 TAIL LIGHT

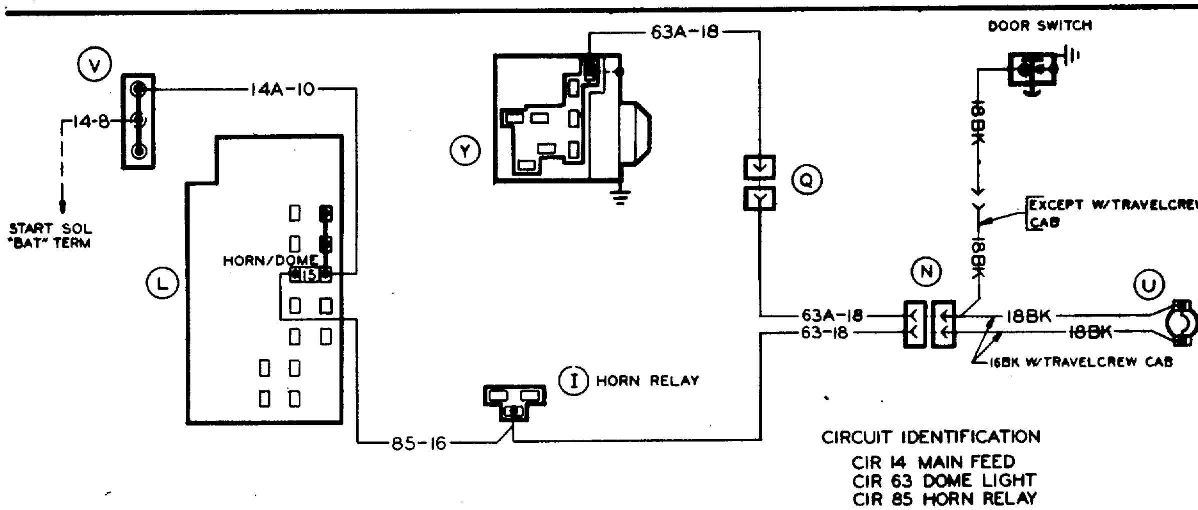
CIR 72 TRAILER

TRAILER LIGHT WIRING MT-23295

CIRCUIT DIAGRAMS



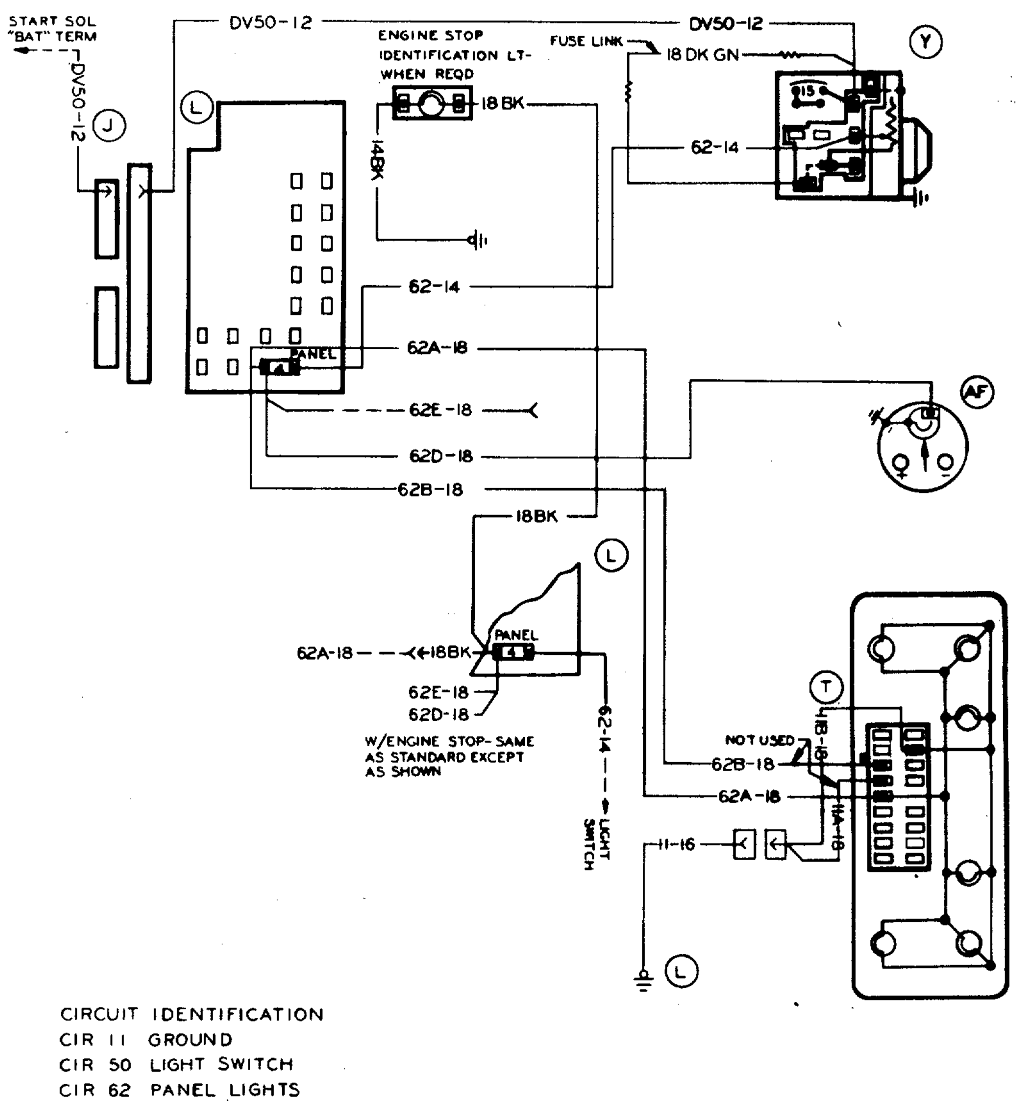
INSTRUMENT PANEL AND CONTROL IDENTIFICATION ILLUMINATION-RH DR



DOME LIGHT WIRING

MT-23296

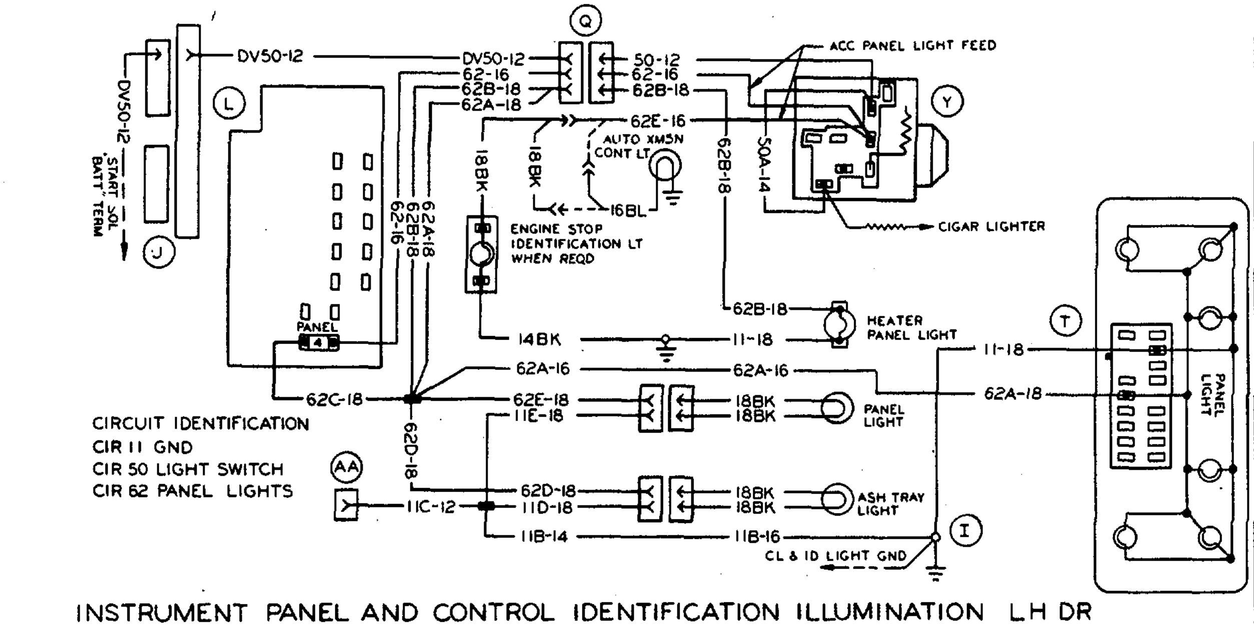
CIRCUIT DIAGRAMS



MT-23297

INSTRUMENT PANEL AND CONTROL IDENTIFICATION ILLUMINATION - FBC/BUS

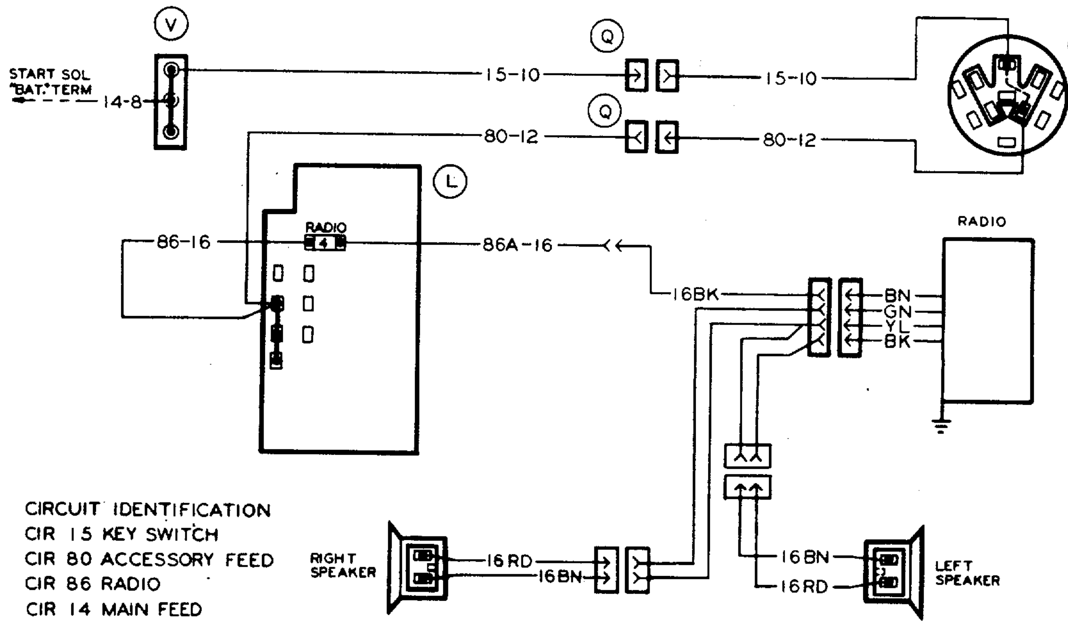
CIRCUIT DIAGRAMS



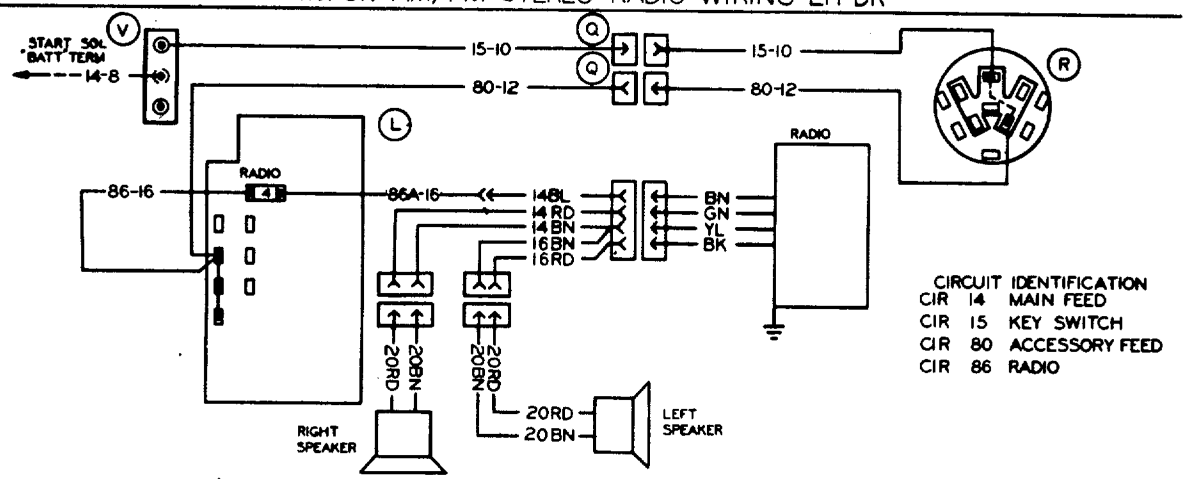
INSTRUMENT PANEL AND CONTROL IDENTIFICATION ILLUMINATION LH DR

MT-21954

CIRCUIT DIAGRAMS



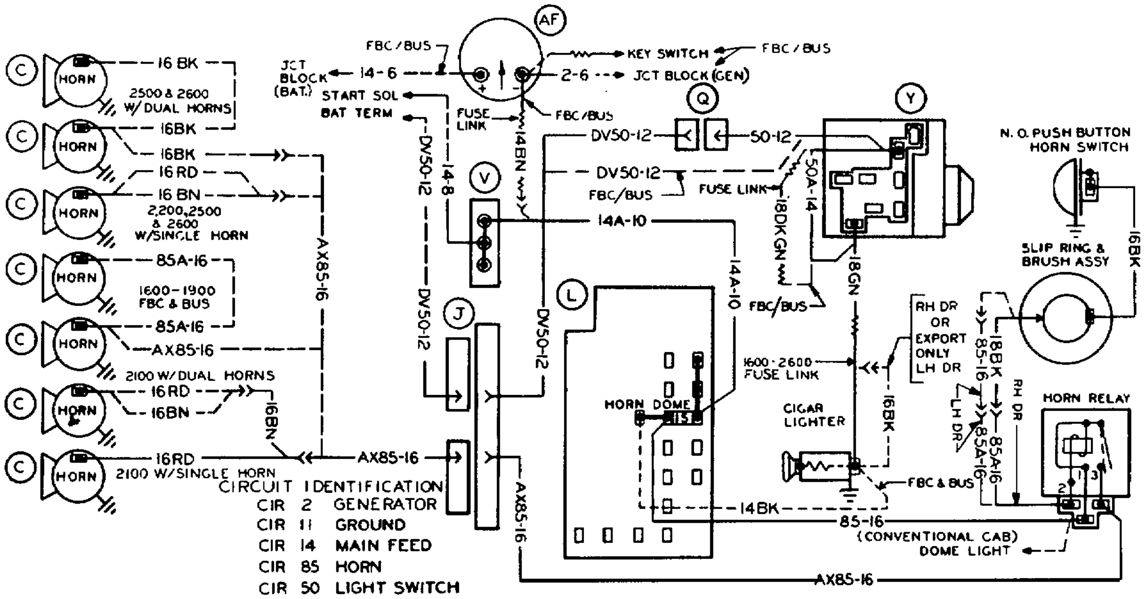
AM OR AM/FM STEREO RADIO WIRING LH DR



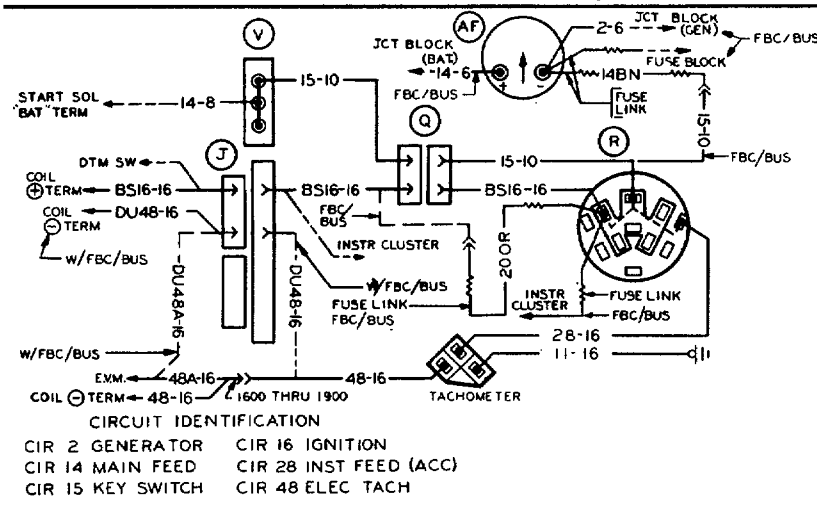
AM OR AM/FM STEREO RADIO WIRING RH DR

MT-23298

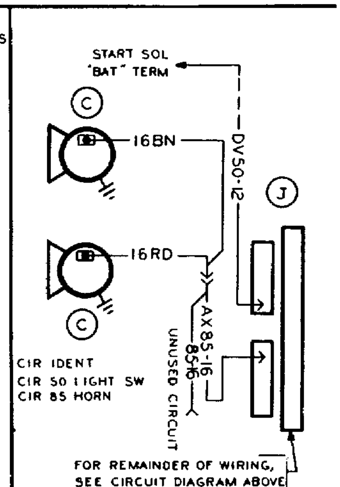
CIRCUIT DIAGRAMS



HORN AND CIGAR LIGHTER WIRING



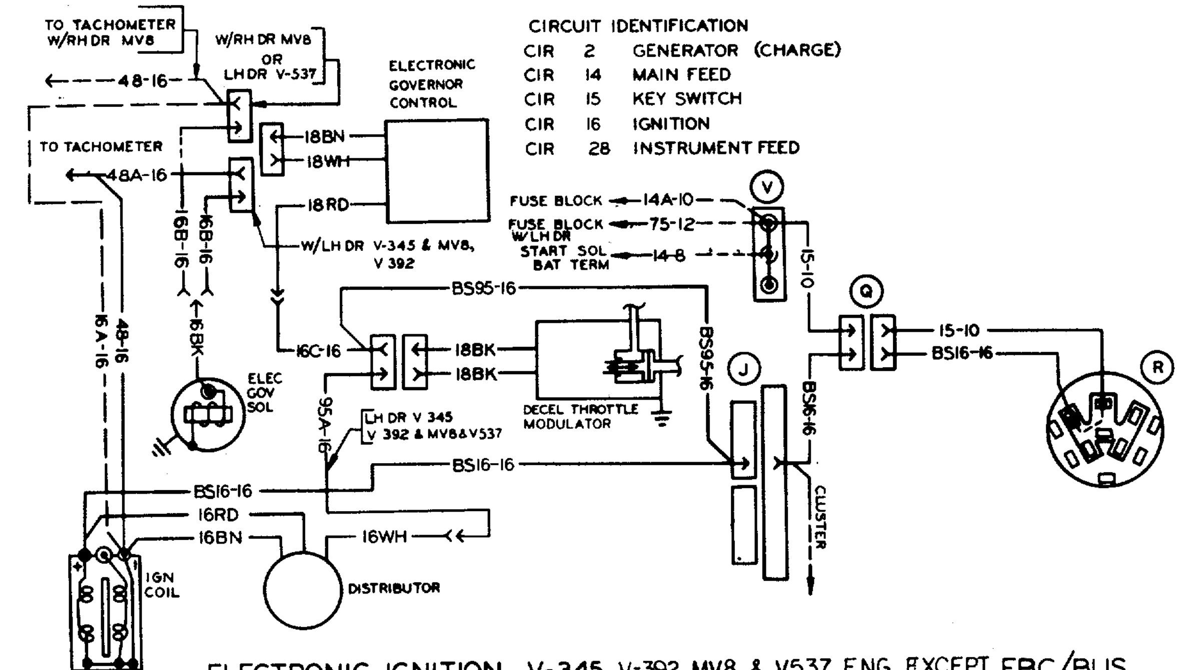
ELECTRIC TACHOMETER WIRING (GAS ENGINES)



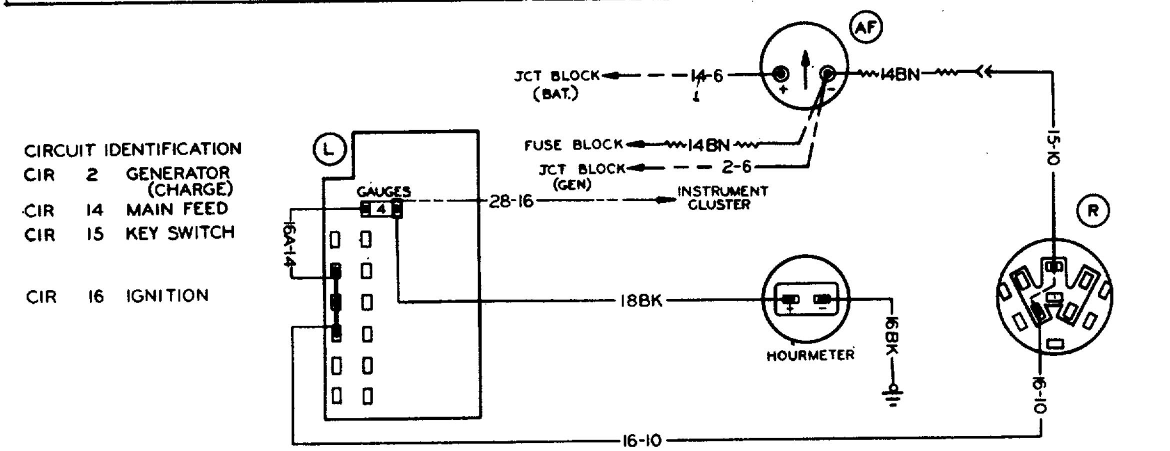
HORN WIRING RH DR

MT-21959

CIRCUIT DIAGRAMS



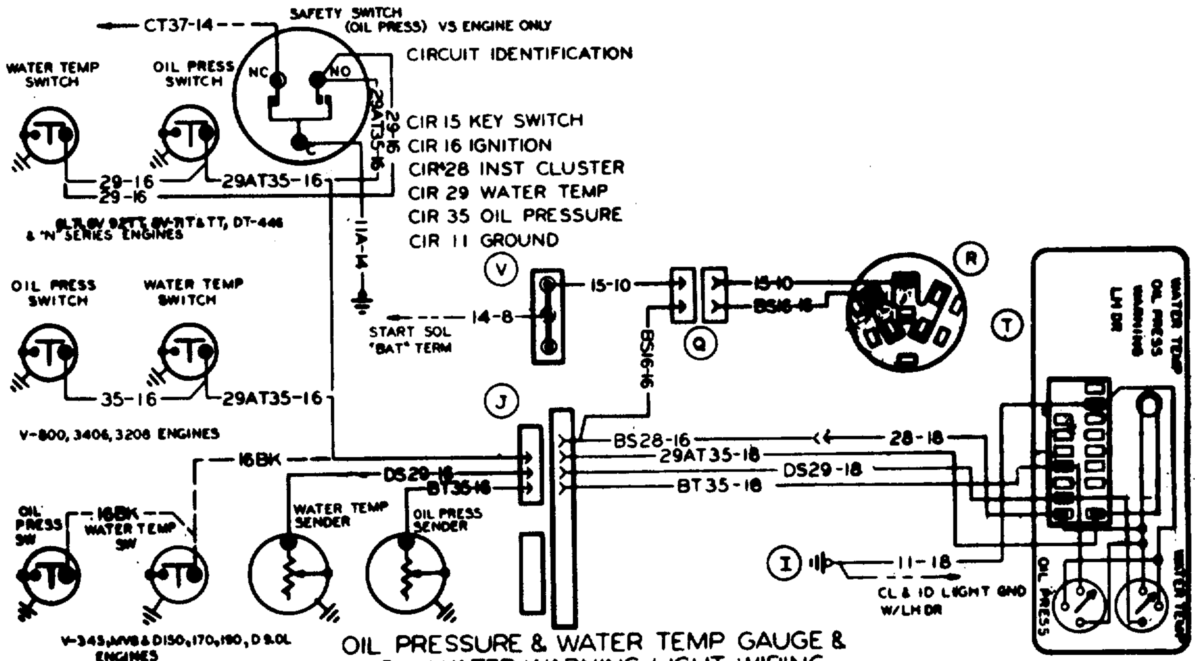
ELECTRONIC IGNITION V-345, V-392, MV8 & V537 ENG EXCEPT FBC/BUS



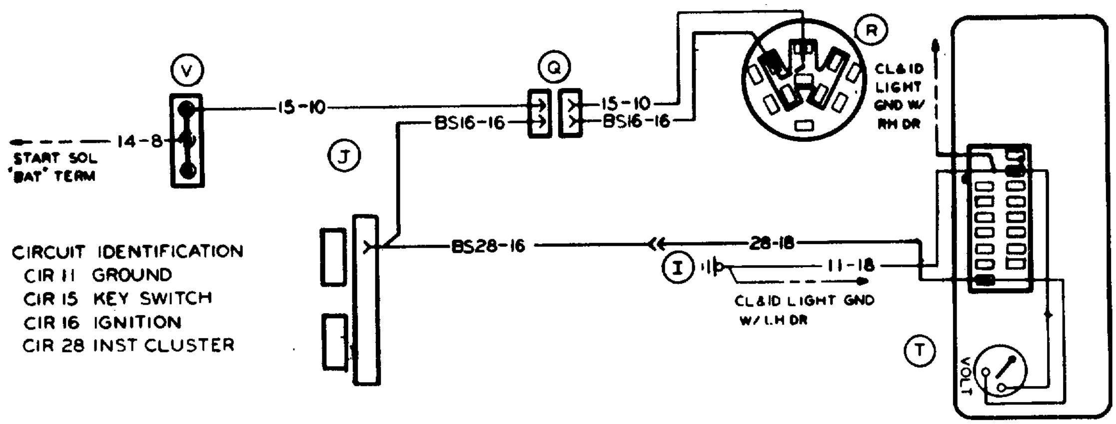
HOURMETER WIRING FBC/BUS

MT-23300

CIRCUIT DIAGRAMS



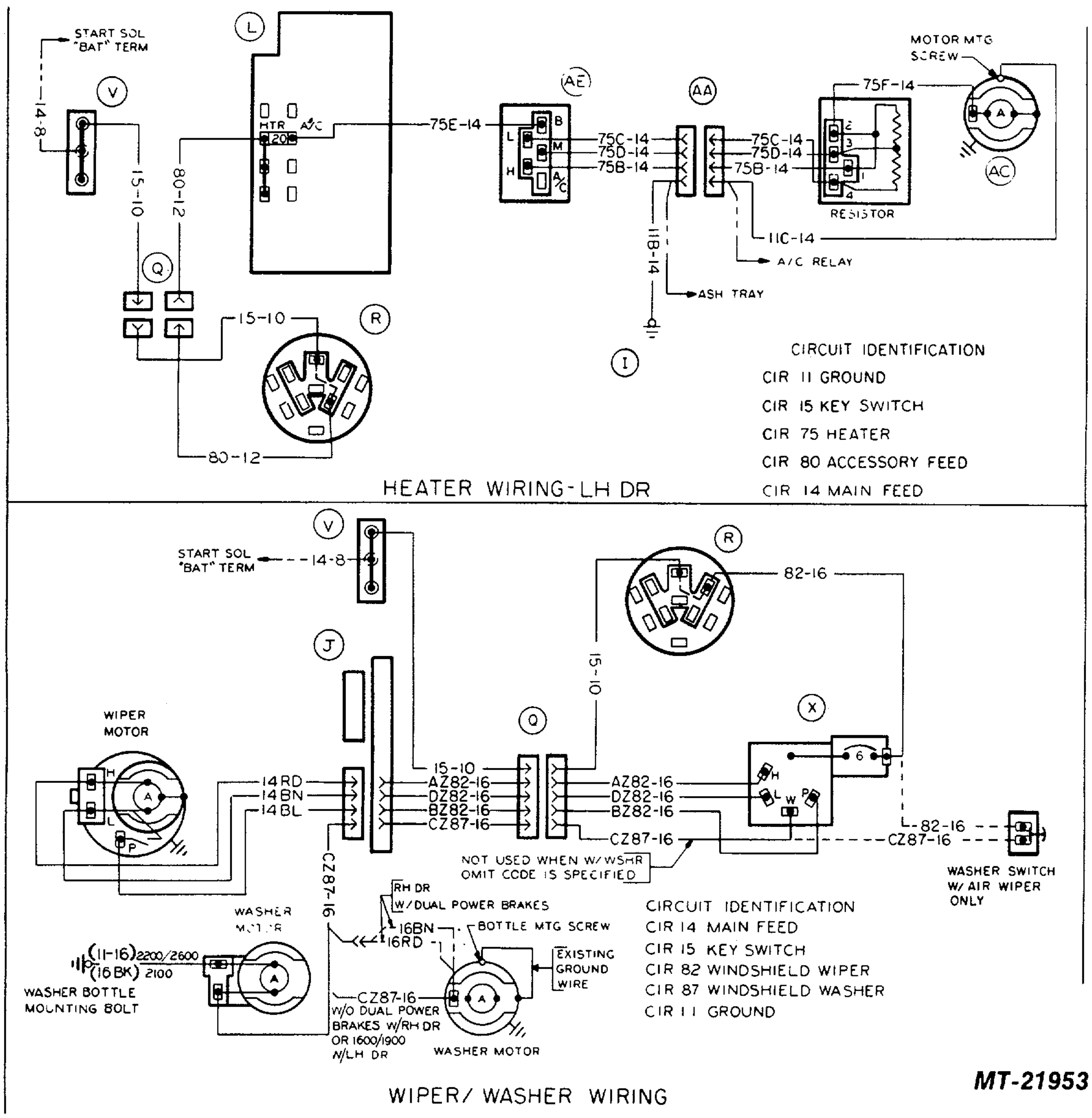
OIL PRESSURE & WATER TEMP GAUGE & OIL/WATER WARNING LIGHT WIRING EXCEPT FBC/BUS



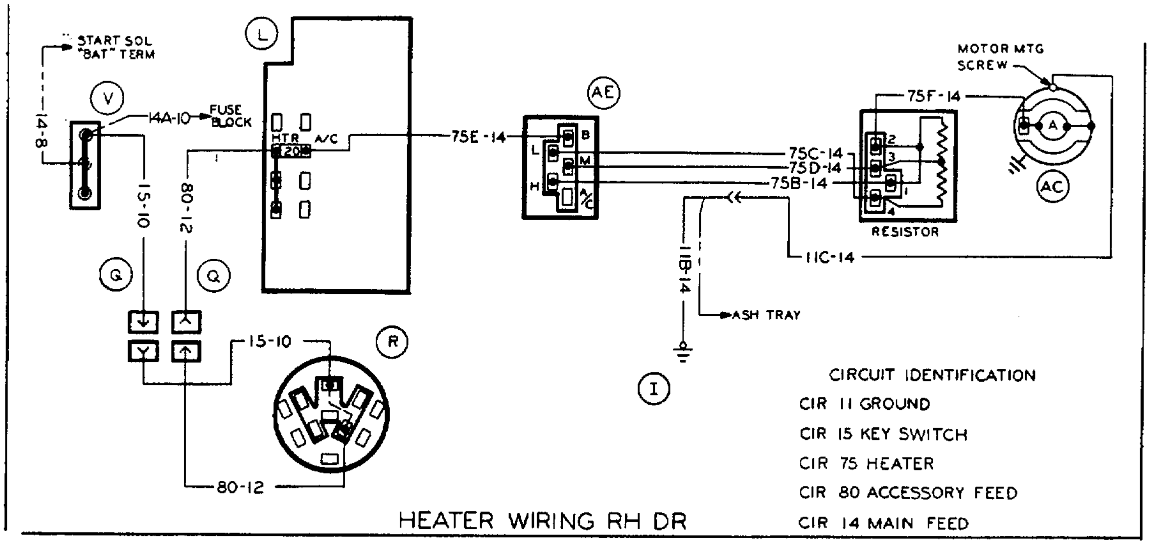
VOLTMETER WIRING EXCEPT FBC/BUS

MT-23306

CIRCUIT DIAGRAMS



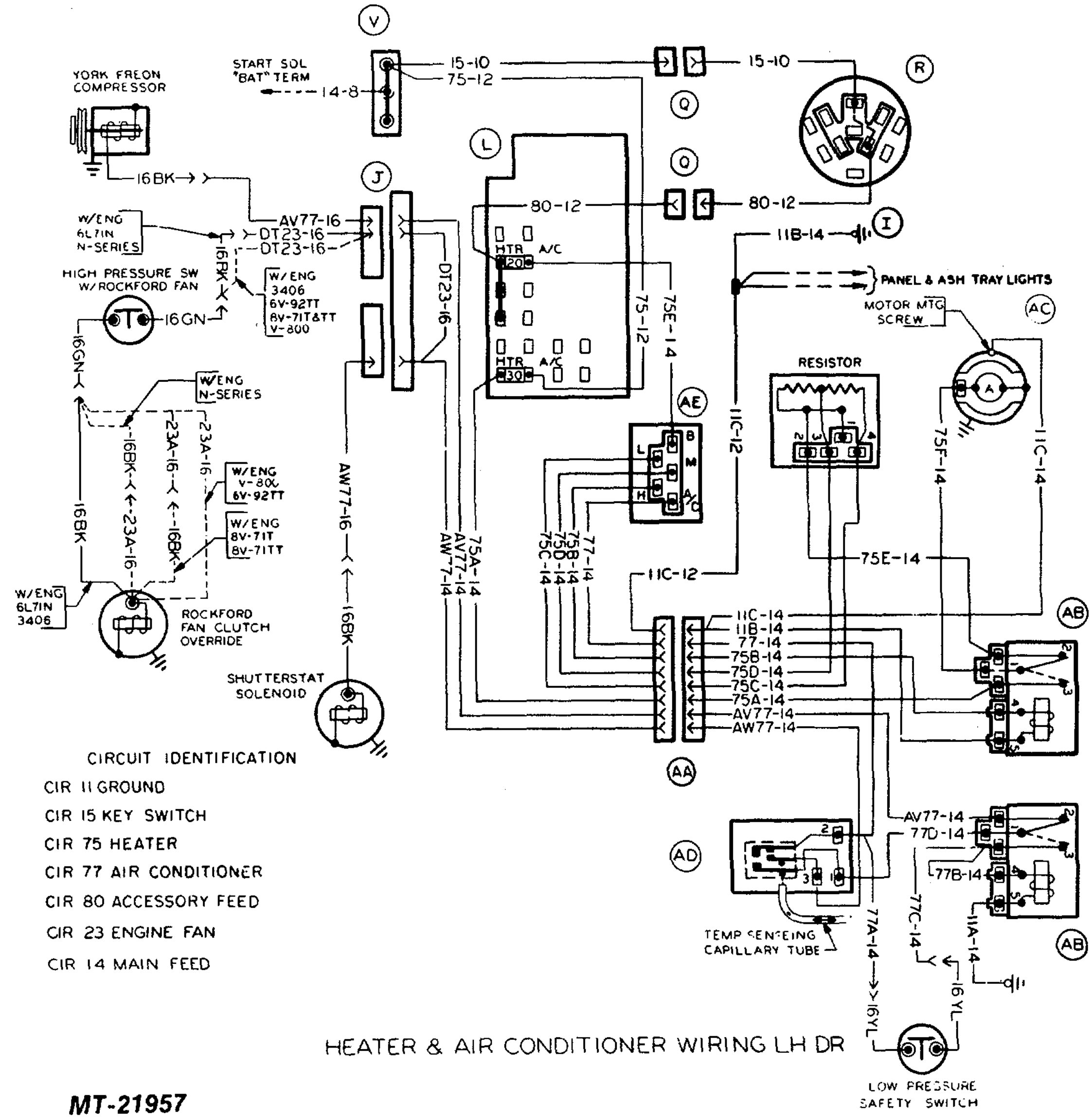
CIRCUIT DIAGRAMS



HEATER WIRING RH DR

MT-21956

CIRCUIT DIAGRAMS



CIRCUIT IDENTIFICATION

CIR 11 GROUND

CIR 15 KEY SWITCH

CIR 75 HEATER

CIR 77 AIR CONDITIONER

CIR 80 ACCESSORY FEED

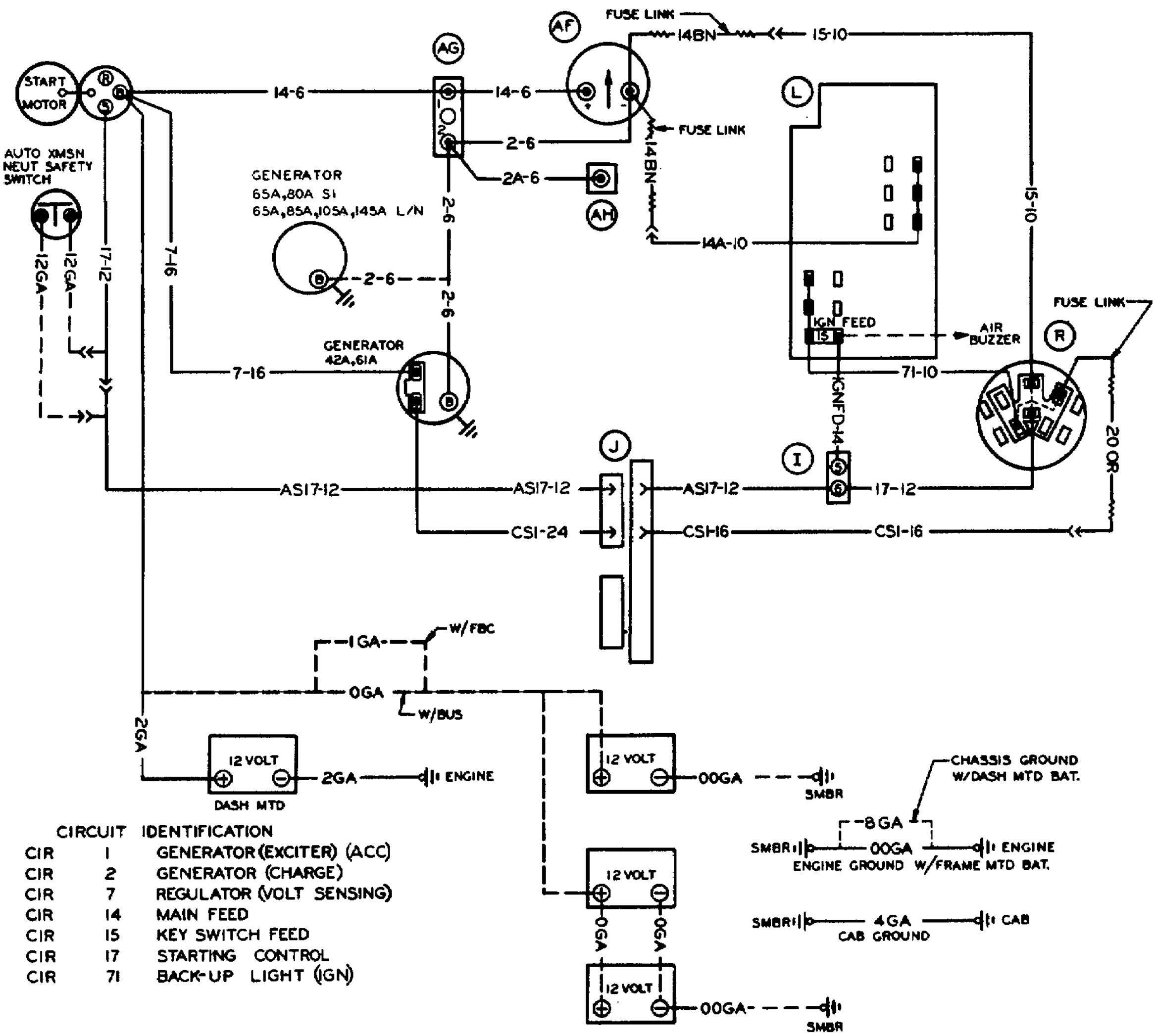
CIR 23 ENGINE FAN

CIR 14 MAIN FEED

HEATER & AIR CONDITIONER WIRING LH DR

MT-21957

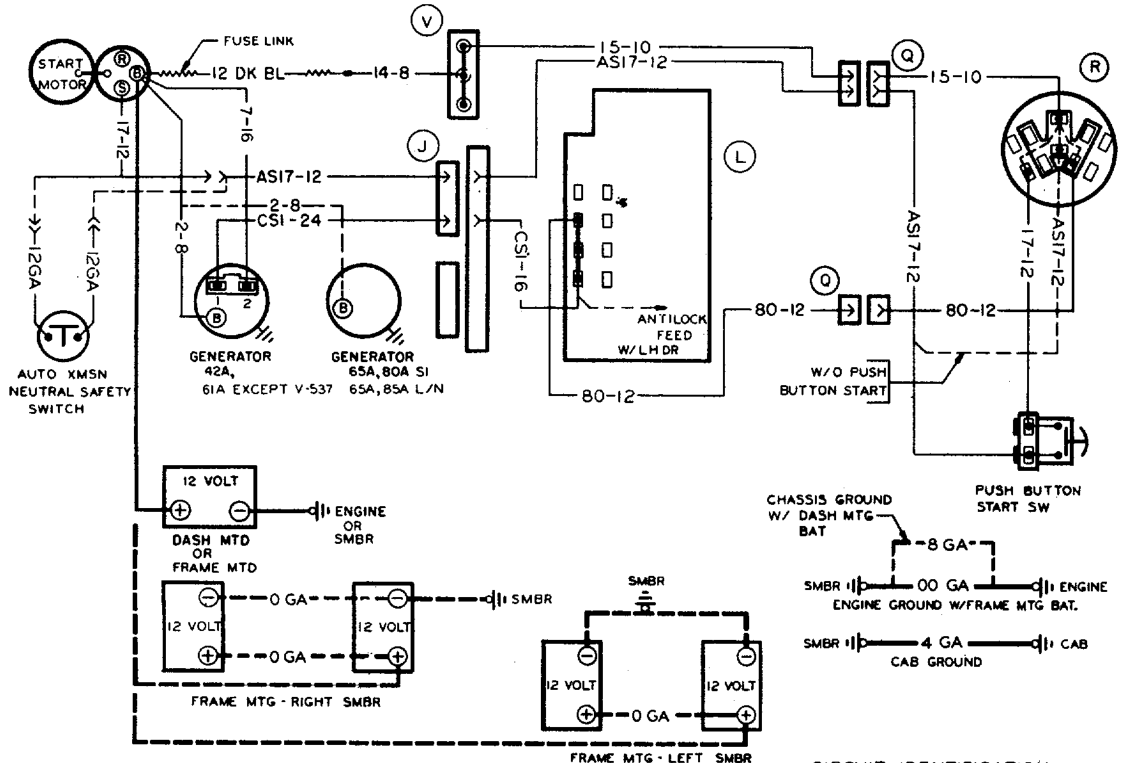
CIRCUIT DIAGRAMS



CIRCUIT		IDENTIFICATION
CIR	1	GENERATOR (EXCITER) (ACC)
CIR	2	GENERATOR (CHARGE)
CIR	7	REGULATOR (VOLT SENSING)
CIR	14	MAIN FEED
CIR	15	KEY SWITCH FEED
CIR	17	STARTING CONTROL
CIR	71	BACK-UP LIGHT (IGN)

V-392, MV8 & V-345 STARTING, CHARGING & MAJOR FEED & GROUND WIRING FBC/BUS *MT-21961*

CIRCUIT DIAGRAMS

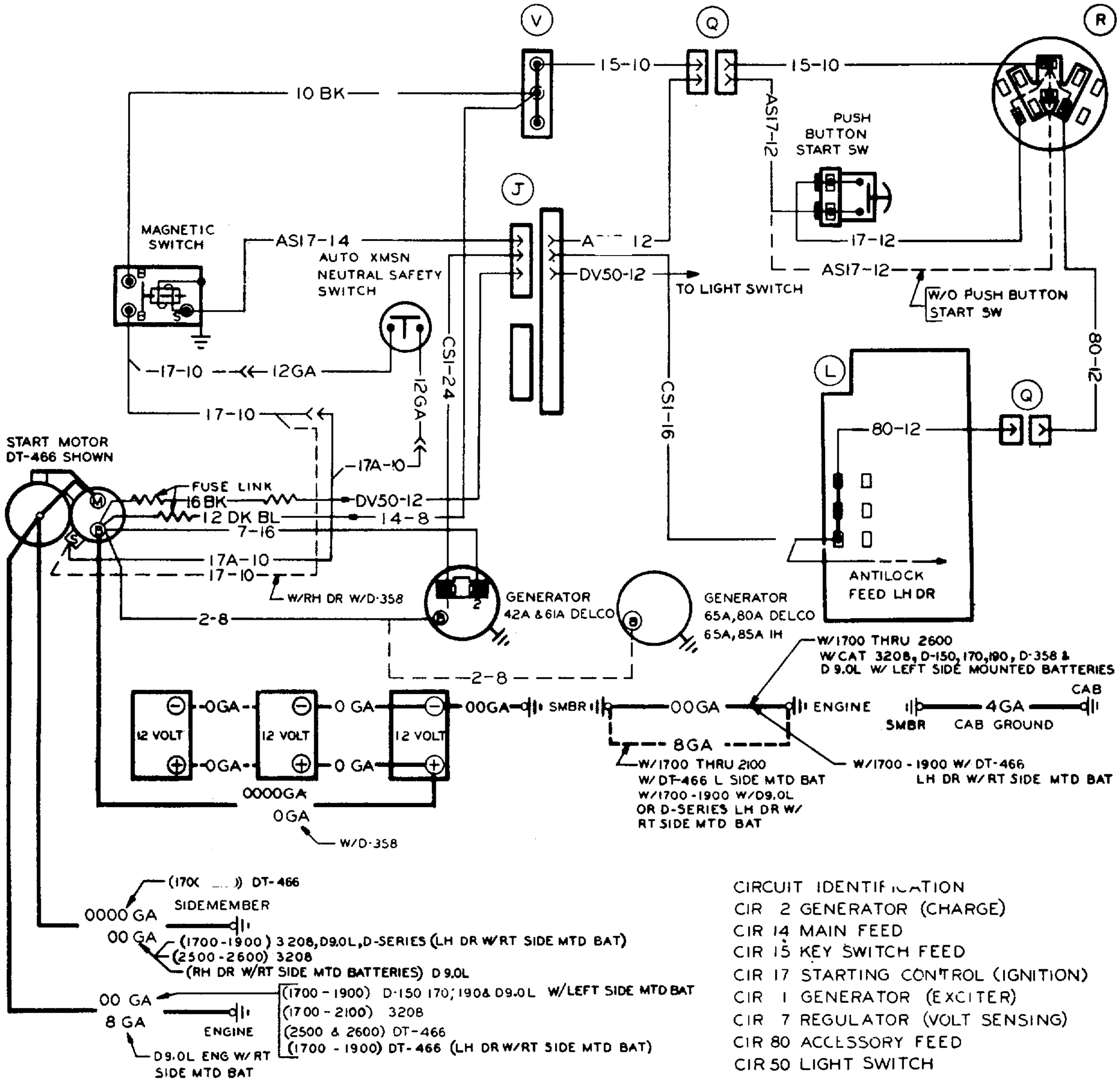


BATTERY LOCATION	BATTERY COMBINATION	POSITIVE CABLE GAUGE	NEGATIVE CABLE GAUGE	ENGINE	MODEL
DASH PANEL	1/ 12 VOLT	2	2	V-345, MV8 & V-392	1600 THRU 1900
LEFT SMBR	2/ 12 VOLT	1	0 0		
LEFT SMBR	1/ 12 VOLT	1	0 0		
LEFT SMBR	2/ 12 VOLT	1	0 0	V-537	2100
LEFT SMBR	1/ 12 VOLT	1	0 0		
RIGHT SMBR	1/ 12 VOLT	0	0 0	V-537	2500&2600-CONSTR
RIGHT SMBR	2/ 12 VOLT	0	0 0		

CIRCUIT IDENTIFICATION
CIR 1 GENERATOR (EXCITER)
CIR 2 GENERATOR (CHARGE)
CIR 7 REGULATOR (VOLT SENSING)
CIR 14 MAIN FEED
CIR 15 KEY SWITCH FEED
CIR 17 STARTING CONTROL
CIR 80 ACCESSORY FEED

V-392, V-345, MV8 & V-537 STARTING, CHARGING & MAJOR FEED & GROUND WIRING **MT-21960**

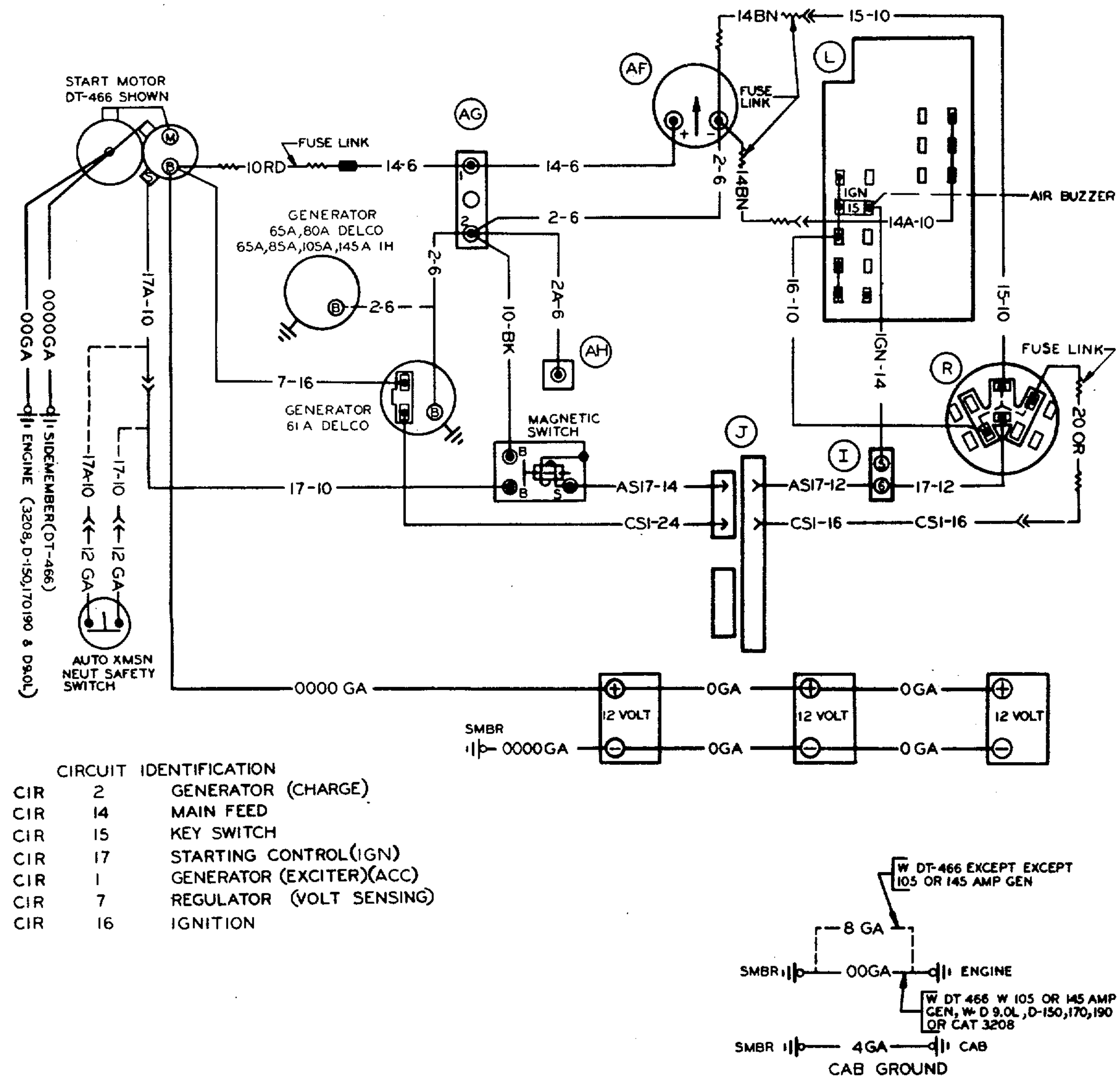
CIRCUIT DIAGRAMS



MT-23304

D-358, D9.0L, D-150,170,190, DT-466 & 3208 STARTING CHARGING MAJOR FEED & GROUND WIRING 1600-2100, 2500-2600 CONSTRUCTOR

CIRCUIT DIAGRAMS



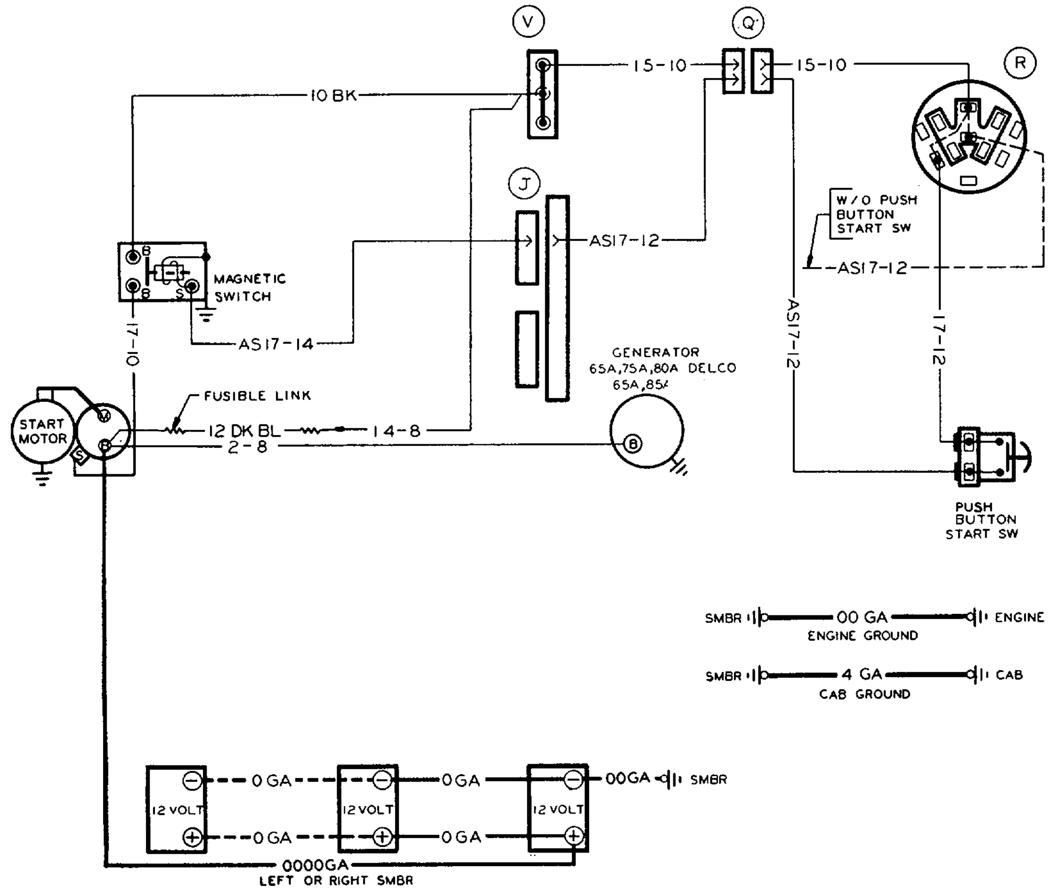
CIRCUIT IDENTIFICATION

CIR	2	GENERATOR (CHARGE)
CIR	14	MAIN FEED
CIR	15	KEY SWITCH
CIR	17	STARTING CONTROL (IGN)
CIR	1	GENERATOR (EXCITER)(ACC)
CIR	7	REGULATOR (VOLT SENSING)
CIR	16	IGNITION

D 9.0L, D-150, 170, 190, DT-466 OR 3208 STARTING, CHARGING, MAJOR FEED & GROUND WIRING FBC/BUS

MT-23305

CIRCUIT DIAGRAMS



CIRCUIT IDENTIFICATION

CIR 2 GENERATOR (CHARGE)

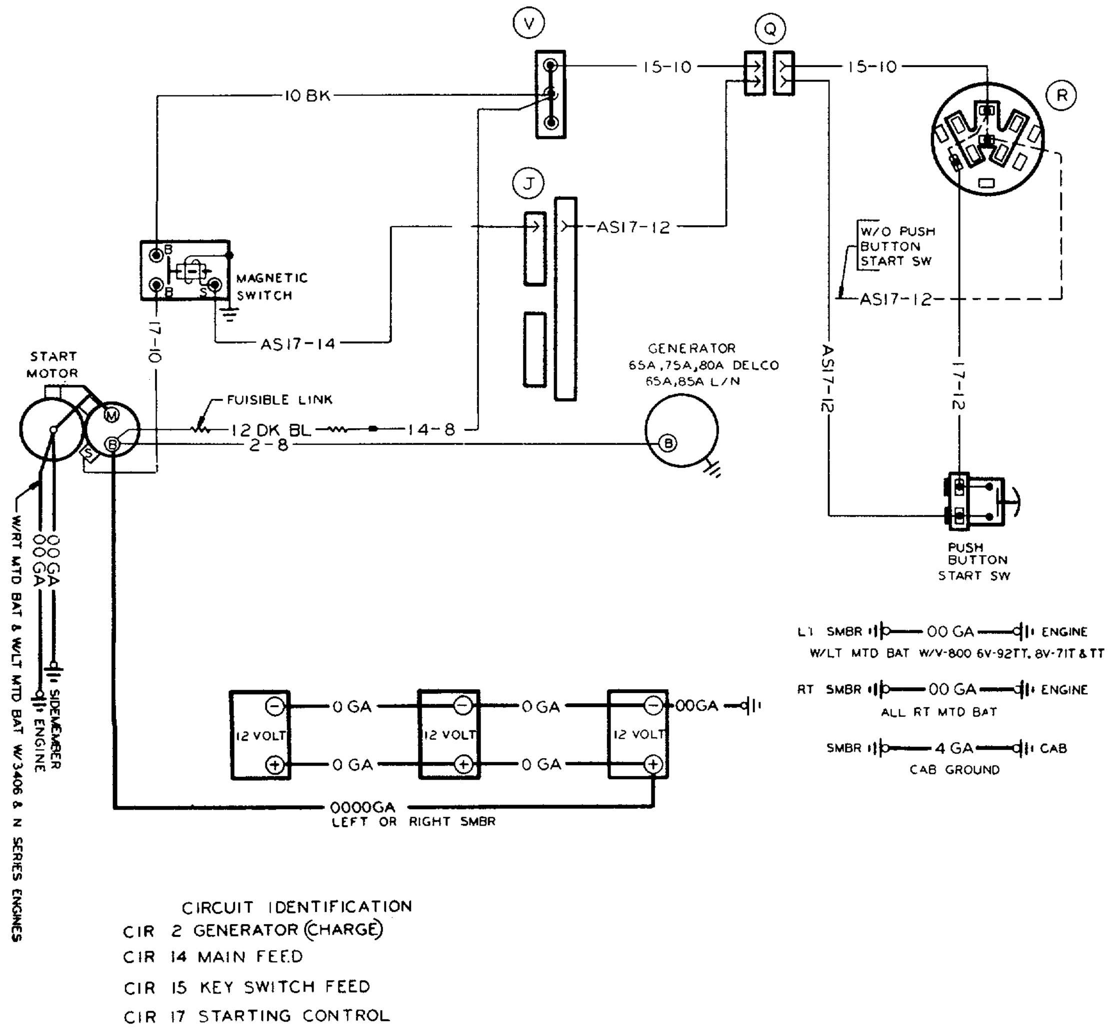
CIR 14 MAIN FEED

CIR 15 KEY SWITCH FEED

CIR 17 STARTING CONTROL

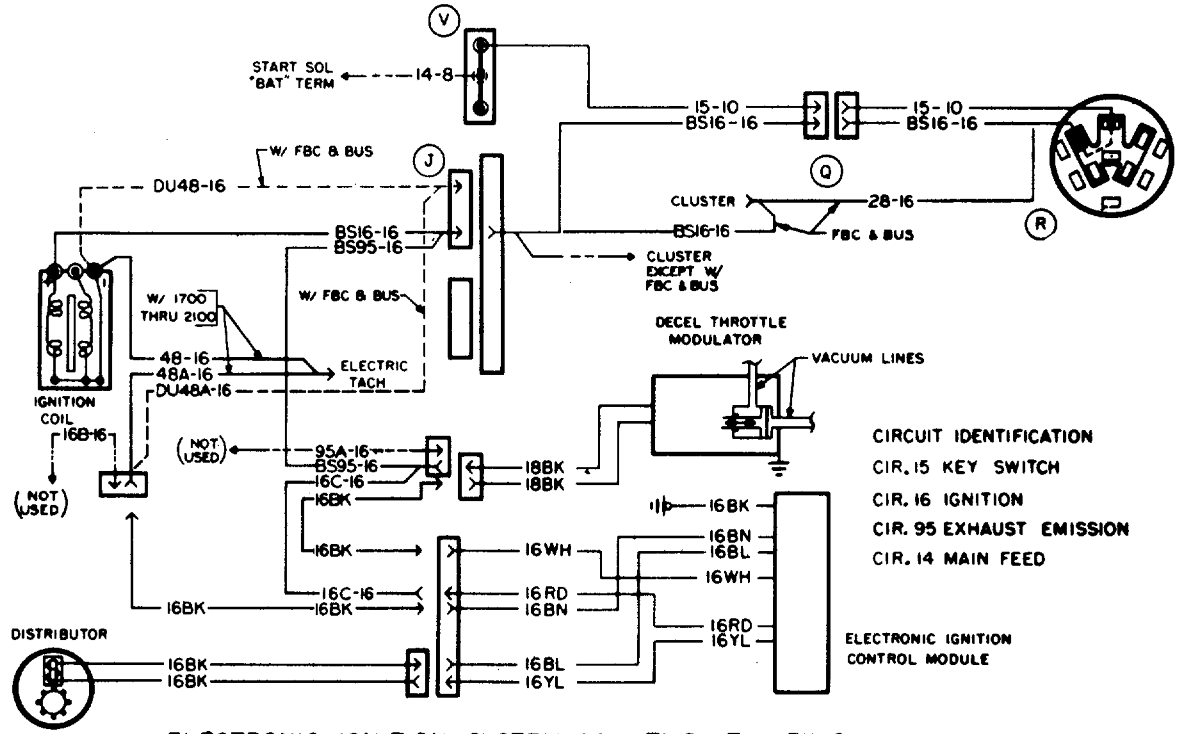
6-71 STARTING, CHARGING, & MAJOR FEED & GROUND WIRING **MT-21962**

CIRCUIT DIAGRAMS

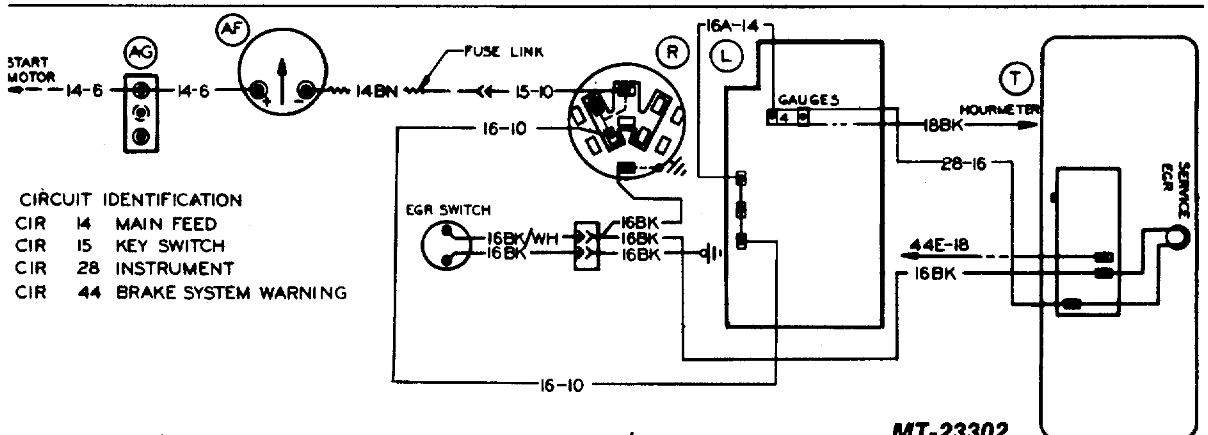


6V-92TT,8V-71T&TT,800,3406 &N-SERIES STARTING,CHARGING & MAJOR FEED & GROUND WIRING **MT-21971**

CIRCUIT DIAGRAMS



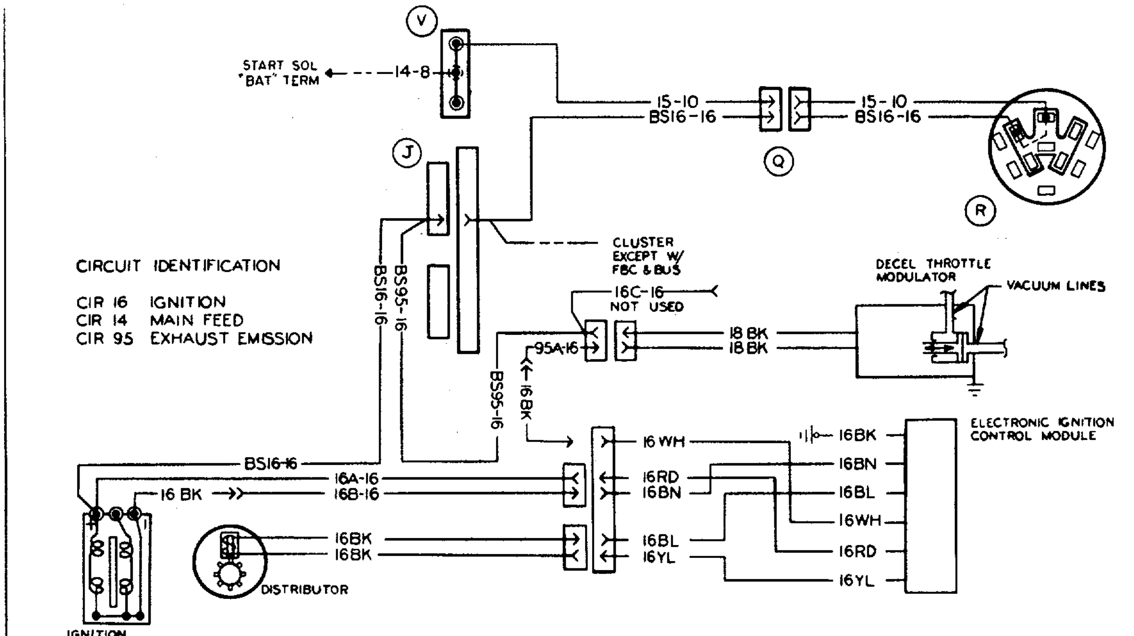
ELECTRONIC IGNITION SYSTEM MV8 ENGINE WIRING
W/ HOLLEY DISTRIBUTOR



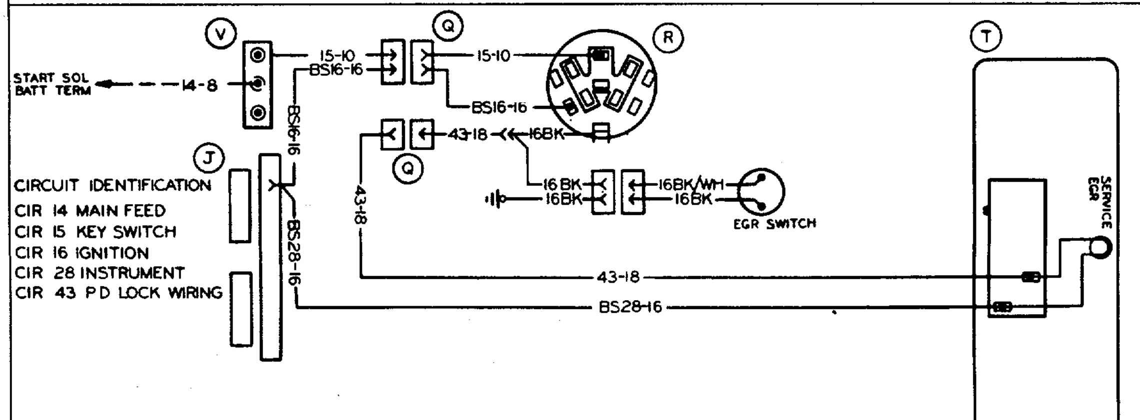
EGR SERVICE WARNING LIGHT WIRING W/FBC & BUS

MT-23302

CIRCUIT DIAGRAMS

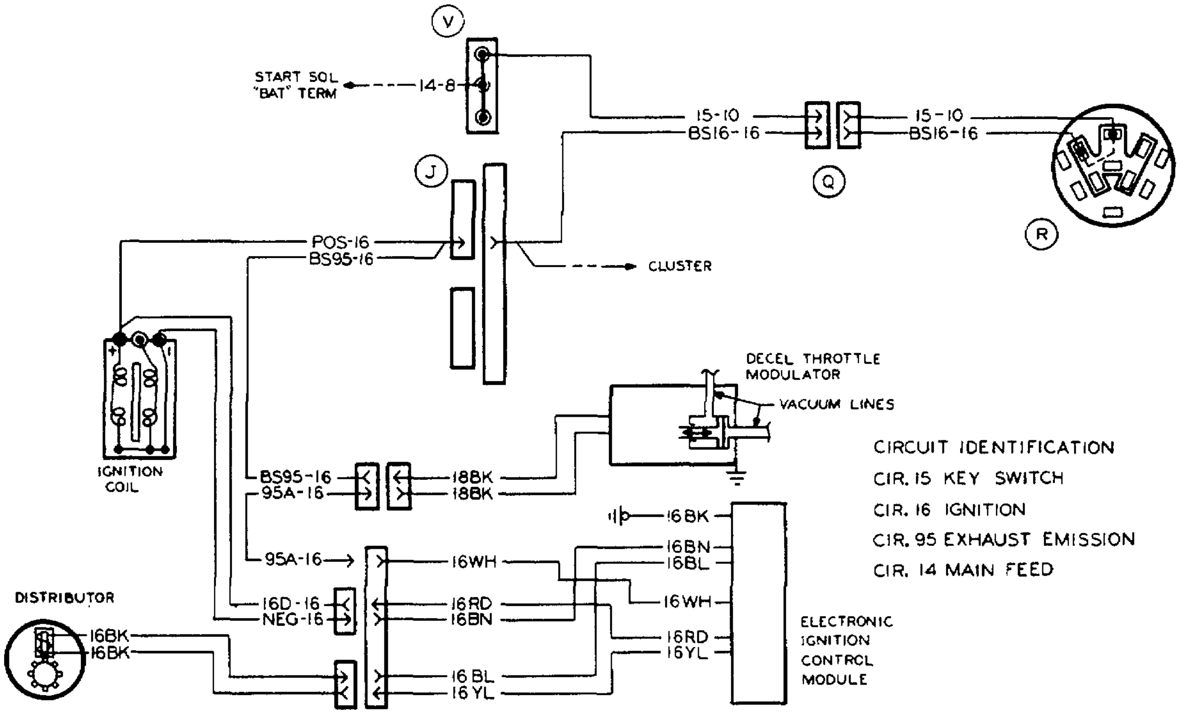


ELECTRONIC IGNITION SYSTEM V-537 ENGINE WIRING W/ HOLLY DISTRIBUTOR

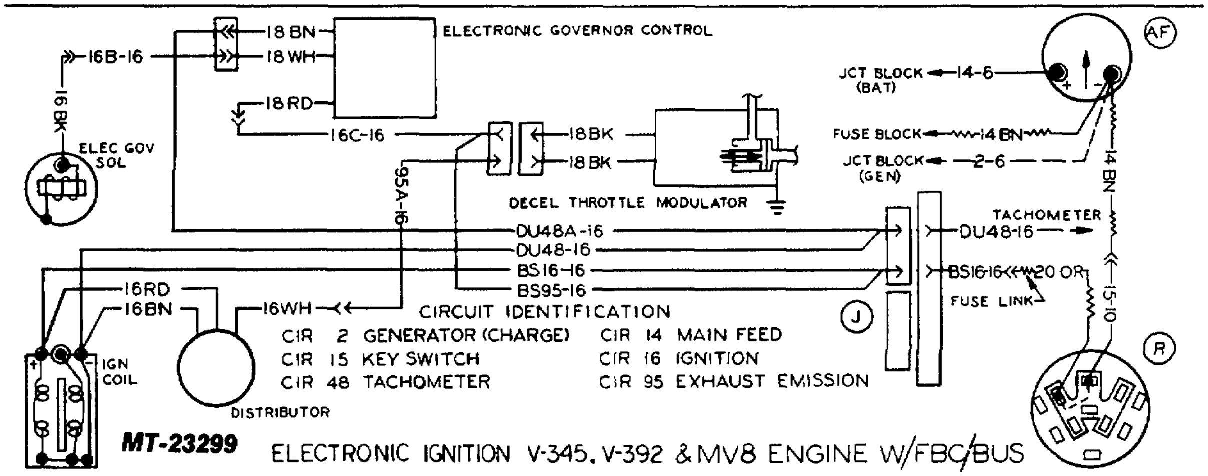


EGR SERVICE WARNING LIGHT WIRING W/1600 & 1700

CIRCUIT DIAGRAMS

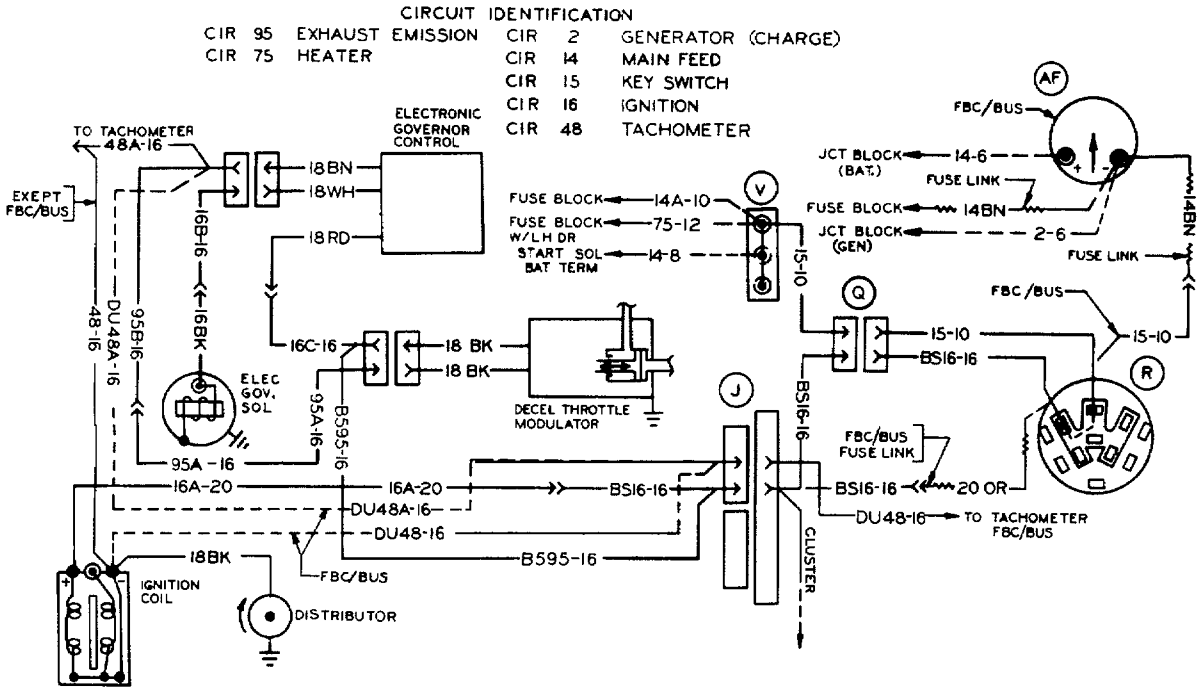


ELECTRONIC IGNITION SYSTEM V-537 ENGINE WIRING 2500 & 2600 W/2 WIRE DISTRIBUTOR & EXTERNAL IGNITION CONTROL MODULE



MT-23299 ELECTRONIC IGNITION V-345, V-392 & MV8 ENGINE W/FBC/BUS

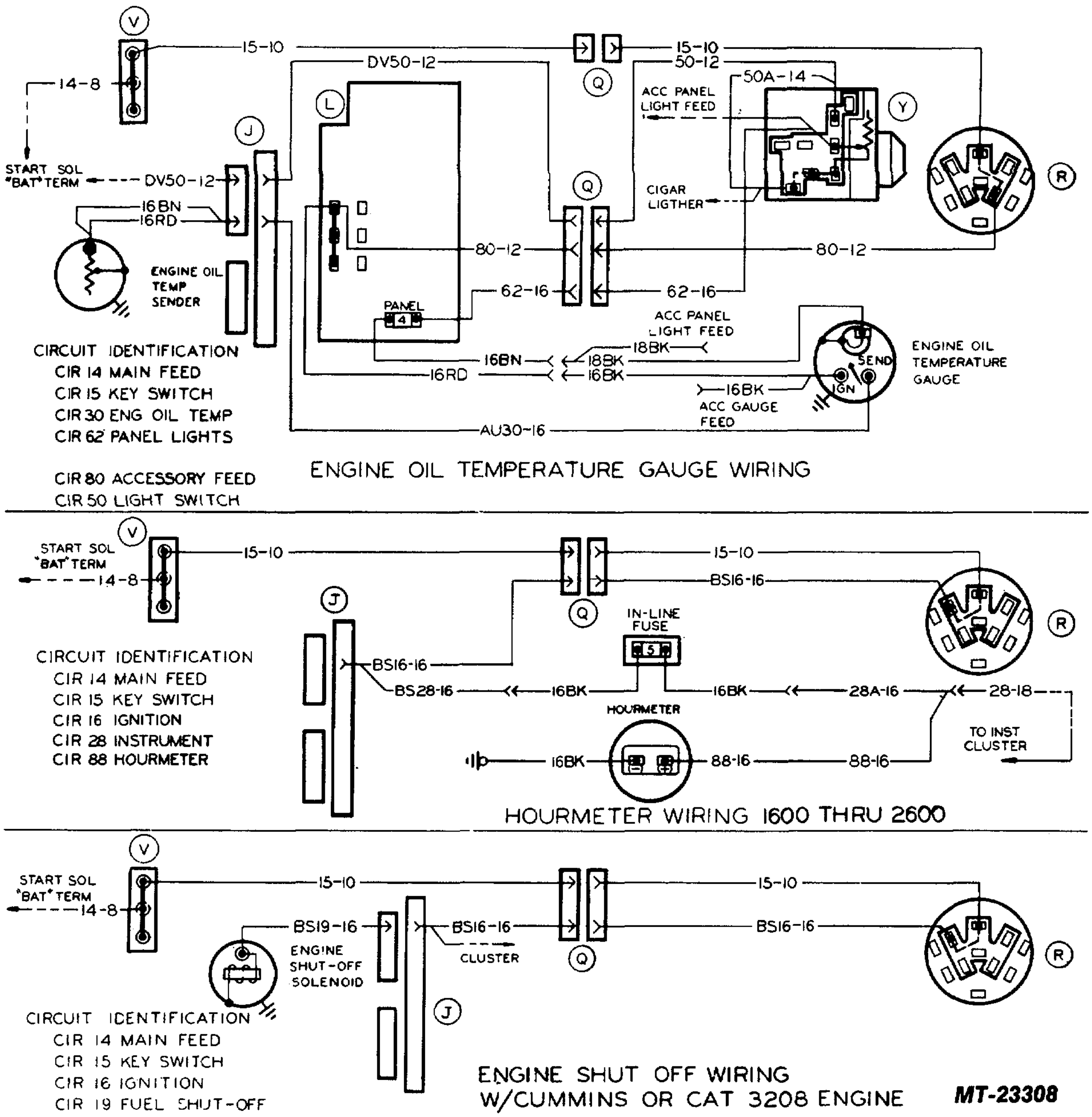
CIRCUIT DIAGRAMS



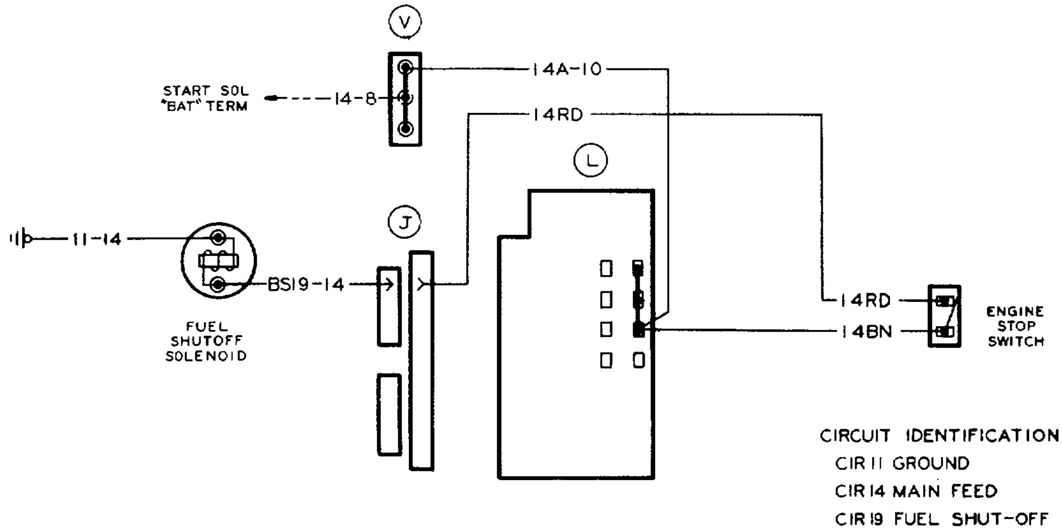
BREAKER POINT IGNITION V-345 ENG

MT-23301

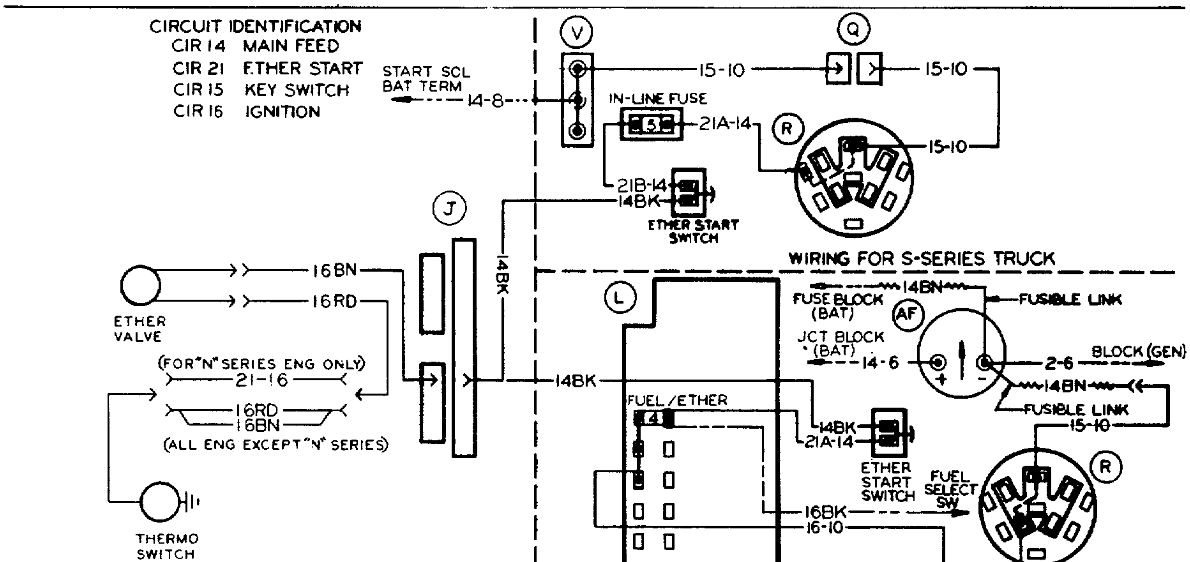
CIRCUIT DIAGRAMS



CIRCUIT DIAGRAMS



ENGINE STOP WIRING W/CAT-3406 ENGINE

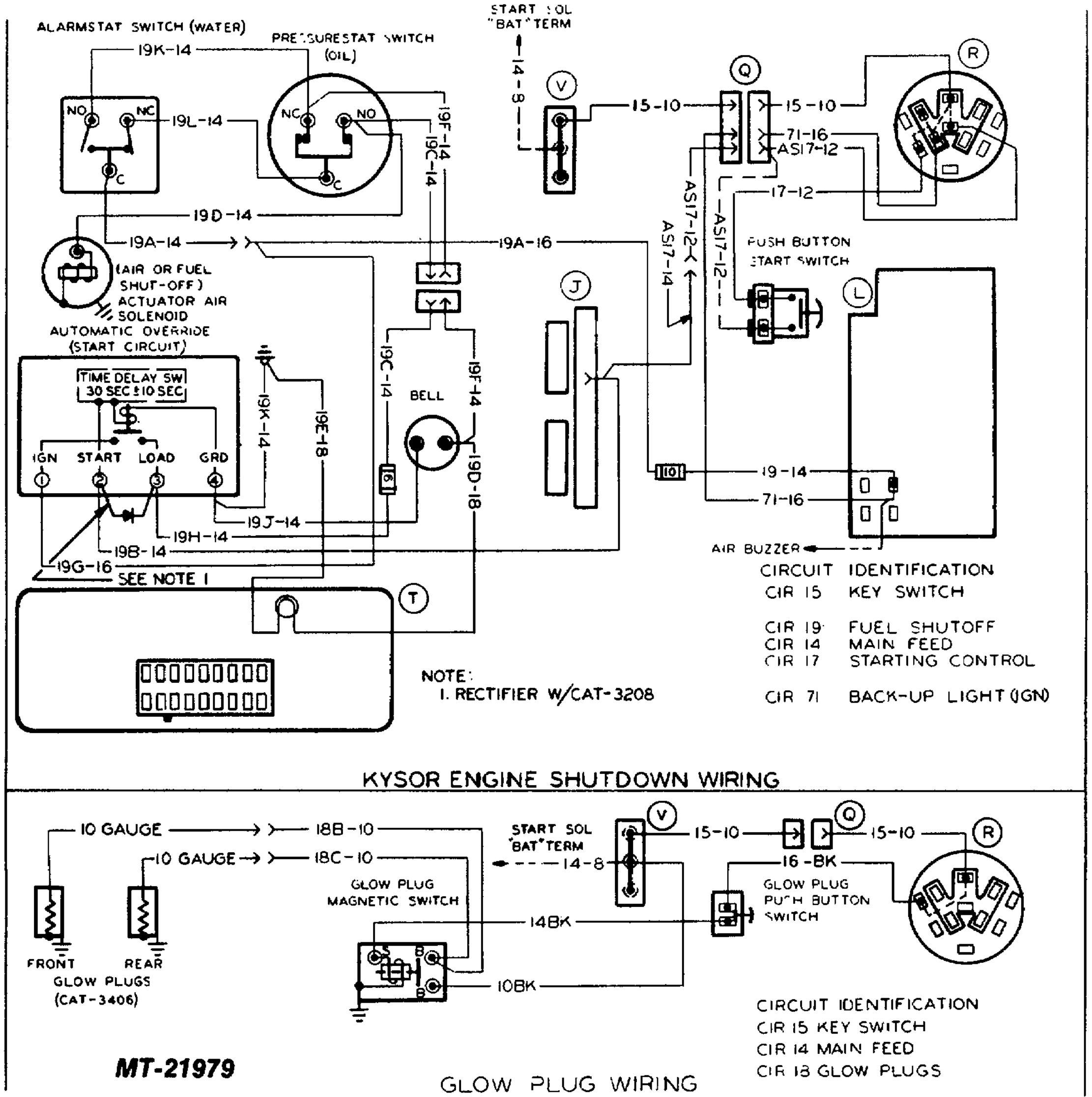


MT-23309

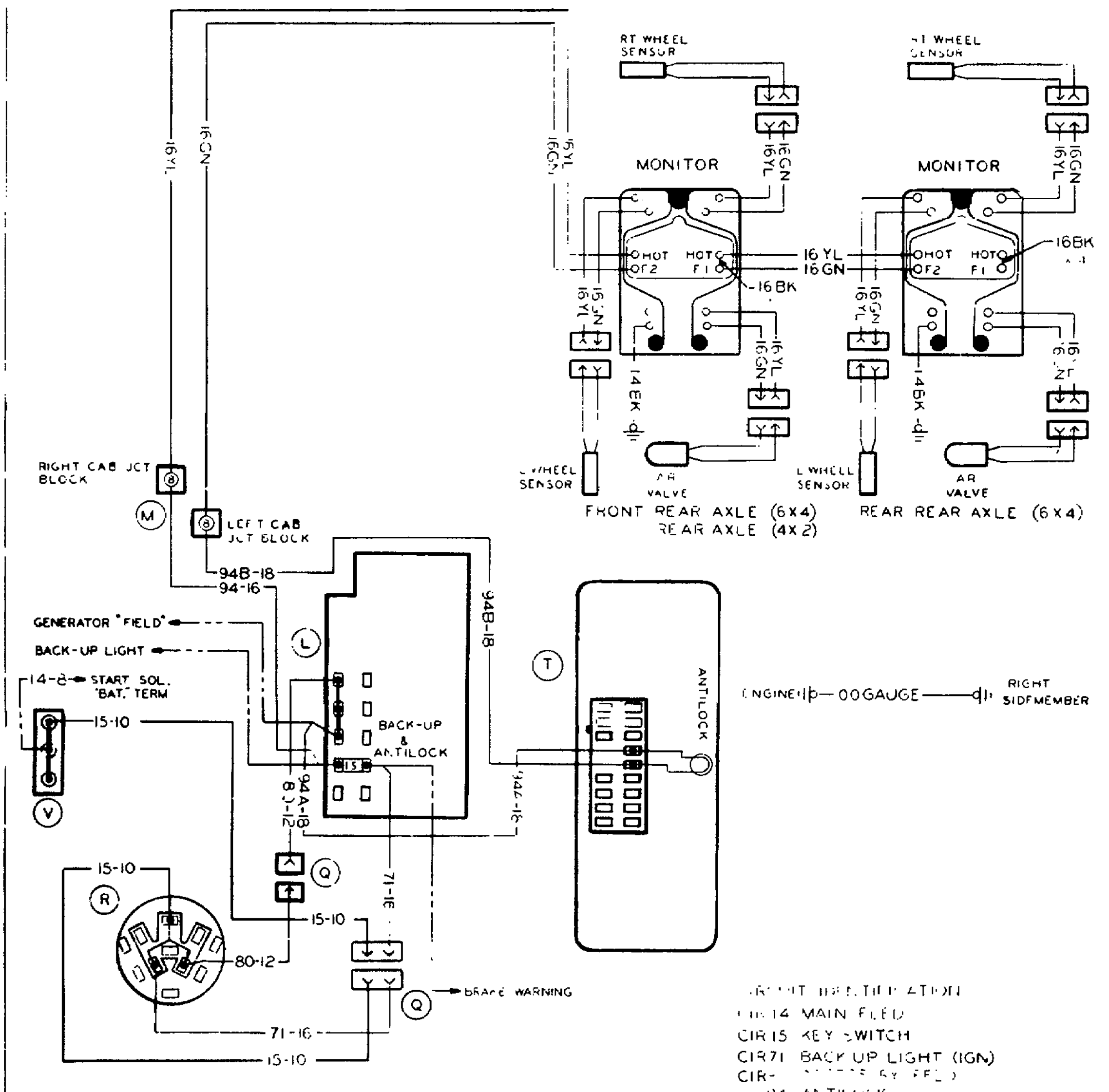
ETHER START WIRING

WIRING FOR S-SERIES FBC & BUS

CIRCUIT DIAGRAMS



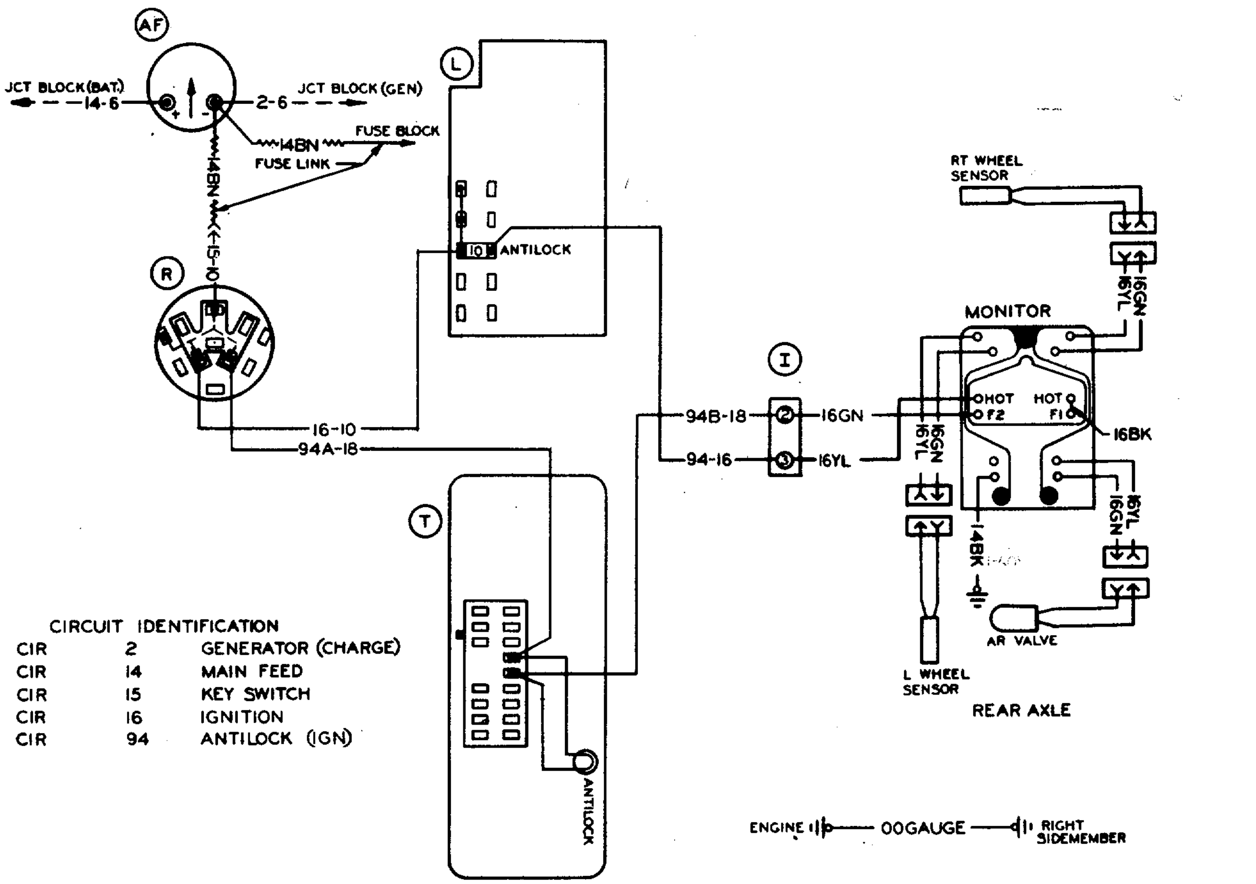
CIRCUIT DIAGRAMS



AIR BRAKES ANTILOCK WIRING

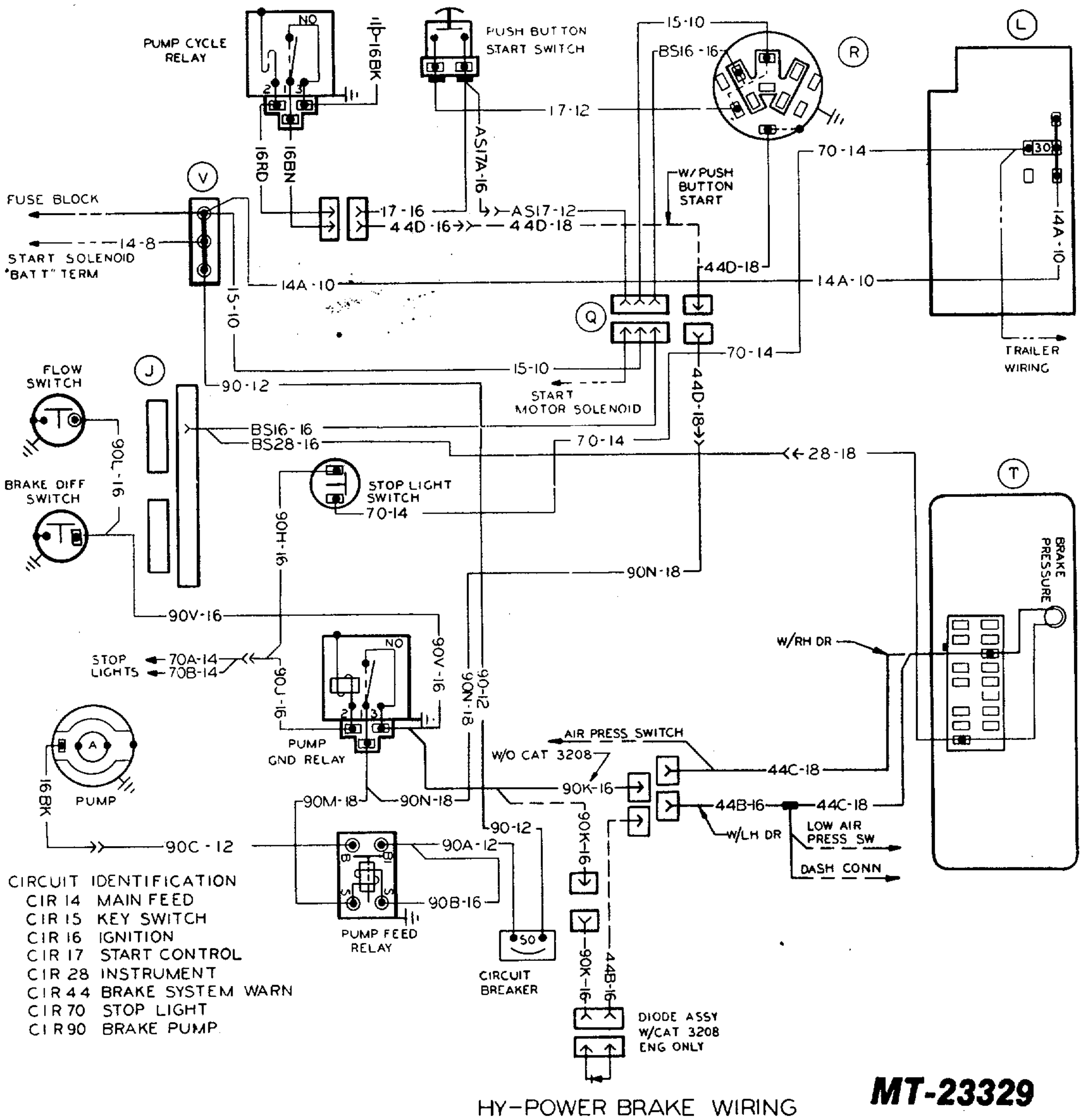
MT-21977

CIRCUIT DIAGRAMS

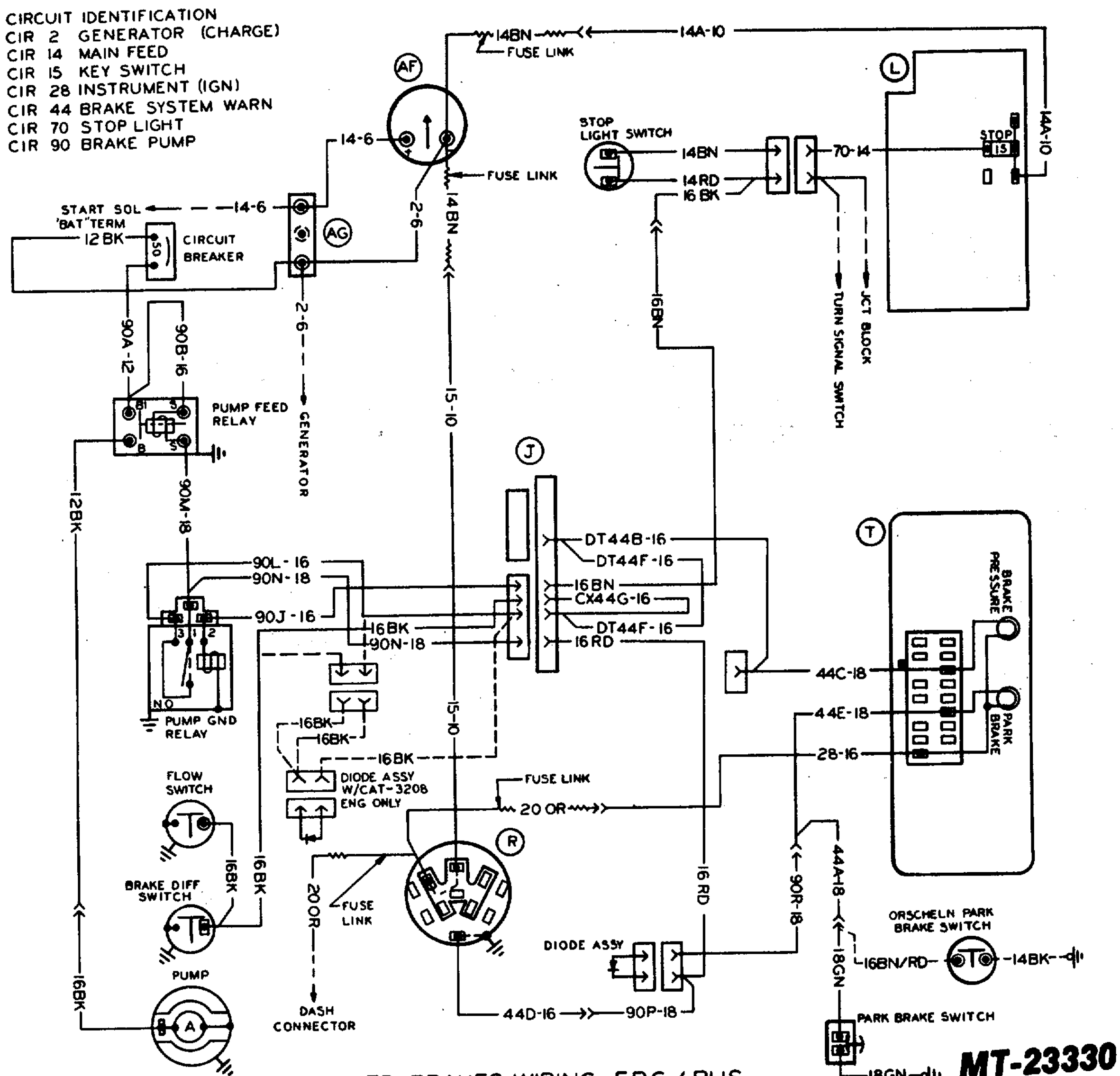


AIR BRAKES ANTILOCK WIRING FBC/BUS MT-23310

CIRCUIT DIAGRAMS

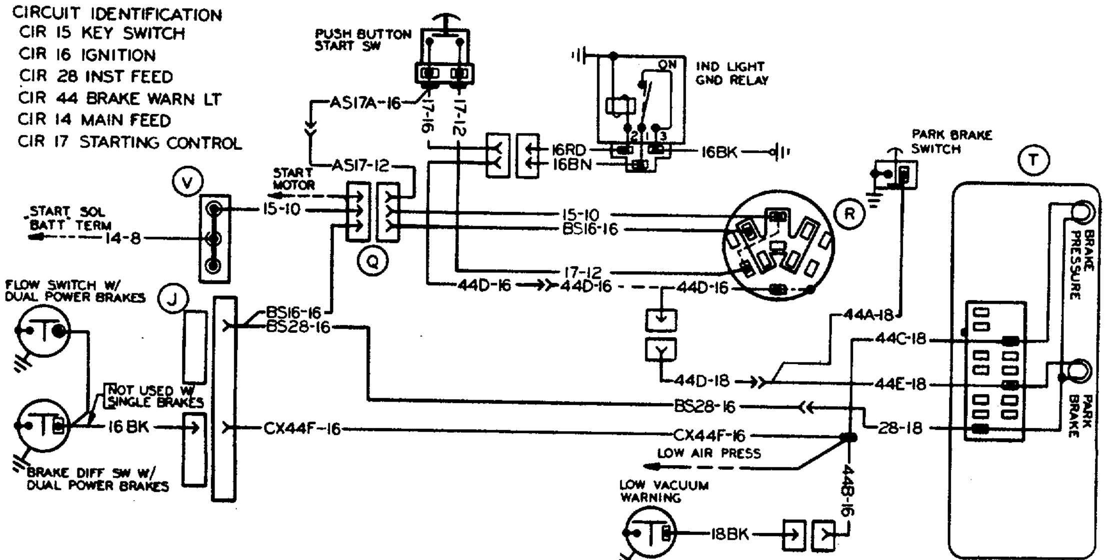


CIRCUIT DIAGRAMS



HY-POWER BRAKES WIRING FBC / BUS

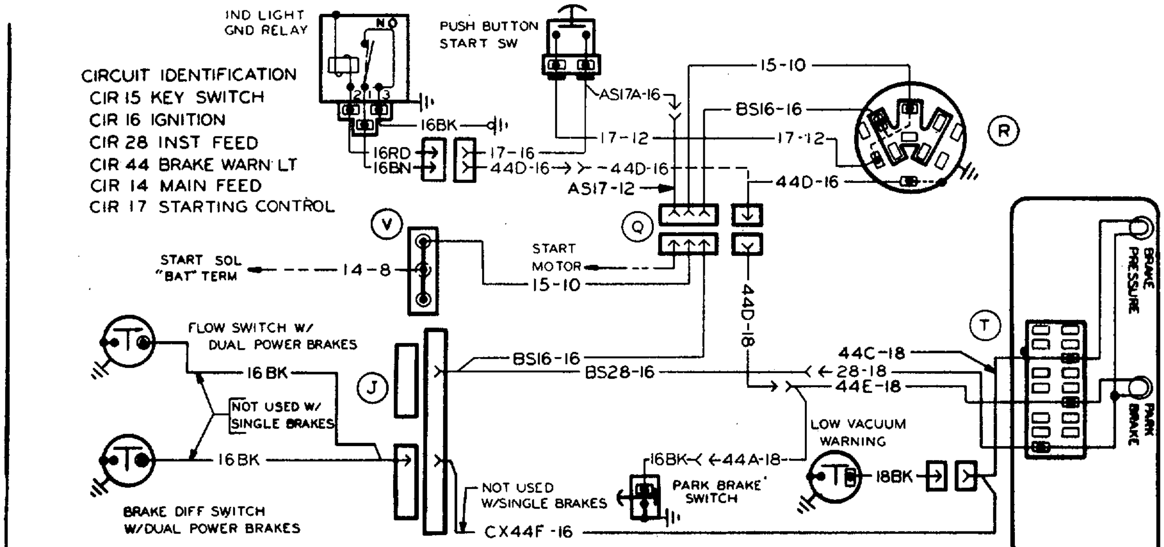
CIRCUIT DIAGRAMS



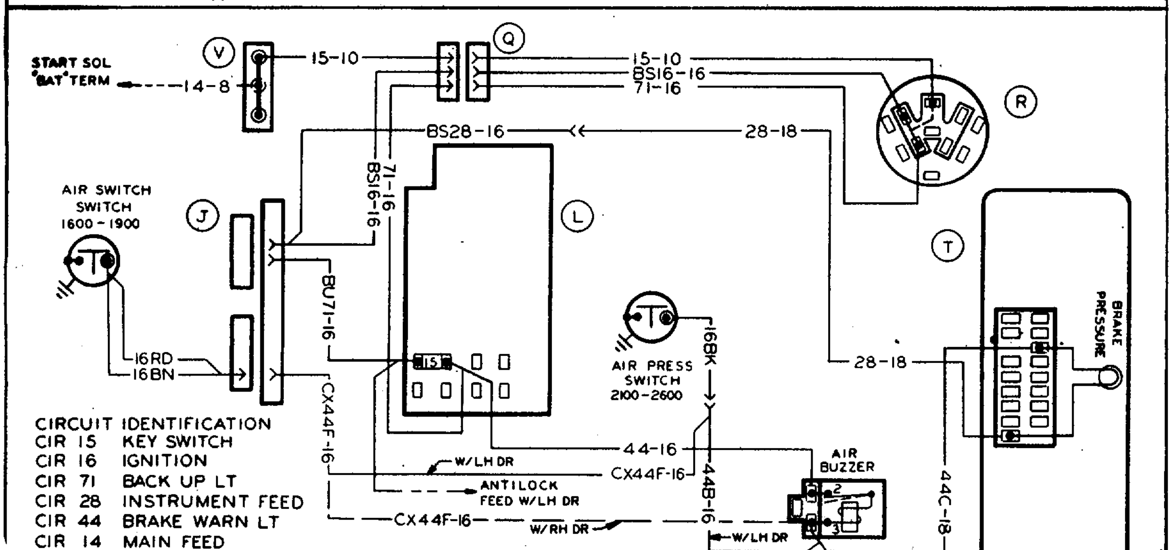
PARKING BRAKE & HYDRAULIC BRAKE PRESS WARNING LIGHT WIRING W SINGLE OR DUAL POWER BRAKES 1600 THRU 1900 LH DR

MT-21984

CIRCUIT DIAGRAMS



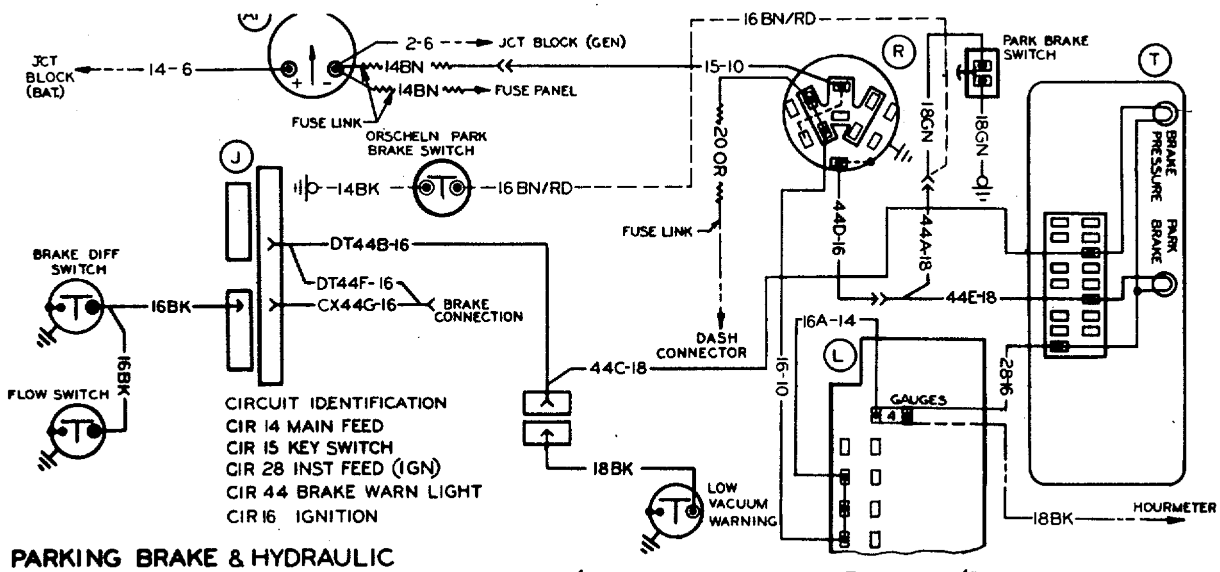
PARKING BRAKE & HYDRAULIC BRAKE PRESS WARNING LIGHT WIRING W/ SINGLE OR DUAL POWER BRAKES 1700 THRU 1900 RH DR



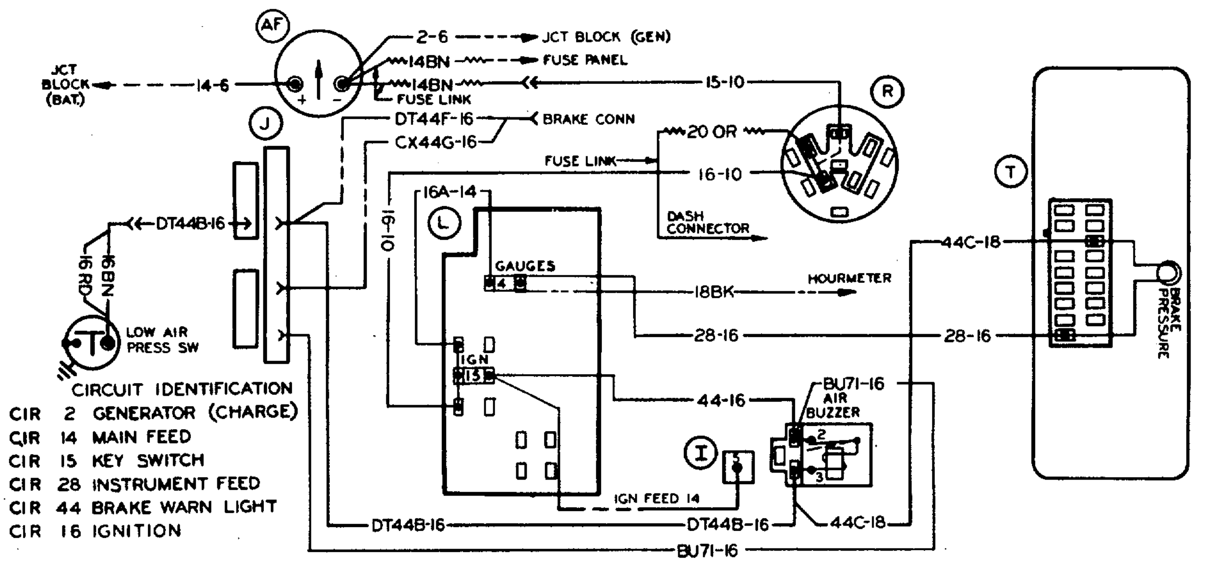
LOW AIR PRESS WARN LIGHT WIRING 1700 THRU 2600

MT-21982

CIRCUIT DIAGRAMS



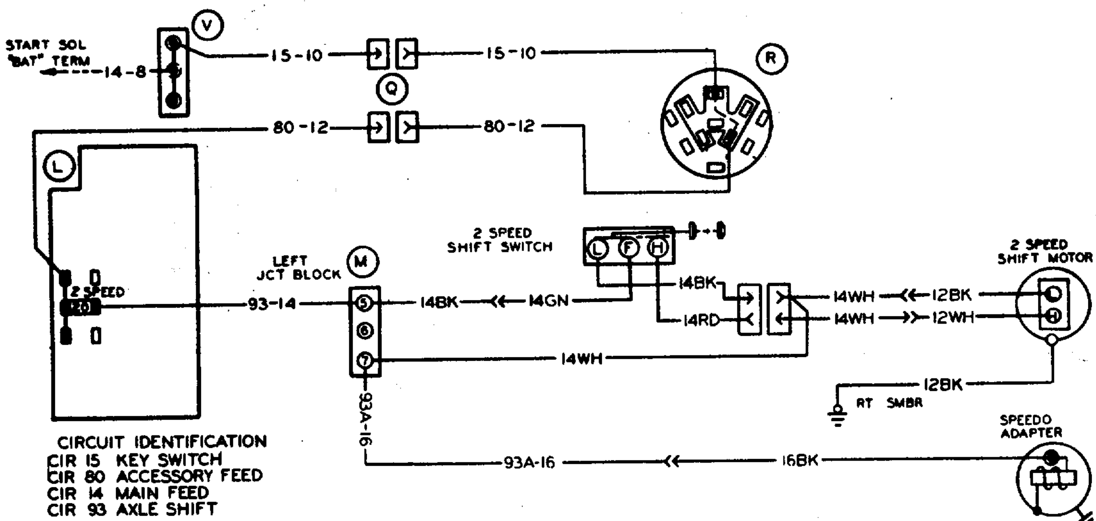
PARKING BRAKE & HYDRAULIC
BRAKE PRESS WARNING LIGHT WIRING W/DUAL POWER BRAKES FBC/BUS



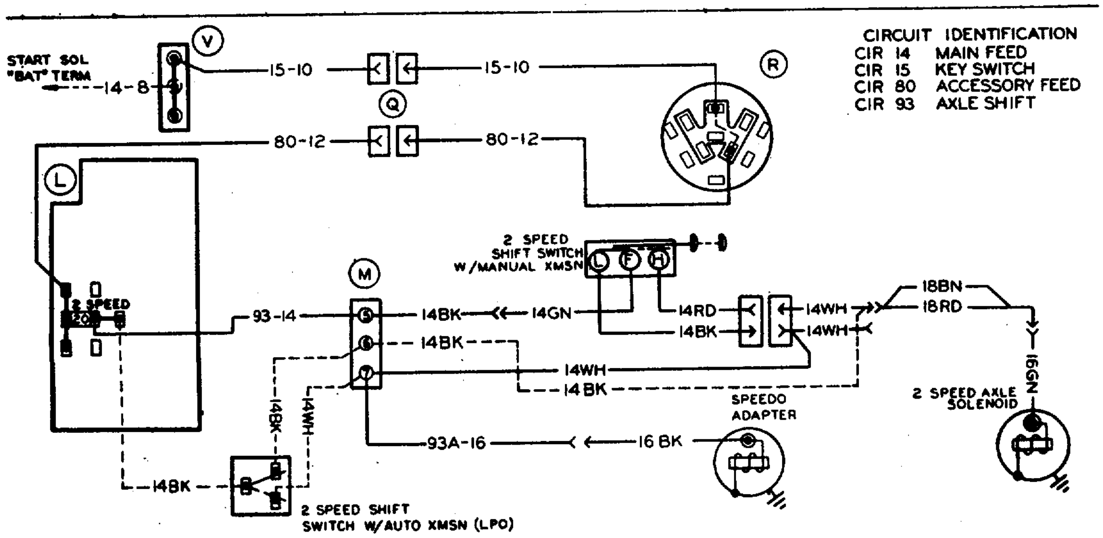
LOW AIR PRESS WARN LIGHT WIRING FBC/BUS

MT-23311

CIRCUIT DIAGRAMS



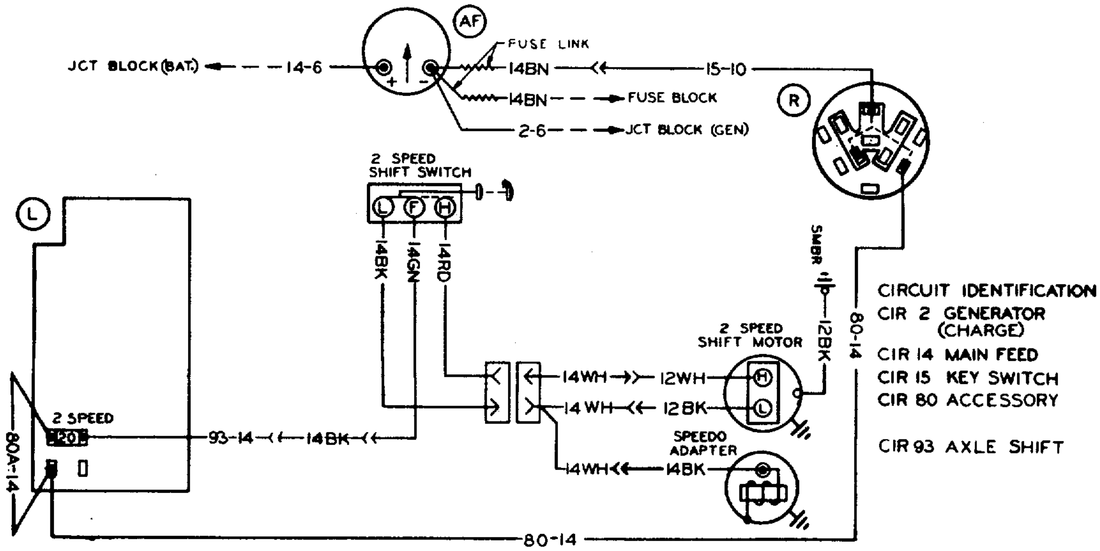
2-SPEED AXLE ALL ELECTRIC SHIFT 1600 THRU 2600



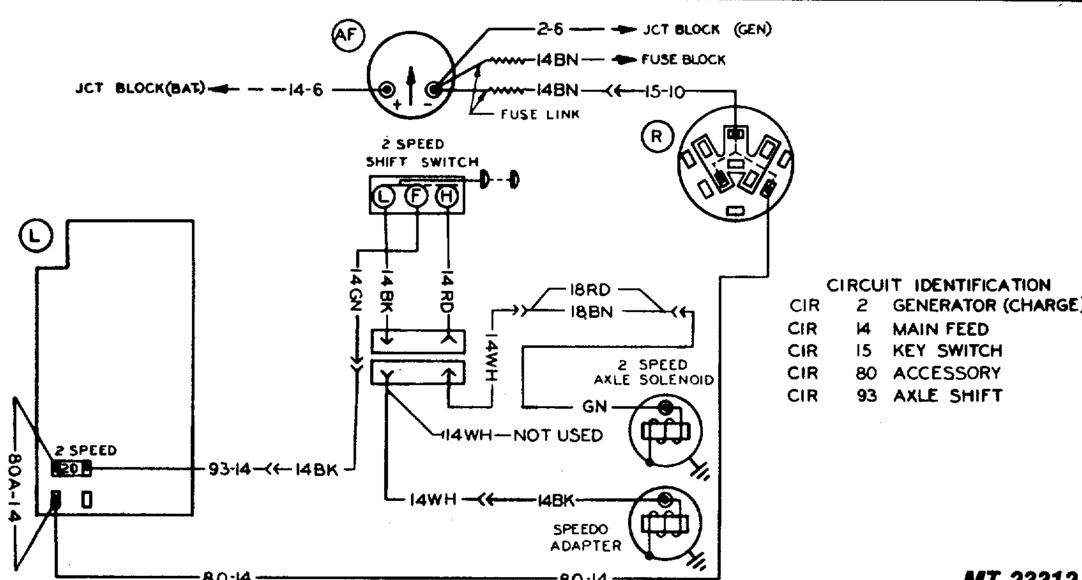
2-SPEED AXLE ELECTRIC OVER AIR 1600 THRU 2600

MT-21985

CIRCUIT DIAGRAMS



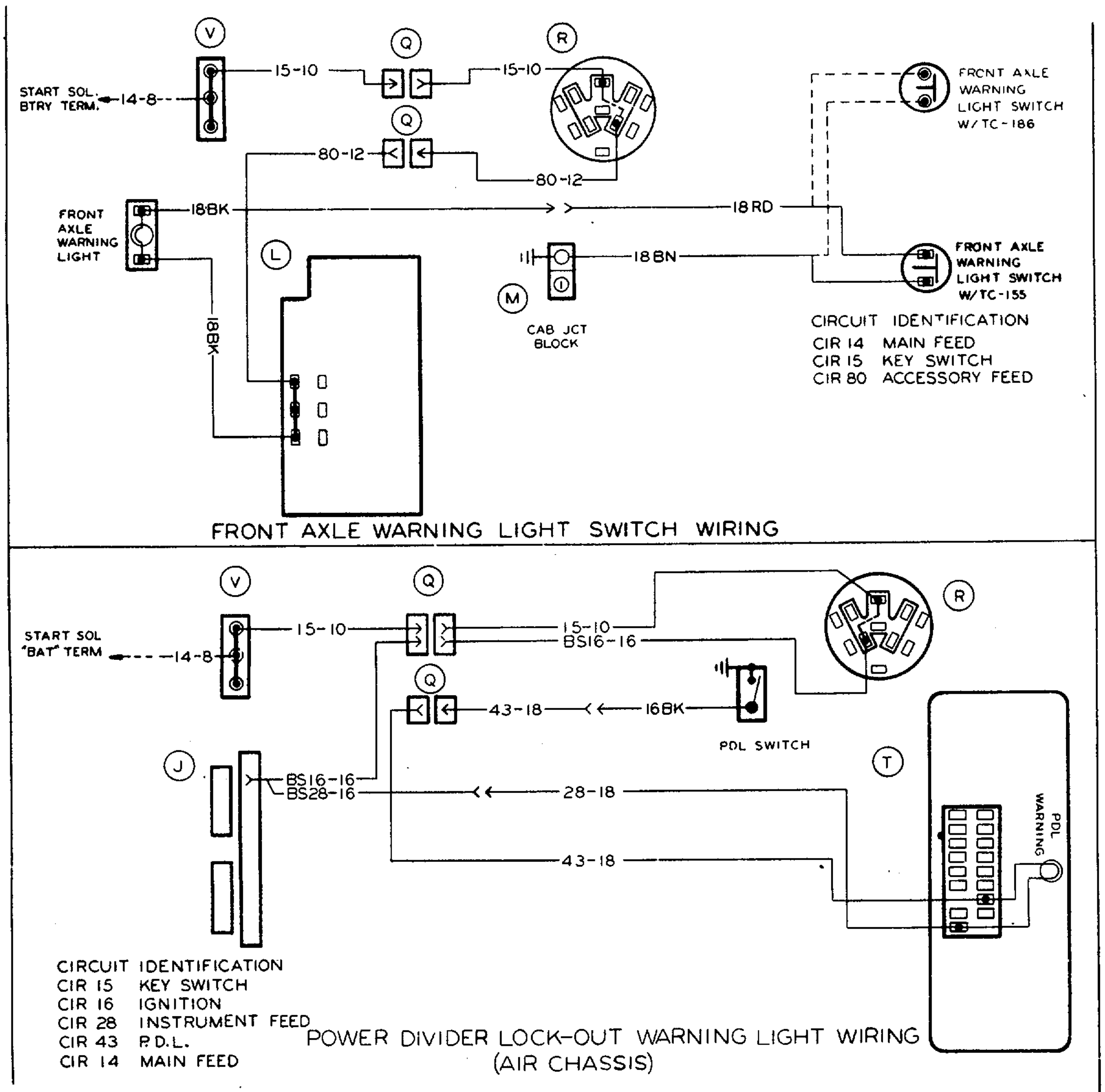
2 SPEED AXLE ALL ELECTRIC SHIFT FBC/BUS



MT-23312

2 SPEED AXLE ELECTRIC OVER AIR FBC/BUS

CIRCUIT DIAGRAMS

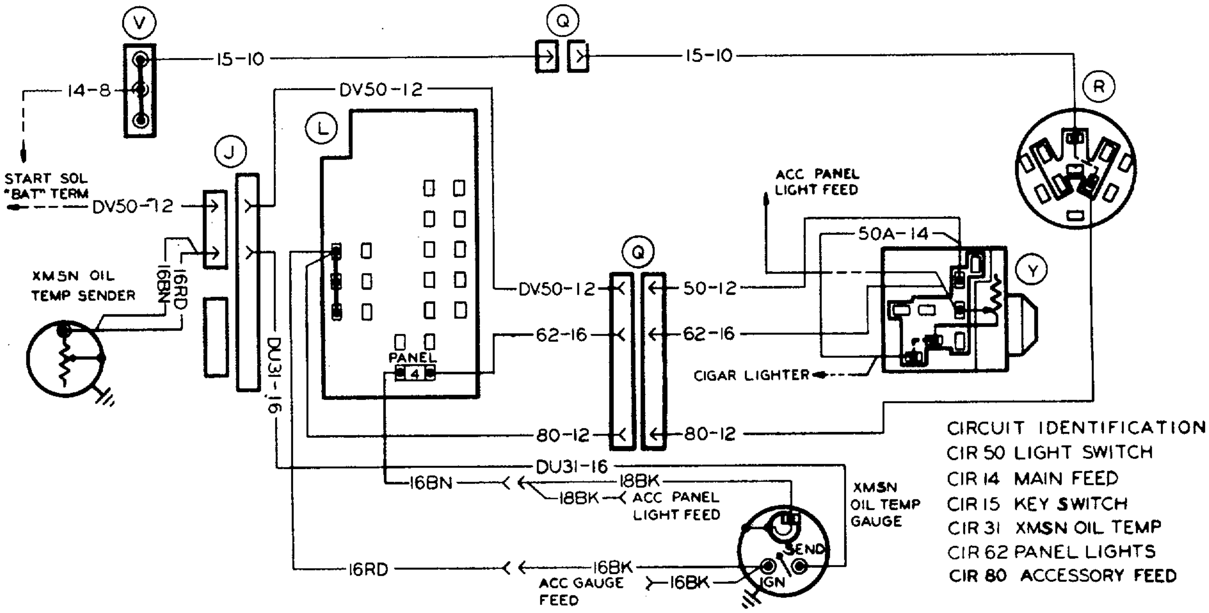


FRONT AXLE WARNING LIGHT SWITCH WIRING

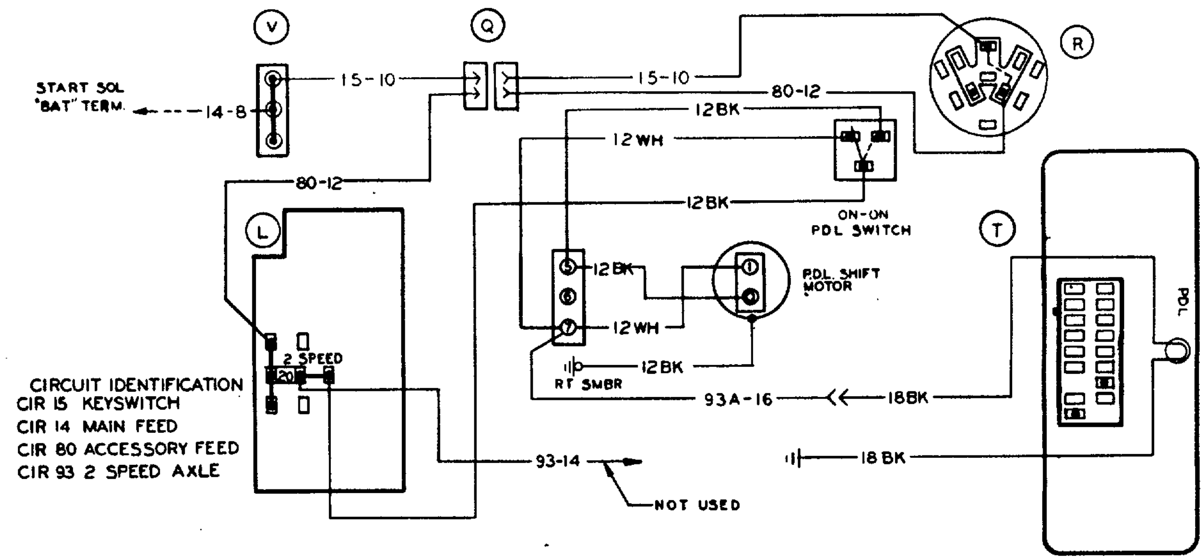
POWER DIVIDER LOCK-OUT WARNING LIGHT WIRING (AIR CHASSIS)

MT-21994

CIRCUIT DIAGRAMS

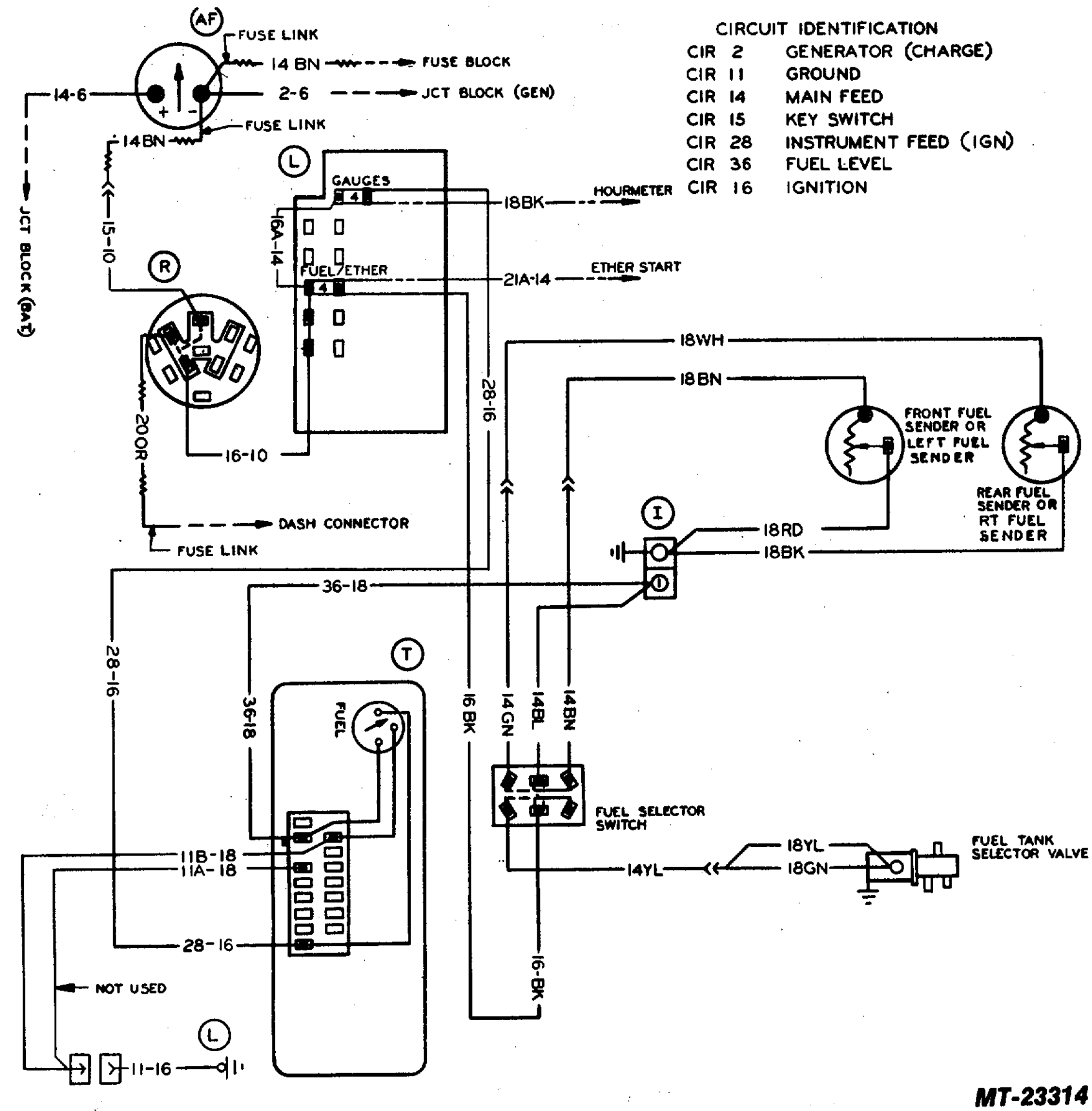


TRANSMISSION OIL TEMPERATURE GAUGE WIRING



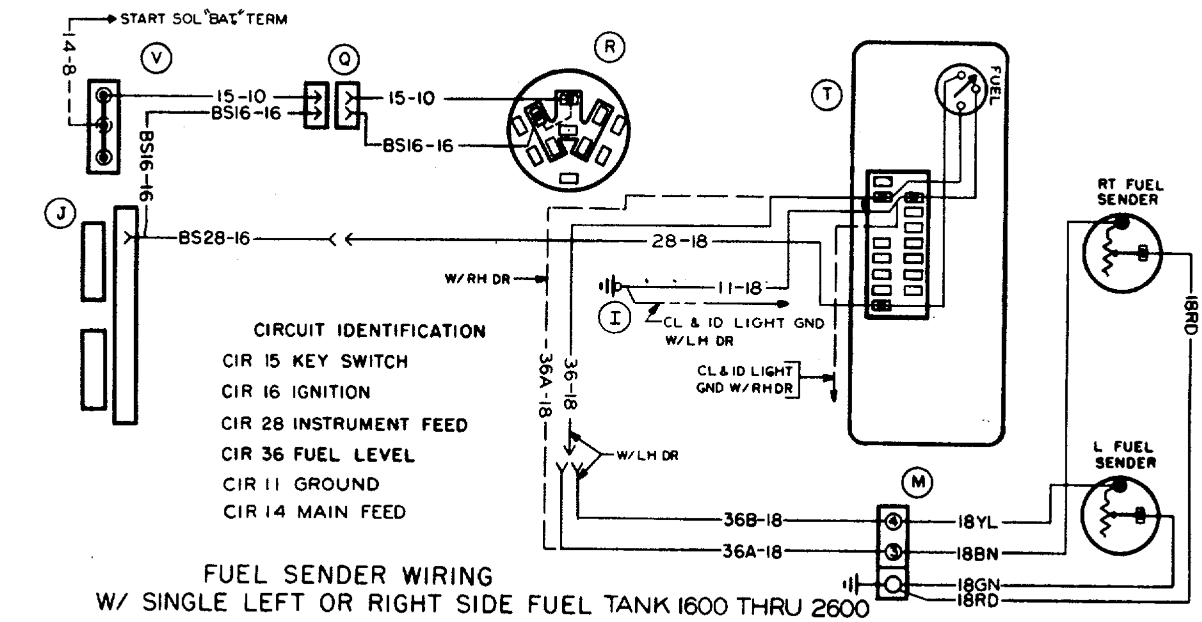
MT-23327 ELECT. POWER DIVIDER LOCK-OUT WIRING (HYD CHASSIS)

CIRCUIT DIAGRAMS

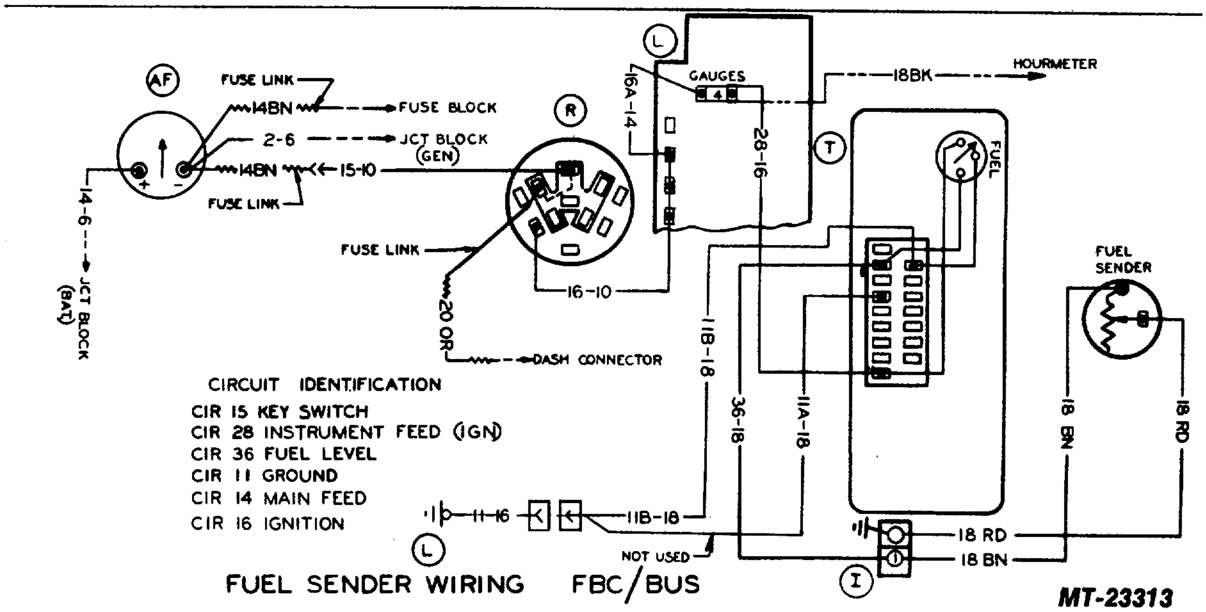


DUAL SENDERS WITH DUAL FUEL TANKS FBC &BUS W/GAS ENG.ONLY

CIRCUIT DIAGRAMS



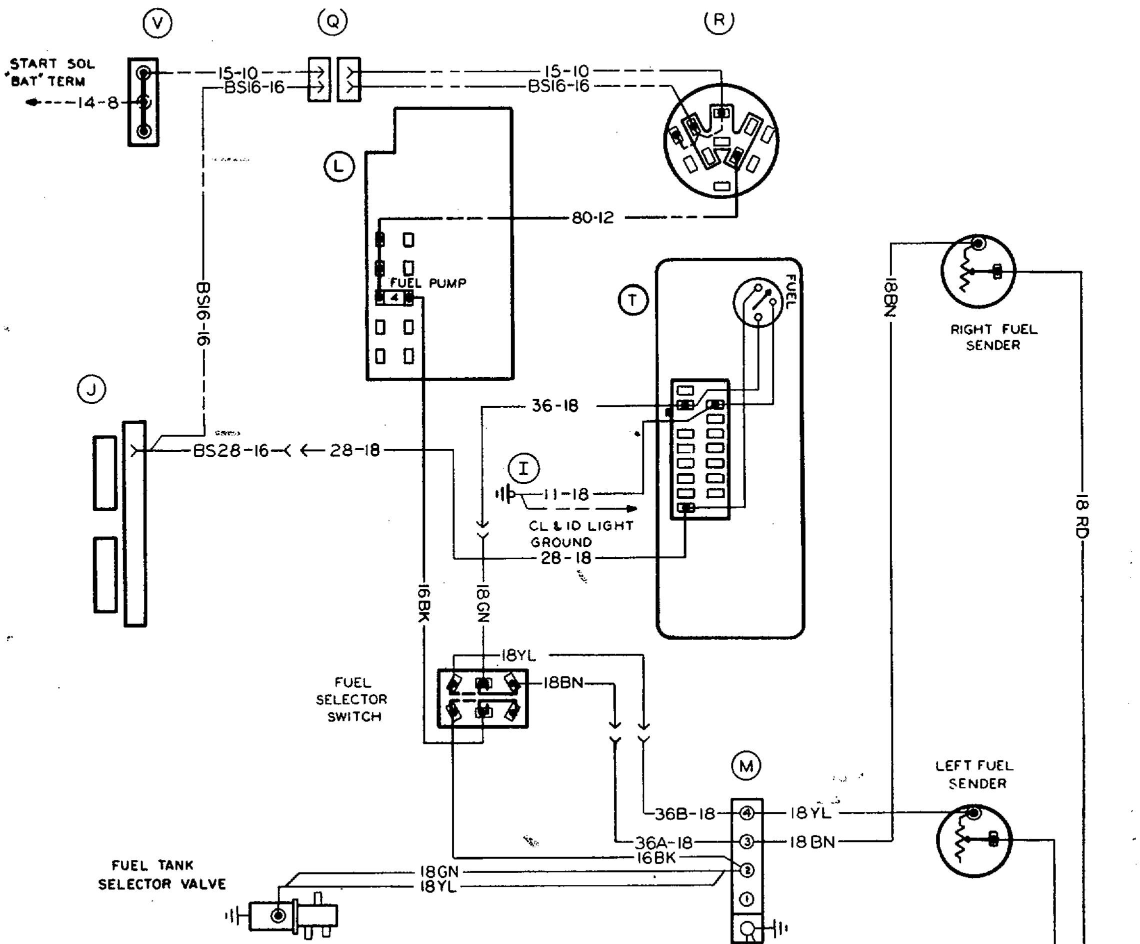
FUEL SENDER WIRING
W/ SINGLE LEFT OR RIGHT SIDE FUEL TANK 1600 THRU 2600



FUEL SENDER WIRING FBC/BUS

MT-23313

CIRCUIT DIAGRAMS

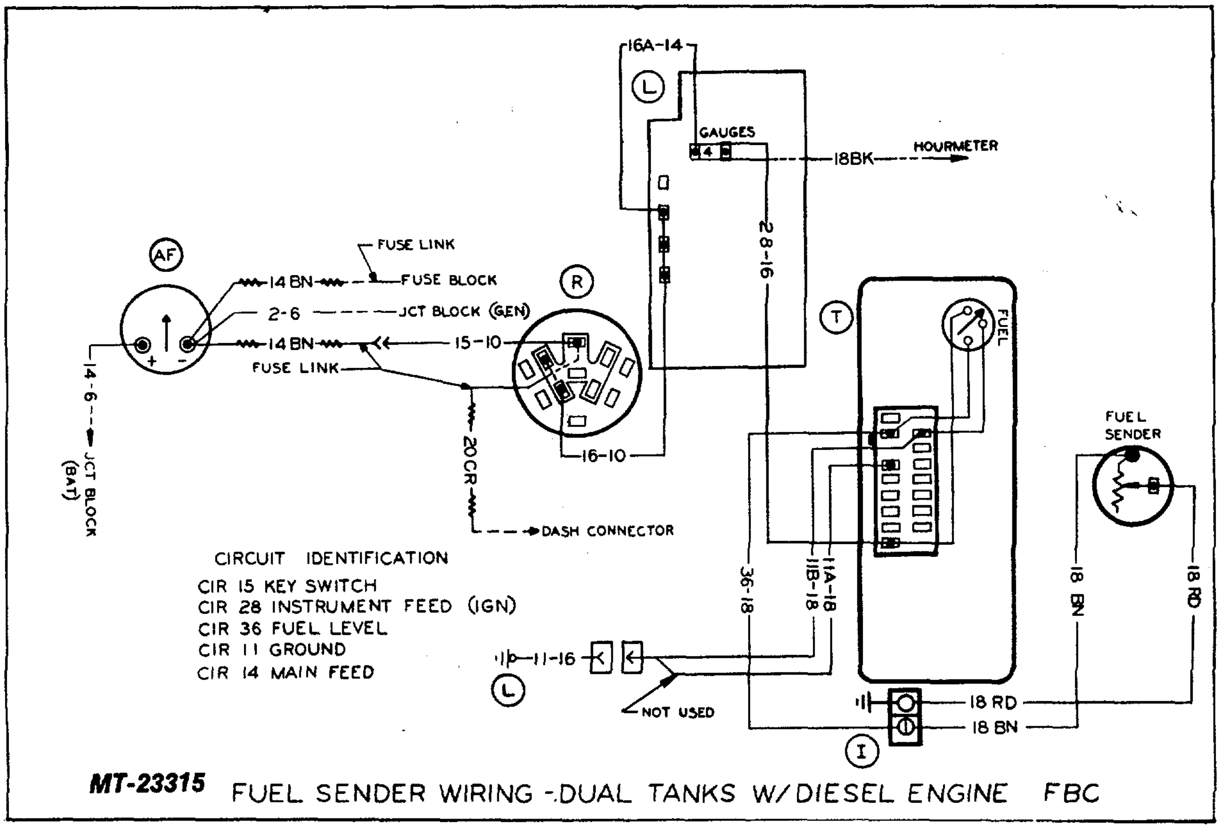


CIRCUIT IDENTIFICATION

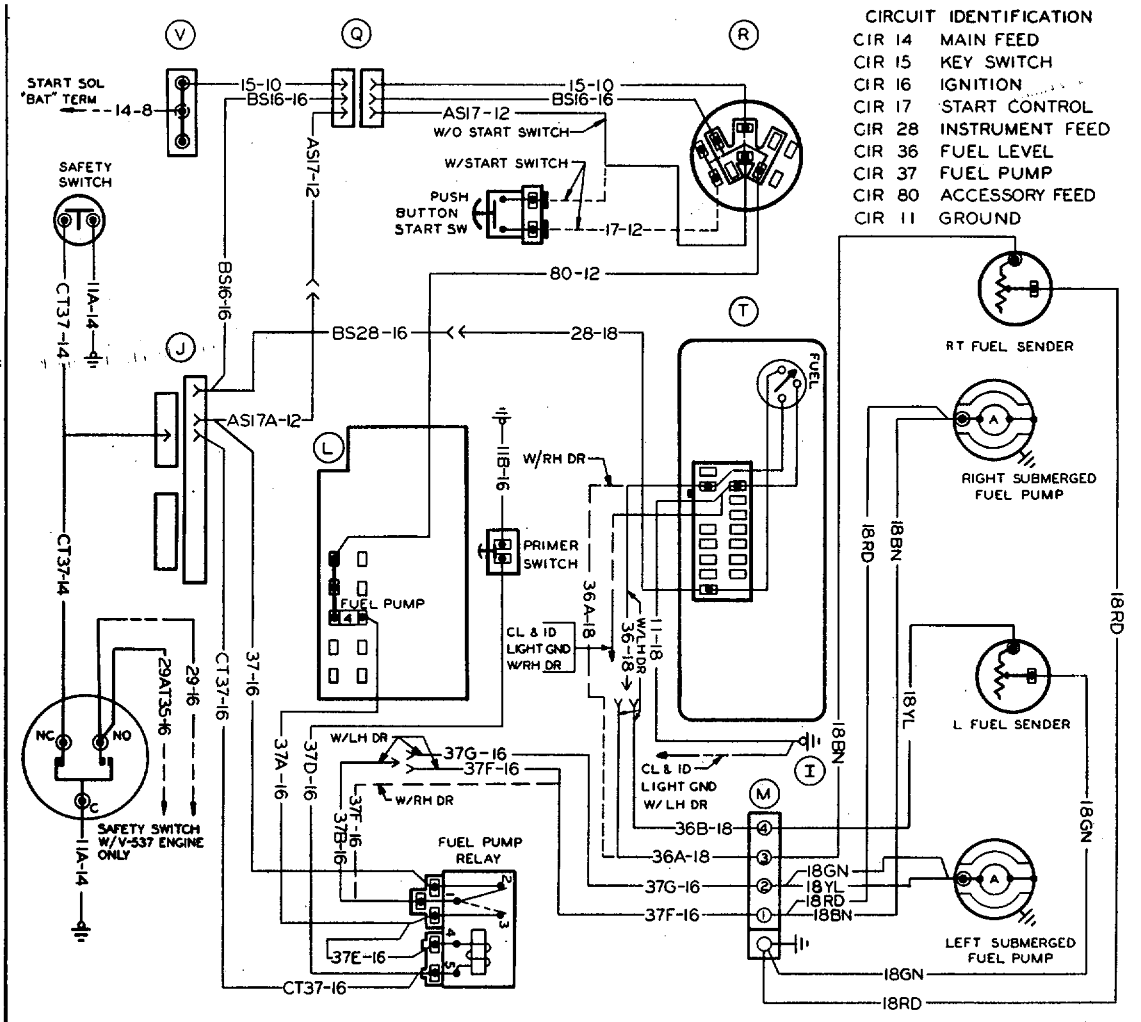
CIR 15 KEY SWITCH	CIR 28 INSTRUMENT FEED
CIR 16 IGNITION	CIR 36 FUEL LEVEL
CIR 14 MAIN FEED	CIR 11 GROUND
CIR 80 ACCESSORY FEED	

DUAL SENDERS W/DUAL FUEL TANKS W/O FBC MT-21990
GAS ENGINES ONLY

CIRCUIT DIAGRAMS



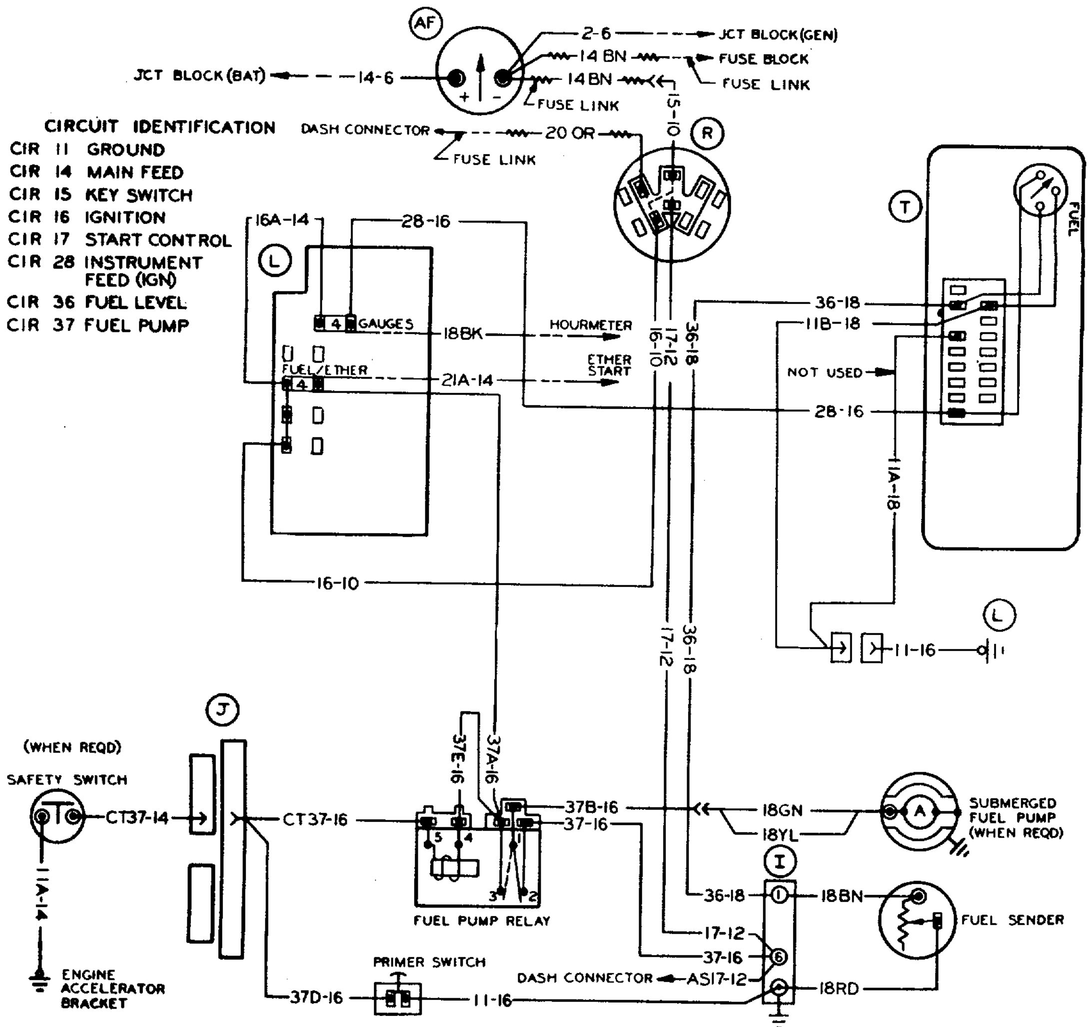
CIRCUIT DIAGRAMS



FUEL SENDER & SUBMERGED FUEL PUMP WIRING
W SINGLE LEFT OR RIGHT SIDE FUEL TANKS 1600 THRU 2100, 2500, 2600

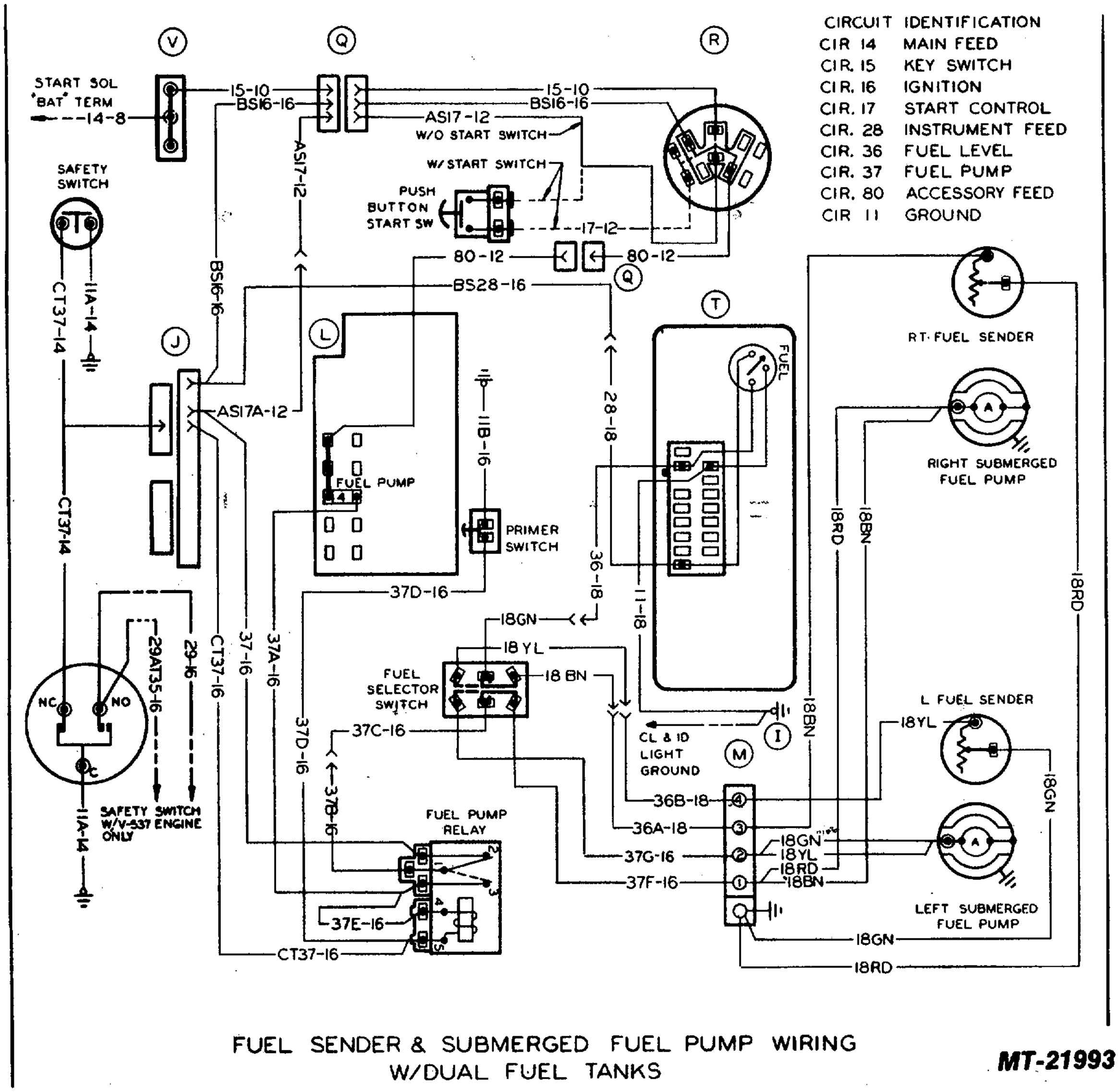
MT-21991

CIRCUIT DIAGRAMS



MT-23316 FUEL SENDER & SUBMERGED FUEL PUMP WIRING FBC/BUS

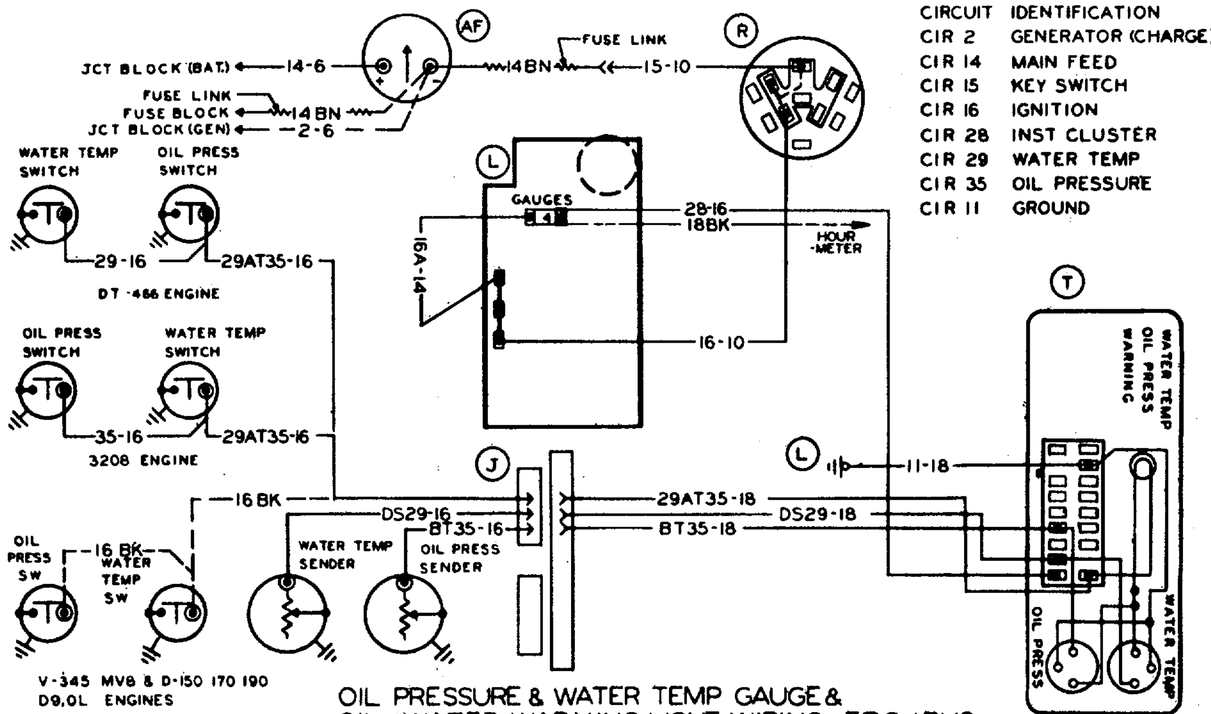
CIRCUIT DIAGRAMS



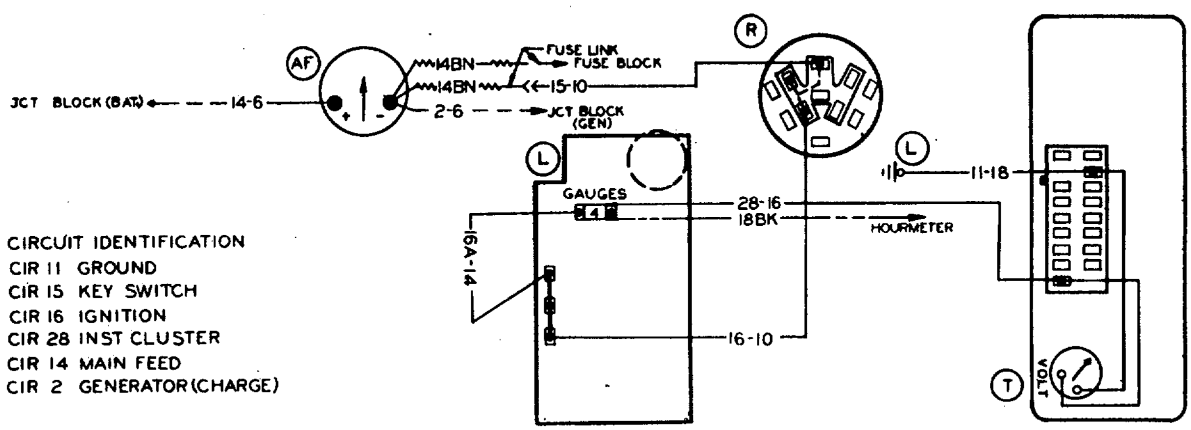
FUEL SENDER & SUBMERGED FUEL PUMP WIRING
W/DUAL FUEL TANKS

MT-21993

CIRCUIT DIAGRAMS



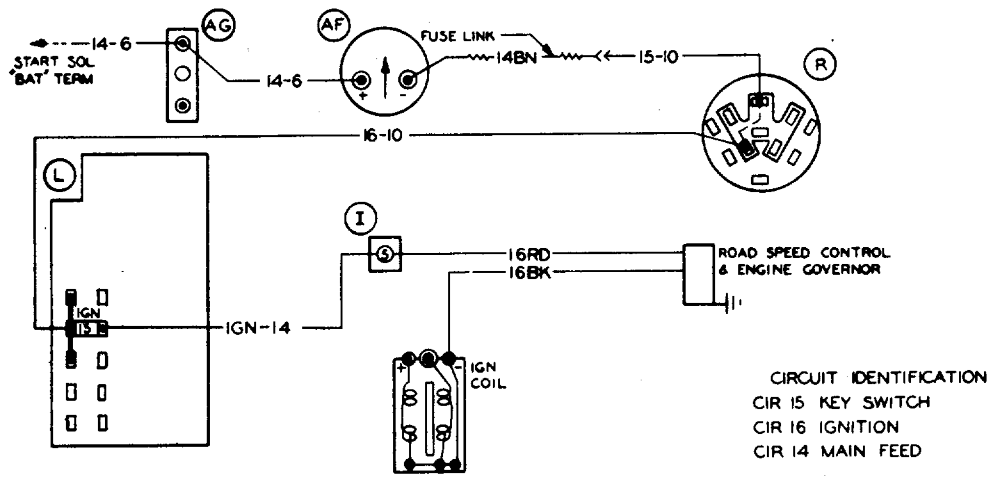
OIL PRESSURE & WATER TEMP GAUGE & OIL/WATER WARNING LIGHT WIRING FBC/BUS



VOLTMETER WIRING FBC/BUS

MT-23307

CIRCUIT DIAGRAMS



ROAD SPEED CONTROL 8 ENGINE GOVERNOR
W/V-345, V-392 & MV8 ENGINES W/FBC/BUS

MT-23303

CIRCUIT DIAGRAMS

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CIRCUIT DIAGRAMS

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NOTES

IMPORTANT U.S.A. ONLY

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SECTION II

TRUCK SERVICE MANUAL

S-SERIES
VOLUME 1

CTS-2311

CTS-2311 SERVICE MANUAL

S-SERIES

VOLUME 1 **CHECK LIST**

CT-2311 SERVICE MANUAL

S-SERIES

AXLE-FRONT

FRONT AXLE ALIGNMENT SPECIFICATIONS

1978 - 1979 - 1980

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

Introduction

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

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

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

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

Caster Measurement and Correction

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

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

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

1. Positive frame angle should be subtracted from specified setting.

2. Negative frame angle should be added to specified setting.

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

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

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

IMPORTANT

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

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

Checking and Correcting Front Wheel Toe-In

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

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

IMPORTANT

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

SPECIAL INSTRUCTIONS

Before attempting front alignment procedures observe the following:

A. Caster angles are for an unladen (no payload) vehicle. If frame is not level, the frame angle must be added to -front high - or subtracted from - front low - the caster angle to obtain true caster reading.

B. Caster angle difference between left and right wheel not to exeed 0 deg. 30 minutes.

C. Toe-In dimension may be measured from center of tread, or from inside of tire.

D. Tolerance unless otherwise noted:

1. Caster - plus or minus 0 deg. 30 minutes except Scout II & Cargostar which is plus or minus 1 deg. 0 min.
2. Toe-In plus or minus 1/16 inch.
3. Camber - plus or minus 0 deg. 30 minutes.

E. After the axle model "P/S" = Power Steering
"M/S" = Manual Steering

FRONT ALIGNMENT SPECIFICATIONS

1978

FRONT ALIGNMENT SPECIFICATIONS

CHASSIS MODEL	AXLE MODEL	CASTER		TOE - IN		CAMBER		KING PIN INCLINATION (DEGREE)	
		DEGREE	MINUTES	INCH	MM	DEGREE	MINUTES	LT.	RT.
SCOUT II	FA-3	0	0	3/32 to 5/16	1.59 to 7.94	1	0	8 1/2	8 1/2
	FA-44	0	0	3/32 to 5/16	1.59 to 7.94	1	0	8 1/2	8 1/2
LOADSTAR	FA-54	0	0	1/16	1.59	1	0	8	8
	FA-64	2	0	1/16	1.59	0	±30	0	0
	FA-71	2	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-73	2	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-78	2	0	0 to 3/8	0 to 9.53	0	±30	0	0
	FA-79	2	0	0 to 3/8	0 to 9.53	0	±30	0	0
	FA-101	2	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-109	1	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4/12
	FA-139	1	0	1/16	1.59	LT.0 RT.0	30 15	4 1/4	4 1/2
	FA-309	1	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-329	1	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-339	2	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-342	1	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
CARGOSTAR	FA-74	3	30	1/8	3.15	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-103	3	30	1/8	3.15	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-109	3	30	1/8	3.15	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-139	3	30	1/8	3.15	LT. 0 RT. 0	30 15	4 1/4	4 1/2

FRONT ALIGNMENT SPECIFICATIONS (Cont'd.)

1978

FRONT ALIGNMENT SPECIFICATIONS

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

FRONT ALIGNMENT SPECIFICATIONS (Cont'd.)

1978

FRONT ALIGNMENT SPECIFICATIONS

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

FRONT ALIGNMENT SPECIFICATIONS (Cont'd.)

1978

FRONT ALIGNMENT SPECIFICATIONS

CHASSIS MODEL	AXLE MODEL	CASTER		TOE - IN		CAMBER		KING PIN INCLINATION (DEGREE)	
		DEGREE	MINUTES	INCH	MM	DEGREE	MINUTES	LT.	RT.
FLEETSTAR (Cont.) (4x2)	FA-309	1	30	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
(6x4)	FA-309	3	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
(4x2)	FA-329	1	30	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
(6x4)	FA-329	3	0	1/16	1.59	LT. 0 RT. 0	30 15	4 14	4 1/2
(4x2)	FA-339	1	30	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
(6x4)	FA-339	3	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
(4x2)	FA-340	1	30	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
(6x4)	FA-340	3	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
PAYSTAR	FA-191	3	30	1/16	1.59	0	-15	0	0
	FA-192	3	30	1/16	1.59	0	-15	0	0
	FA-193	3	30	1/16	1.59	0	-15	0	0
	FA-194	3	30	1/16	1.59	0	45	5 1/2	5 1/2
	FA-195	3	30	1/16	1.59	0	45	5 1/2	5 1/2
	FA-231	3	30	1/16	1.59	LT. 0 RT. 0	30 0	5 3/4	6 1/4
	FA-232	3	30	1/16	1.59	LT. 0 RT. 0	30 0	5 3/4	6 1/4
	FA-233	3	30	1/16	1.59	LT. 0 RT. 0	30 0	5 3/4	6 1/4
	FA-237	3	30	1/16	1.59	LT. 0 RT. 0	30 0	5 3/4	6 1/4
	FA-238	3	30	1/16	1.59	LT. 0 RT. 0	30 0	5 3/4	6 1/4
	FA-239	3	30	1/16	1.59	LT. 0 RT. 0	30 0	5 3/4	6 1/4

FRONT ALIGNMENT SPECIFICATIONS (Cont'd.)

1978

FRONT ALIGNMENT SPECIFICATIONS

CHASSIS MODEL	AXLE MODEL	CASTER		TOE - IN		CAMBER		KING PIN INCLINATION (DEGREE)	
		DEGREE	MINUTES	INCH	MM	DEGREE	MINUTES	LT.	RT.
PAYSTAR (Cont.)	FA-339	3	30	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
COF-5370	FA-231	3	30	1/16	1.59	LT. 0 RT. 0	30 0	5 3/4	6 1/4
	FA-232	3	30	1/16	1.59	LT. 0 RT. 0	30 0	5 3/4	6 1/4
	FA-233	3	30	1/16	1.59	LT. 0 RT. 0	30	5 3/4	6 1/4
CONVENTIONAL TRANSTAR	FA-231	0	45	1/16	1.59	LT. 0 RT. 0	30 0	5 3/4	6 1/4
	FA-329	1	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-339	0	45	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-340	0	45	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-341	1	0	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
CO-TRANSTAR	FA-231	1	15	1/16	1.59	LT. 0 RT. 0	30 0	5 3/4	6 1/4
	FA-329	1	30	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-339	1	15	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-340	1	15	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2
	FA-341	1	30	1/16	1.59	LT. 0 RT. 0	30 15	4 1/4	4 1/2

FRONT ALIGNMENT SPECIFICATIONS

1979-1980

FRONT ALIGNMENT SPECIFICATIONS (LEFT HAND DRIVE)

PS = Power Steering
MS = Manual Steering

CHASSIS MODEL	AXLE MODEL	CASTER		TOE IN		CAMBER	
		Degree	Minutes	Inch	MM	Degree	Minutes
Scout	FA-3 - FA-44 1979	0	0	3/32-5/16	1.59-7.94	1	0
	FA-3 - FA-44 1980	2	30	.00-.20	.00-5.08	0	30
Cargostar	FA-74 - FA-103 - FA-109 - FA-139	ALL AXLES		ALL AXLES		ALL AXLES	
	FA-309 - FA-329 - FA-339	3	30	1/8	3.175	LT 0 RT 0	30 15
	FA-231 - FA-232	3	30	1/8	3.175	LT 0 RT 0	30 0
S-Series	FA-64 - FA-78	2	30	.00-.19	.00-5.08	0	45
	FA-71 - FA-73	2	0	1/16	1.59	LT 0 RT 0	30 15
	FA-81	3	0	.00-.19	.00-5.08	0	45
	FA-82 - FA-83	2	30	.00-.30	.00-7.62	0	15
	FA-101	2	30	1/16	1.59	LT 0 RT 0	30 15
	FA-109	(PS) 3 (MS) 2	30 30	1/16	1.59	LT 0 RT 0	30 15
	FA-118 - FA-127	(PS) 3 (MS) 2	30 30	1/16	1.59	LT 0 RT 0	30 15
	FA-139	(PS) 3 (MS) 2	45 45	1/16	1.59	LT 0 RT 0	30 15
	FA-226	(PS) 3 (MS) 2	0 0	1/16	1.59	LT 0 RT 0	30 0
	FA-231 - FA-232 - FA-233	3	15	1/16	1.59	LT 0 RT 0	30 0
	FA-309 - FA-329	(PS) 3 (MS) 2	30 30	1/16	1.59	LT 0 RT 0	30 15
	FA-339 - FA-340	(PS) 3 (MS) 2	45 45	1/16	1.59	LT 0 RT 0	30 15
	FA-341	(PS) 3 (MS) 2	30 30	1/16	1.59	LT 0 RT 0	30 15

FRONT ALIGNMENT SPECIFICATIONS (Cont'd.)

1979-1980

FRONT ALIGNMENT SPECIFICATIONS (LEFT HAND DRIVE)

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

FRONT ALIGNMENT SPECIFICATIONS (Cont'd.)

1979-1980

RIGHT HAND DRIVE

1980 PRODUCTION ONLY

SERIAL NOS. KH 10001 AND UP = SPRINGFIELD
KG 10001 AND UP = FORT WAYNE
KC 10001 AND UP = CHATHAM

IMPORTANT

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

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

FRONT ALIGNMENT SPECIFICATIONS (Cont'd.)

1979-1980

KING PIN INCLINATION

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

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

*Top of King Pin Hole tilted outboard in I-Beam.

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AXLE-FRONT

IH MODEL	IH CODE
FA-64	02064
FA-78	02078
FA-81	02081

CONTENTS

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DESCRIPTION

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

Complete Overhaul

1. Jack up truck until load is removed from the springs and place floor jack under frame to safely secure truck weight off axle.

2. Drain lubricant from housing.

3. Disconnect brakes.

4. Disconnect drag link from ball stud bracket .

5. Disconnect propeller shaft from pinion shaft yoke.

6. Support axle on portable floor jack and remove spring bolts.

7. Roll axle out from truck and position on stationary floor jacks.

8. Remove tires and rims or disc wheels as appropriate.

DISASSEMBLY

Differential

1. To remove differential carrier from axle housing remove mounting nuts from carrier to axle housing flange.

2. Use puller screws provided in carrier mounting flange to start carrier from housing.

3. Support weight of carrier safely on roller type floor jack or portable floor lift and roll jack and carrier out from under truck.

4. Mount differential carrier in rebuild stand .

5. Remove cotter pins from bearing adjuster locks and remove locks from bearing caps.

6. Match mark one differential bearing cap and leg of carrier with punch or chisel to identify each for correct reassembly.

7. Remove bearing cap bolts and take off the bearing caps and bearing adjusters (Fig. 1).

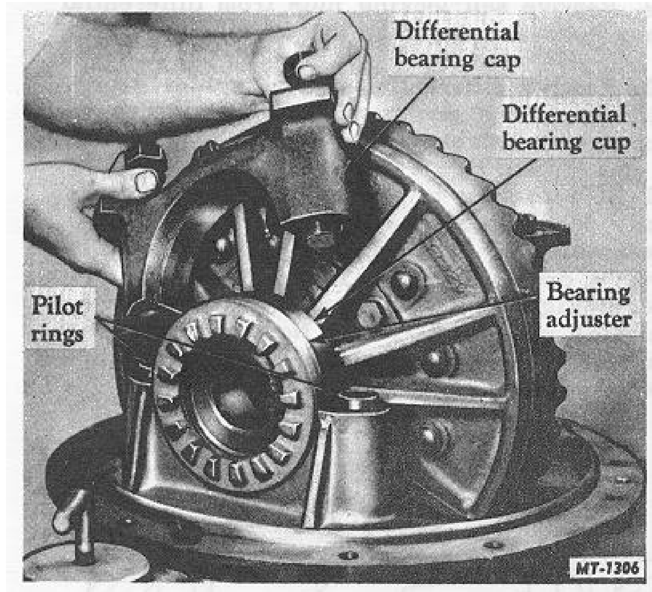

Fig. 1 Removing Differential Bearing Caps

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

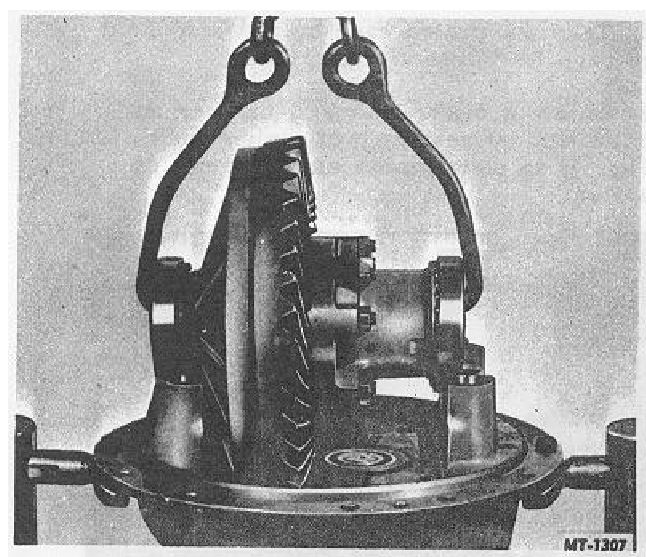

Fig. 2 Lifting Differential from Carrier

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

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9. Remove self-locking nuts from differential case bolts and separate the case halves.

10. Remove differential spider, spider gears, side gears and thrust washers from differential case halves.

11. If necessary to remove drive gear, carefully center punch each rivet head on drive gear side and drill through the rivet head with a drill .79 mm (1/32") smaller than rivet body (Fig. 3). Use a punch to press out remaining portion of rivet. Never use chisel to cut off rivet heads or damage to case might result.

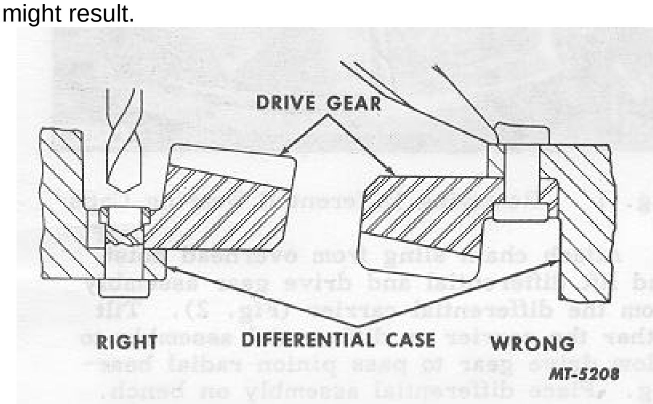

Fig. 3 Drive Gear Rivet Removal

12. Take out pinion cage bolts which hold the cage to differential carrier.

13. Obtain a brass drift and hammer and strike against rear face of pinion shaft (Fig. 4) to start pinion and cage out of carrier.

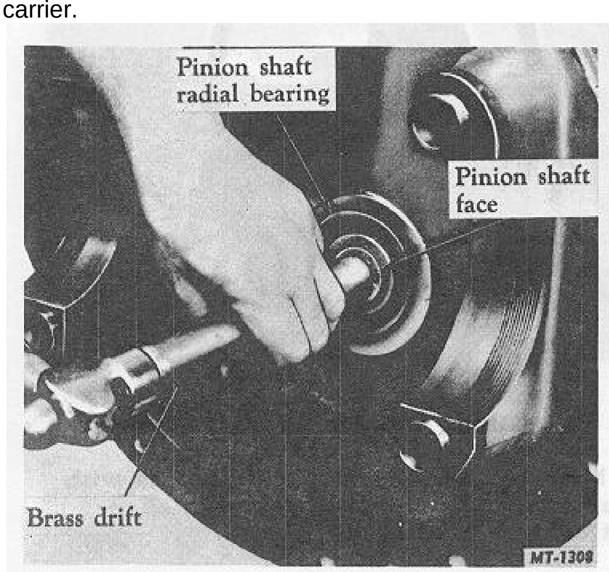

Fig. 4 Loosening Pinion and Cage from Carrier

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

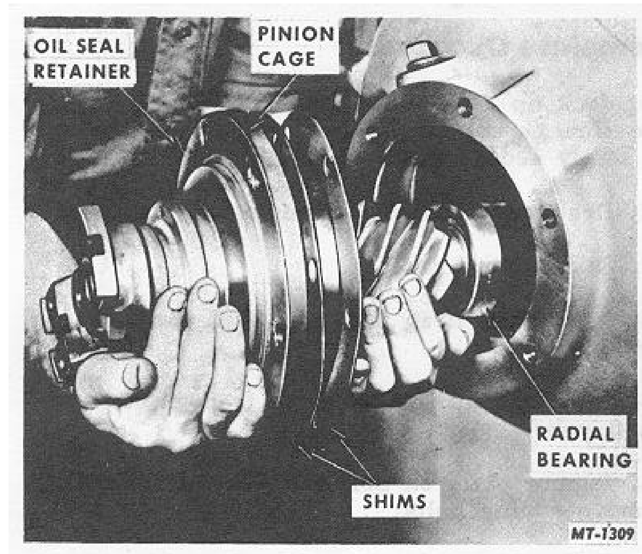

Fig. 5 Removing Pinion and Cage Assembly

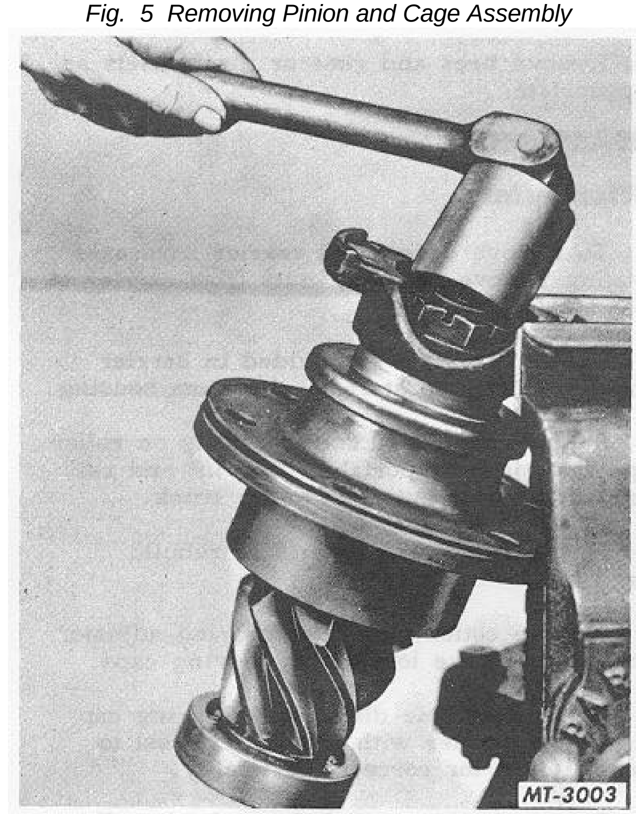

Fig. 6 Removing Pinion End Nut

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

16. Drive the pinion assembly from the companion flange with a soft hammer. Do not allow pinion assembly to fall.

17. Remove pinion cage "O" ring type seal (Fig. 7).

18. Tap pinion from cage and remove forward thrust bearing.

19. Remove the thrust bearing spacer from the pinion shaft.

20. If it is necessary to remove the rear thrust bearing or the radial bearing from the pinion shaft; remove these bearings with a suitable puller.

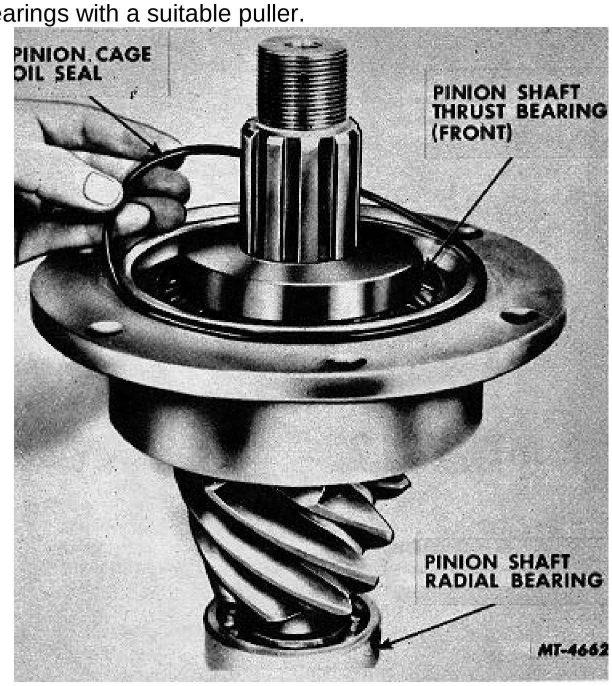

Fig. 7 Removing Pinion Cage Oil Seal

CLEANING, INSPECTION AND REPAIR

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

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

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

REASSEMBLY

Differential

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

1. Preload the pinion bearings.

2. Establish the pinion nominal dimension.

3. Set gear lash.

4. Preload the differential bearings.

5. Check the gear tooth contact.

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

1. Press rear thrust bearings (6) firmly against shoulder of pinion shaft (12).

2. Press radial bearing (13) on stub end of pinion shaft (12) and against pinion. Stake face of pinion evenly in six places to secure radial bearing in place (Fig. 9).

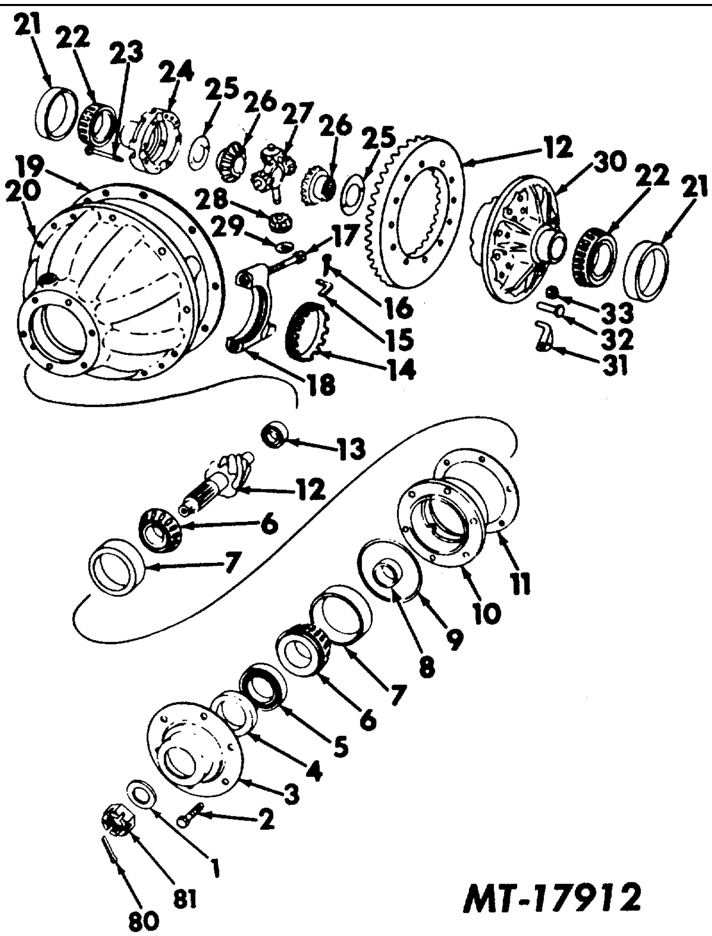

Fig. 8 Differential (Exploded View)

LEGEND FOR FIG. 8

Key	Description	Key	Description
1	WASHER	19	GASKET, differential carrier
2	BOLT, hex-hd.	20	CARRIER, differential
3	RETAINER, pinion oil seal	21	BEARING, Differential cup
4	SEAL, pinion oil (felt)	22	BEARING, differential cone
5	SEAL, pinion oil	23	BOLT, differential case
6	BEARING, pinion cone	24	CASE, differential
7	BEARING, pinion cup	25	WASHER
8	SPACER, pinion bearing	26	GEAR, differential side
9	SEAL, pinion bearing cage (cork)	27	SPIDER, differential
10	CAGE, pinion bearing	28	PINION, differential
11	SHIM, pinion bearing cage	29	WASHER, differential pinion
12	GEAR SET, ring and pinion	30	CASE, differential
13	BEARING, pinion pilot	31	SCOOP, oil
14	ADJUSTER, differential bearing	32	RIVET, ring gear
15	LOCK, differential bearing adjuster	33	NUT, hex.
16	PIN, cotter		
17	BOLT, bearing cap		
18	CAP, bearing		

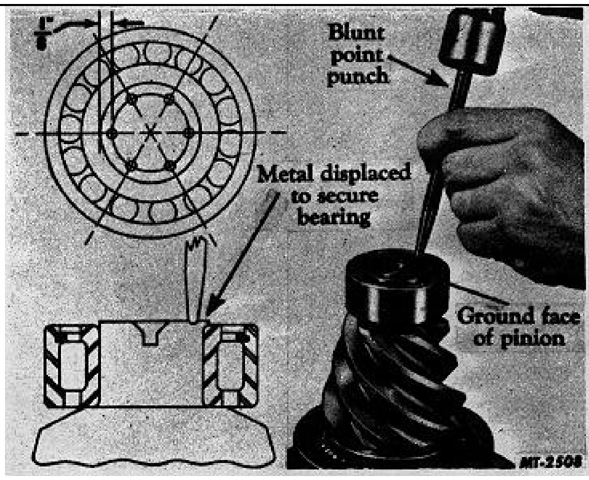

Fig. 9 Staking Pinion Straddle Bearing

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

3. If bearing cups (7) have been replaced, press new cups firmly against shoulders of pinion cage (10).

4. Prelubricate the bearings with gear lubricant.

5. Position spacer (8) on pinion shaft and against rear thrust bearing.

6. Insert pinion and rear thrust bearing (6) in pinion cage.

7. Mount pinion and cage in arbor press and place pre-lubricated front thrust bearing (6) on pinion shaft. Press bearing firmly and squarely against spacer.

Pinion Bearing Preload

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

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

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

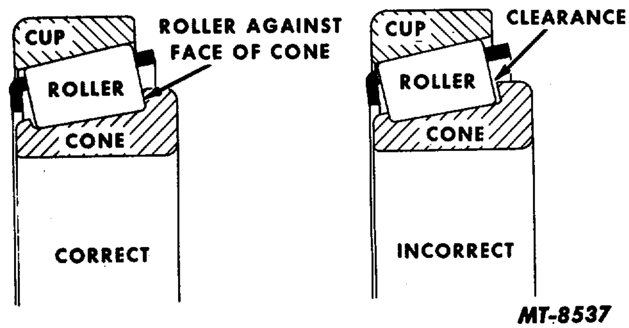

Fig. 10 Pinion Bearing Roller Position

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

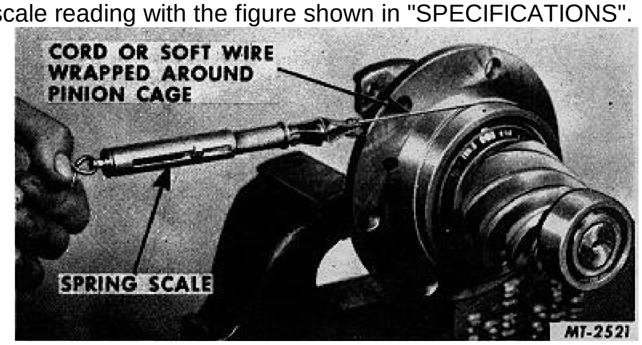

Fig. 11 Measuring Pinion Bearing Preload

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

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

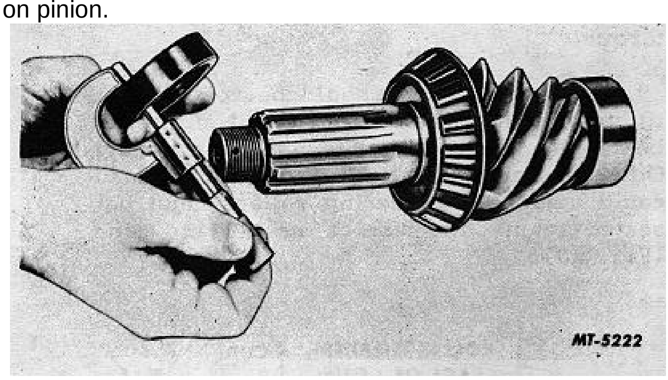

Fig. 12 Measuring Spacer Thickness

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

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

Pinion Nominal Dimension

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

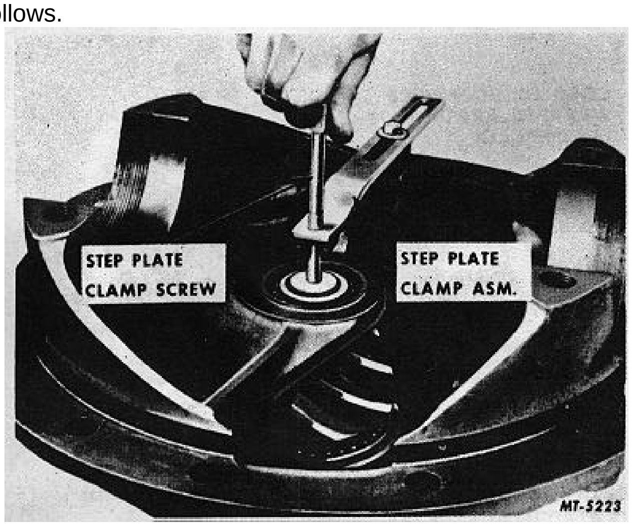

Fig. 13 Locating Step Plate Clamp

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

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

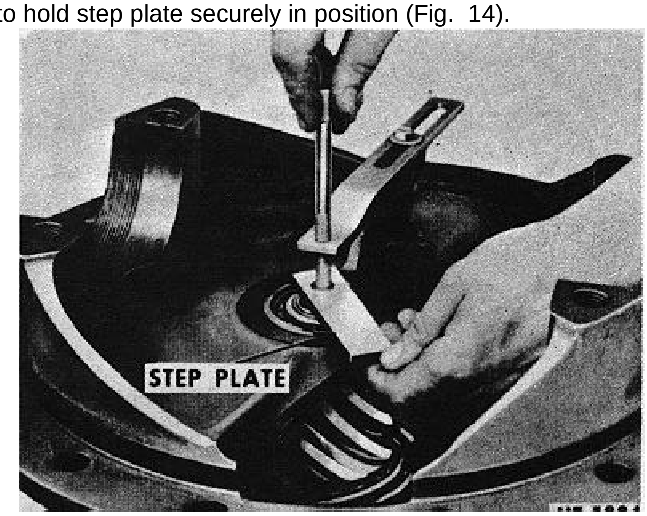

Fig. 14 Installing Step Plate

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

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

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

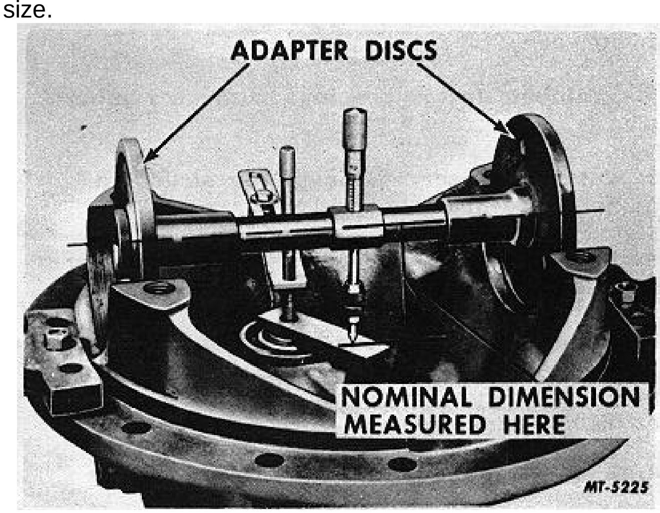

Fig. 15 Assembled Gauge in Position

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

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

20. Remove gauge and prepare to install ring gear and differential carrier in differential housing.

21. If drive gear was removed from case, rivet gear to case flanged half.

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

22. Apply axle lubricant to differential case inner walls and all other component parts.

23. Place thrust washer (25) and side gear (26) in flanged half of case together with spider (27), pinion gears (28) and thrust washers (29).

24. Install opposite side gear and thrust washer in differential case plain half (24).

25. Align the match marks and join the two differential case halves. Draw assembly together with four equally spaced bolts (23) and nuts (33).

26. Check assembly for free rotation of side gears and pinions and if satisfactory, install remaining differential case bolts. Tighten to torque specified in "TORQUE CHART".

27. Differential bearings (22) are installed by pressing them squarely onto differential case halves.

28. Prelubricate differential bearings with axle lube and place bearing cups (21) over bearings. Attach chain sling to differential assembly and install in carrier.

29. Place bearing adjusters (14) in carrier and turn hand tight against bearing cups (21).

30. Observe match marks on bearing caps and install caps onto legs of differential carrier (20).

31. Install bearing cap bolts(17) and washers. Tighten to specified torque. (See "TORQUE CHART".)

32. Tighten bearing adjusters (14) alternately until all end play is eliminated. Rotate differential while tightening.

Gear Lash

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

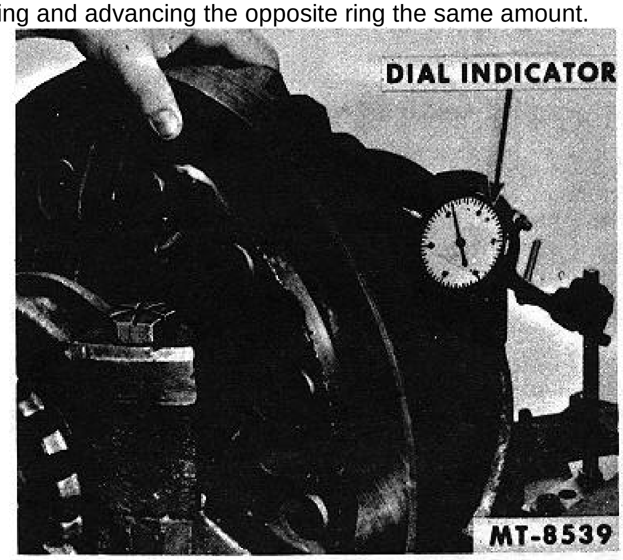

Fig. 16 Setting Correct Backlash

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

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

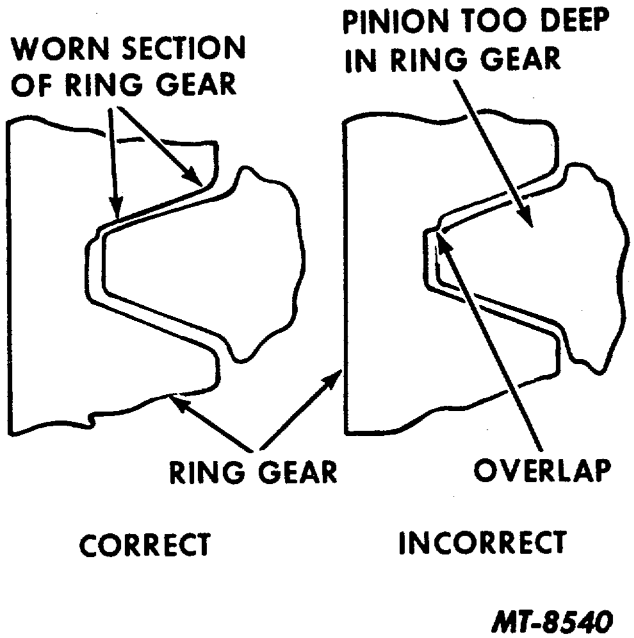

Fig. 17 Correct and Incorrect Lash Adjustment where worn Gears are Reinstalled

Differential Bearing Preload

35. To set the bearing preload, mount dial indicator at side of ring gear (Fig. 18). With the bearing capscrews loosened to permit bearing movement, loosen adjusting nuts only enough to notice end play on indicator.

36. While gear is held in .000" end play and before loading bearings, check gear for runout by revolving ring gear. If runout exceeds 20 mm (.008"), remove differential and check for cause. 37. Tighten both adjusting nuts from .000" end play to preload the differential bearings (see "SPECIFICATIONS").

38. Tighten bearing cap, capscrews or stud nuts to specified torque (see "TORQUE CHART").

39. Recheck gear lash to make certain that the lash setting has not been changed.

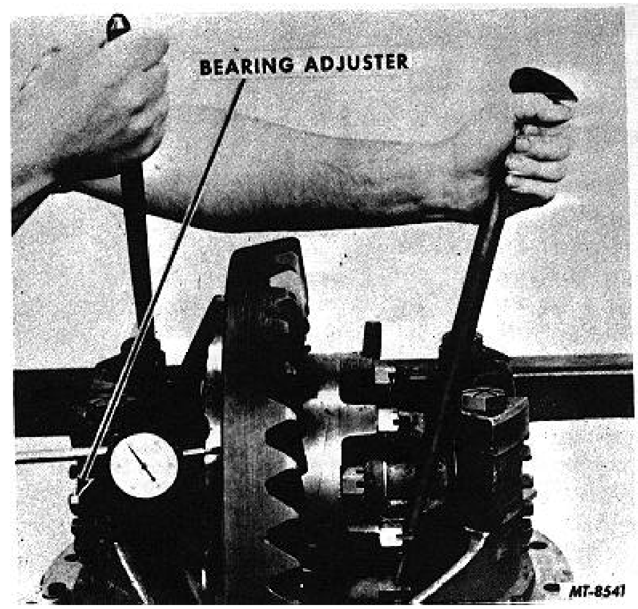

Fig. 18 Adjusting Bearing Preload

40. Install adjusting rings locks and cotter pins.

Gear Tooth Contact

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

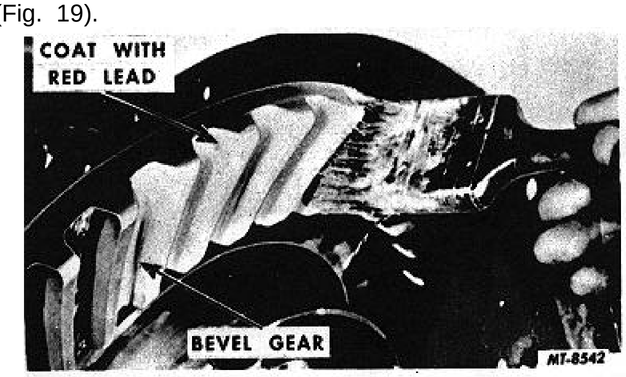

Fig. 19 Painting Gear Teeth for Obtaining Tooth Contact Impressions

42. When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts (Fig. 20).

43. Sharper impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the gear teeth. Coast side should be correct when drive side is correct. Generally, coating approximately

twelve teeth is sufficient for checking purposes

44. With adjustments properly made, a correct tooth contact similar to that shown in Fig. 20, will be secured. The area of contact starts near the toe of the gear and extends about 62 1/2 per cent of the tooth length. This adjustment results in a quiet running gear and pinion set which, because the load is distributed over the teeth within the proper area, will deliver all the long service built into it.

45. When checking paint impressions on gear teeth of an axle under heavy load, the impressions usually spread out somewhat longer than the patterns obtained from a bench test. This can be considered as normal. Ring gears when mounted should show a bearing toward the toe or small end of the tooth, but never at the heel or large end. The reason being that it is practically impossible to make gears and gear mounting so rigid that no deflection will occur when full torque is applied. This deflection causes the bearing to approach the heel of the tooth. When gears are adjusted so that the bearing is toward the heel of the tooth, it results in a concentration of load on the top corner of the heel and breakage will follow.

INSTALLATION

Differential Carrier

46. Using chain sling and overhead hoist, move differential carrier assembly from rebuild stand to roller type floor jack.

47. Place a new carrier to housing gasket (19) on differential carrier (20) and roll carrier into position on the axle housing. Install the housing bolts and lockwashers and tighten to specified torque (See "TORQUE CHART").

Fig. 20 Tooth Contact Impressions

AXLE END DISASSEMBLY
(Wheel, Hub, Drum and Brake Group Removed)

Trunnion Housing Disassembly

1. Slide spindle off Trunni9n Housing Studs, (retaining nuts removed when disassembling brake group). See Fig. 1

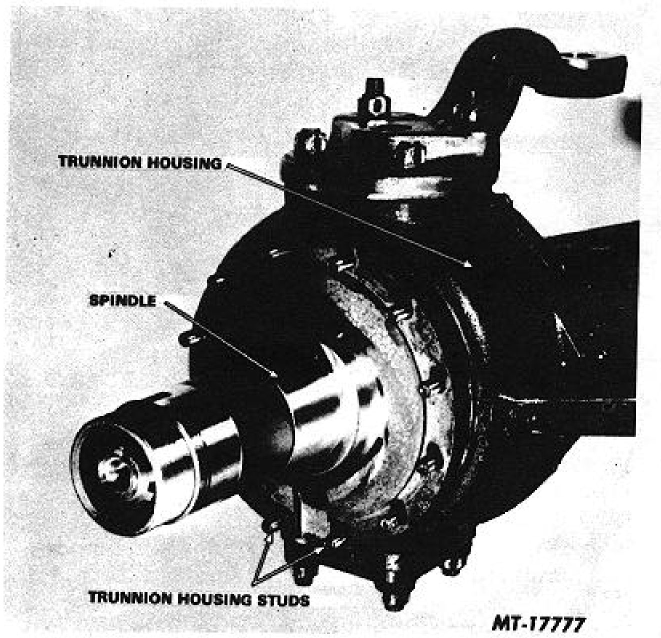

Fig. 1 Removing Spindle

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

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

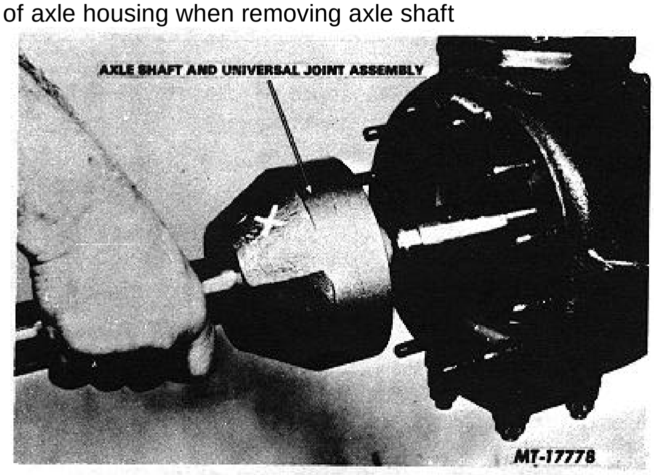

Fig. 2 Removing Axle Shaft and Universal Joint Assembly

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

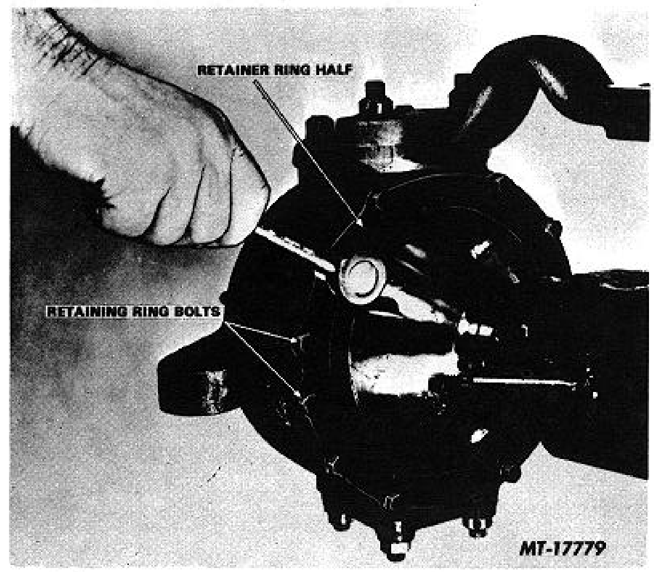

Fig. 3 Removing Retaining Ring Half (Halves) Mounting Bolts

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

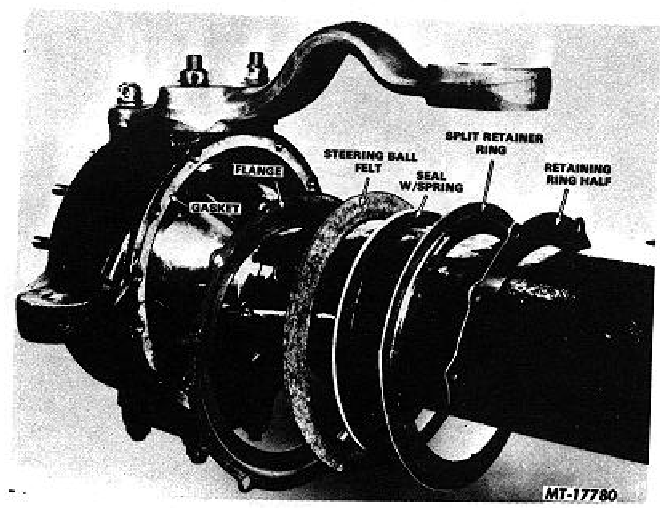

Fig. 4 Trunnion Housing Seals and Retainers

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

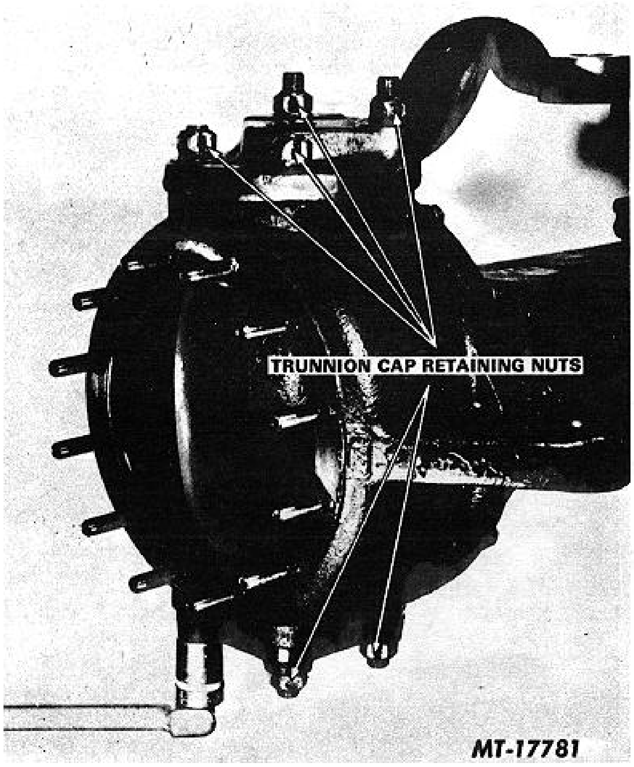

Fig. 5 Trunnion Cap Retaining Nuts

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

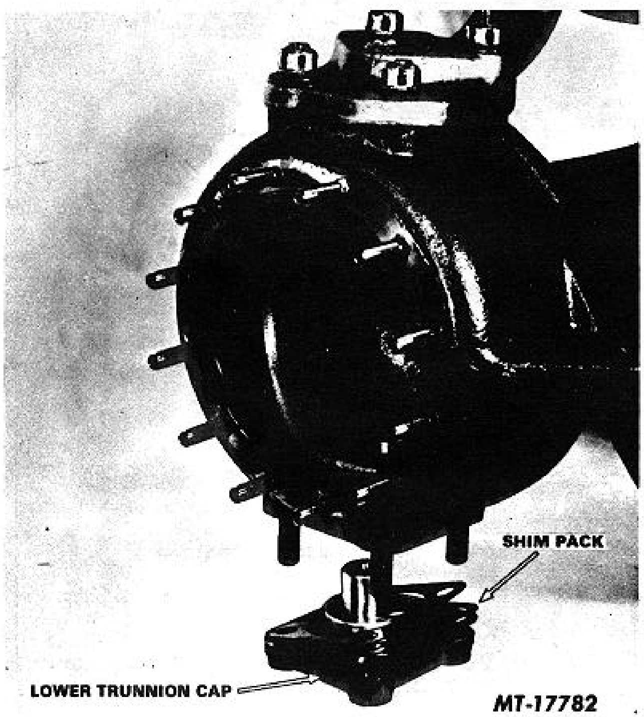

Fig. 6 Trunnion Cap and Shim Pack

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

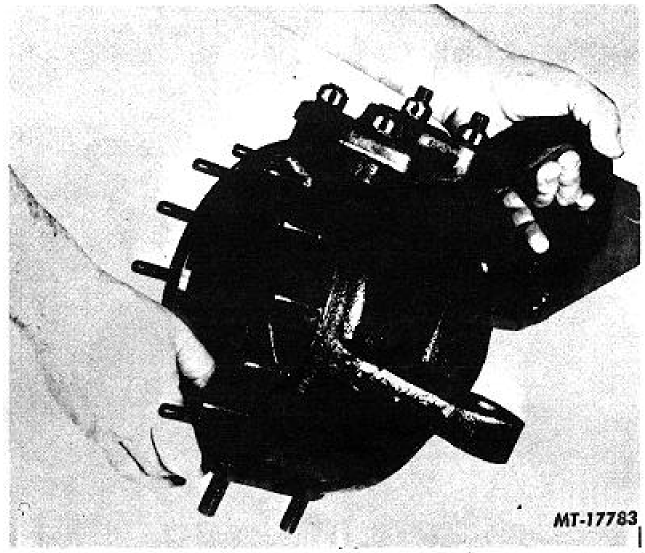

Fig. 7 Removing Trunnion Housing

7. Remove trunnion housing from axle housing by tilting bottom of trunnion housing out and pulling housing upward (Fig. 7).

   The upper trunnion housing bearing will lay loose on upper bearing race of axle housing end when trunnion housing is removed. Remove upper trunnion bearing.

8. Place trunnion housing on workbench and remove upper trunnion cap retaining nuts (previously loosened), lockwashers, trunnion cap and shim pack.

   On trunnion housings equipped with steering arms, remove steering arm retaining nuts exposing tapered dowels shown in Figure 8. Tapered dowels will be used with steering arms only.

9. To remove tapered dowels, work the steering arm back and forth until enough of the dowels are exposed to allow dowels to be gripped with a pliers or other suitable tool.

10. With tapered dowels removed, pull steering arm off of mounting studs and upper trunnion pin (Fig. 9).

    Remove upper trunnion cap shim pack. Retain and mark shim pack for reassembly.

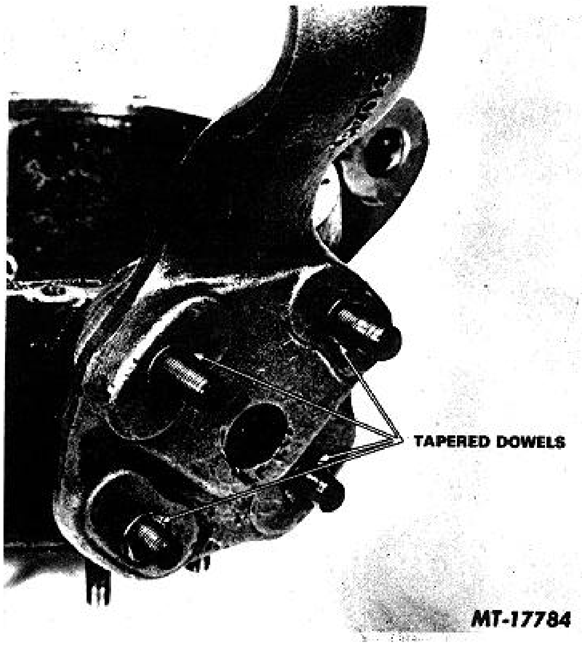

Fig. 8 Tapered Dowels

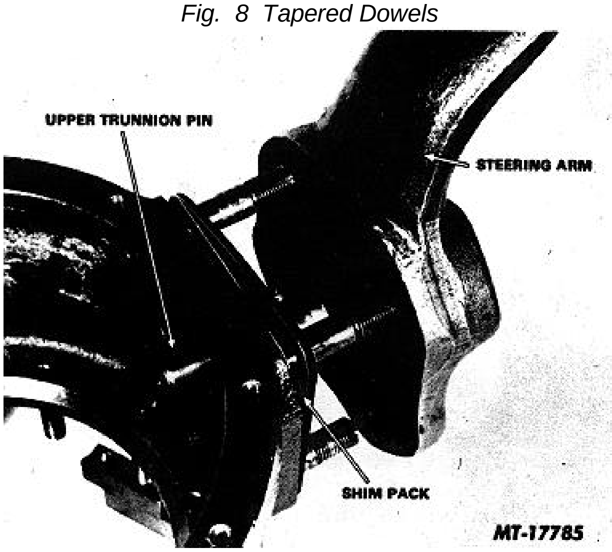

Fig. 9 Steering Arm Removal

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

Axle Shaft and Universal Joint Disassembly

1. Place axle shaft in a vise equipped with soft jaws. Grasp shaft end of universal joint and pull while rapping back side of joint with a soft faced hammer (see Fig. 10).

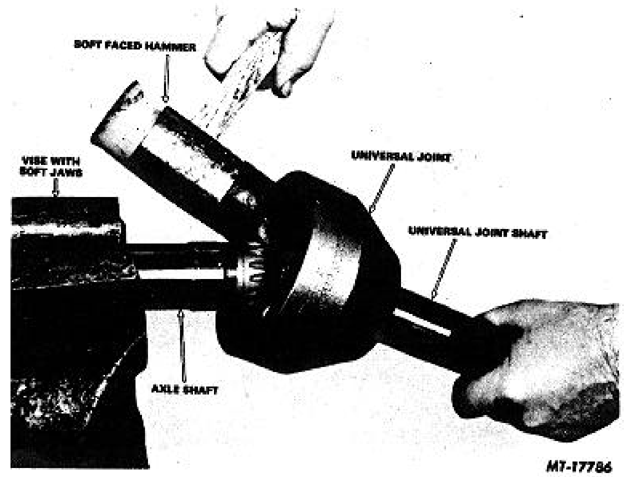

Fig. 10 Axle Shaft and Universal Joint Disassembly

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

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

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

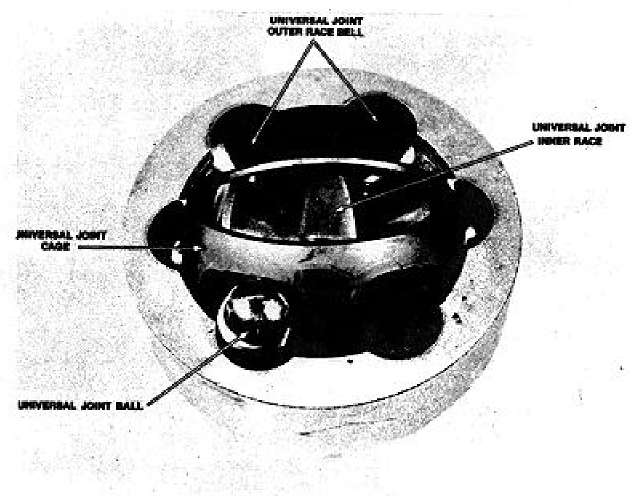

Fig. 11 Removing Universal Joint Balls

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

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

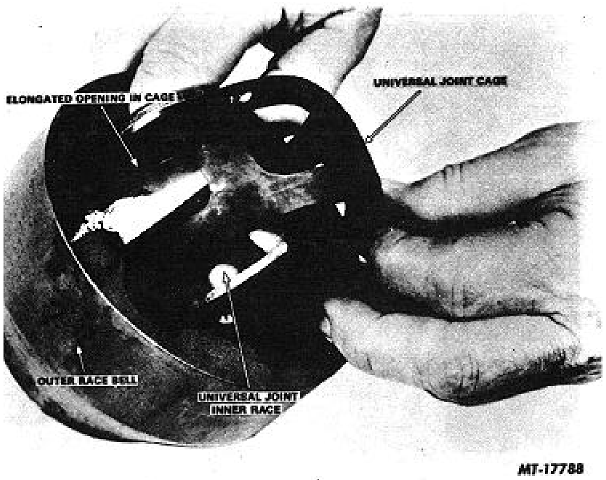

Fig. 12 Removing Cage and Inner Race

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

Cleaning and Inspection

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

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

Inspect axle shaft and universal joint assembly for seizure, broken or chipped balls, broken splines or other damage

Inspect spindle bushing for out of round condition caused by wear or corrosion, scoring or roughness in spots.

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

Inspect for evidence of wear due to improper drive flange shim size. Wear on the interior surface of ball end of axle housing and on edge of ball joint bell housing indicates the use of too thin a shim, allowing contact between the two. If shim is too thick, the spindle bushing will show excessive wear.

Oil Seal and Bearing Replacement

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

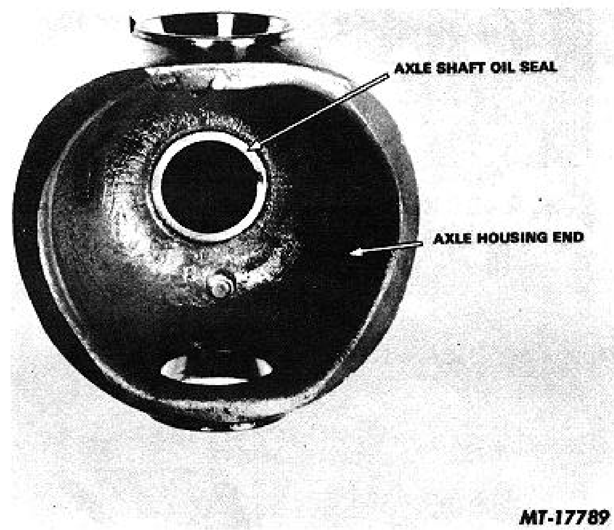

Fig. 13 Axle Shaft Oil Seal

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

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

   Cups and bearings should be replaced as a matched set.

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

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

Fig. 14 Removing Trunnion Bearings Cup

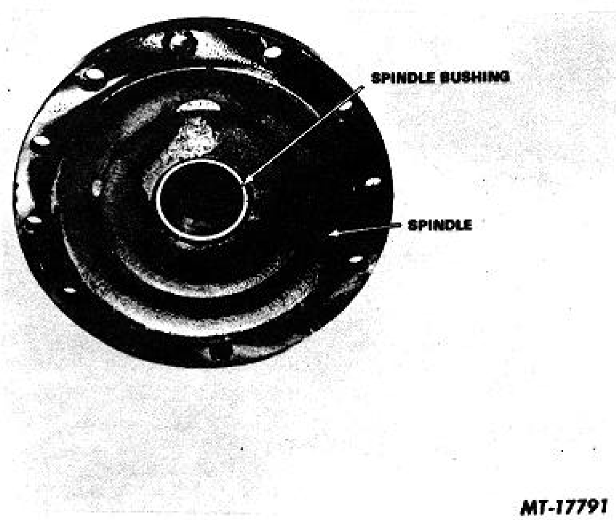

Fig. 15 Spindle Bushing

Axle Shaft and Universal Joint Assembly

1. Assemble inner race and cage by indexing notched tooth of inner race with elongated opening in cage and rolling inner race into cage. See Fig. 16. MT-17792

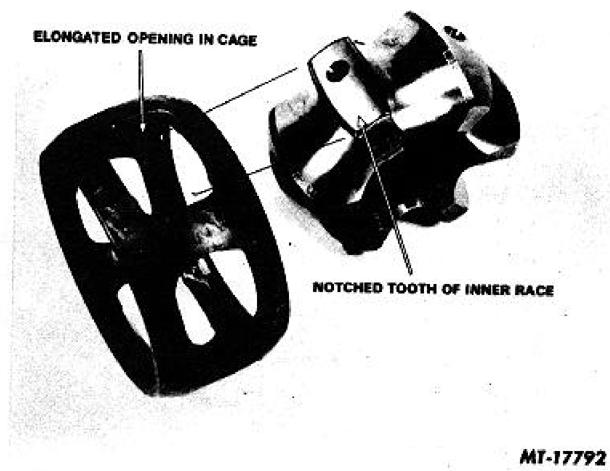

Fig. 16 Assembling Inner Race and Cage

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

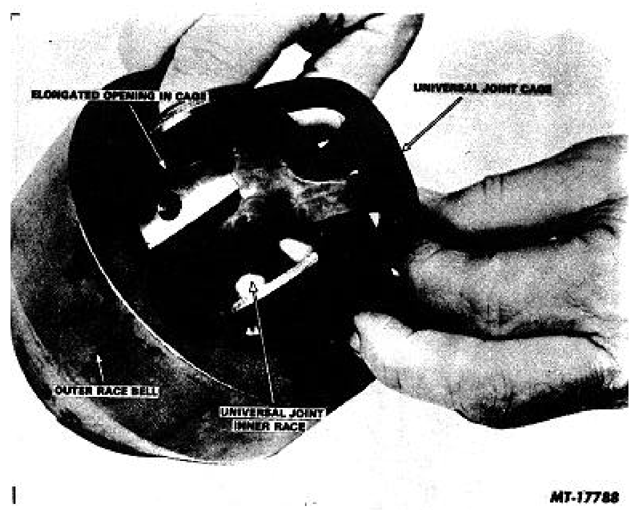

Fig. 17 Assembling Inner Race, Cage and Outer Race Bell

3. Tilt inner race in outer race until one ball can be inserted, continue this procedure until all balls are inserted. Prelubrication of components and a soft faced hammer may be used to aid inner race movement.

4. Install new lock ring on axle shaft end and place axle shaft in a vise equipped with soft jaws. See Fig. 18.

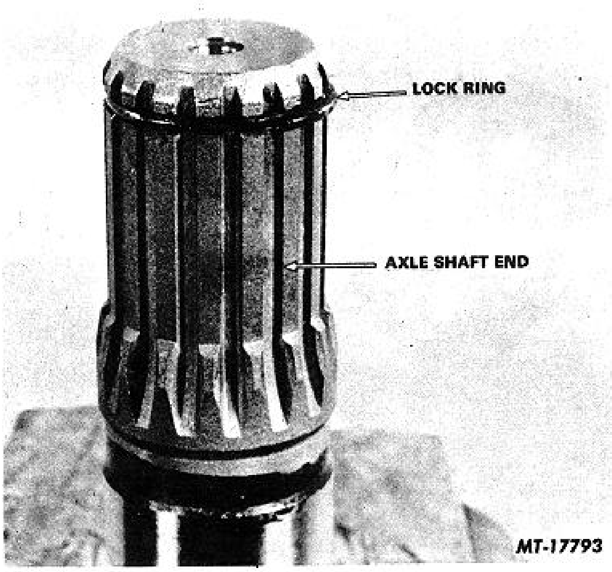

Fig. 18 Axle Shaft Lock Ring

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

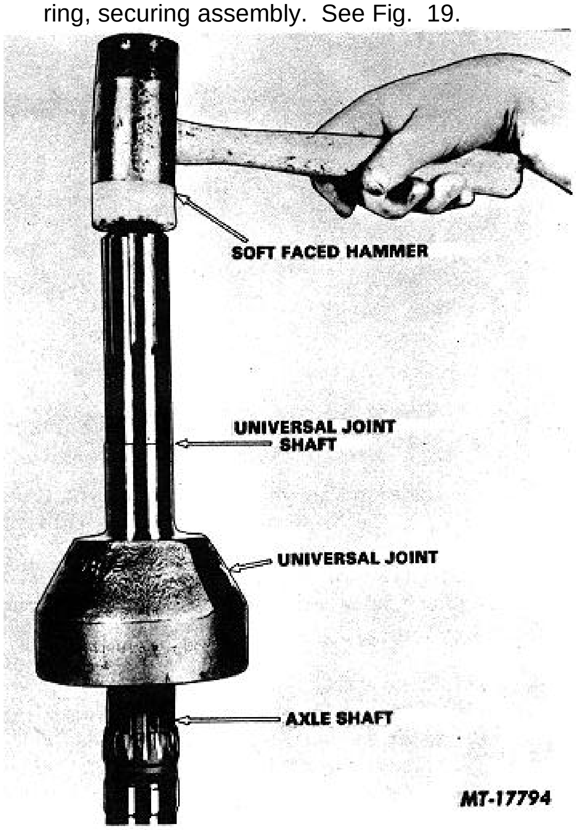

Fig. 19 Assembling Axle Shaft and Universal Joint

6. Pack universal joint bell with lubricant.

Trunnion Housing Assembly

1. Using original shim pack install upper trunnion cap. Torque retaining nuts to 81 to 95 Newton Meters (60 to 70 ft.lbs). On trunnion housings equipped with steering arms, install tapered dowels before installing lockwashers and retaining nuts. Torque retaining nuts to 81 to 95 Newton Meters (60 to 70 ft.lbs.). Refer to Fig. 8.

2. Lubricate trunnion bearings thoroughly. Place a trunnion bearing on upper trunnion bearing cup of axle housing end. Lower trunnion housing into place on axle housing end indexing upper trunnion pin with upper trunnion bearing.

3. Place lower trunnion bearing in bottom of trunnion housing and align with lower bearing cup. Using original shim pack install lower trunnion cap. Torque retaining nuts to 81 to 95 Newton Meters (60 to 70 ft.lbs.).

Fig. 20 Checking Bearing Adjustment

4. Check trunnion bearing adjustment by placing a torque wrench on trunnion cap or steering arm retaining nut and swinging trunnion housing. Torque should be 11 to 20 Newton Meters (8 to 15 ft.lbs.). To increase torque, remove shims, to decrease torque, add shims. See Fig. 20.

5. Install gasket, flange, steering ball felt, seal with spring, split retainer ring and' retaining ring halves on rear of trunnion housing. See Fig. 21 for correct order or component installation.

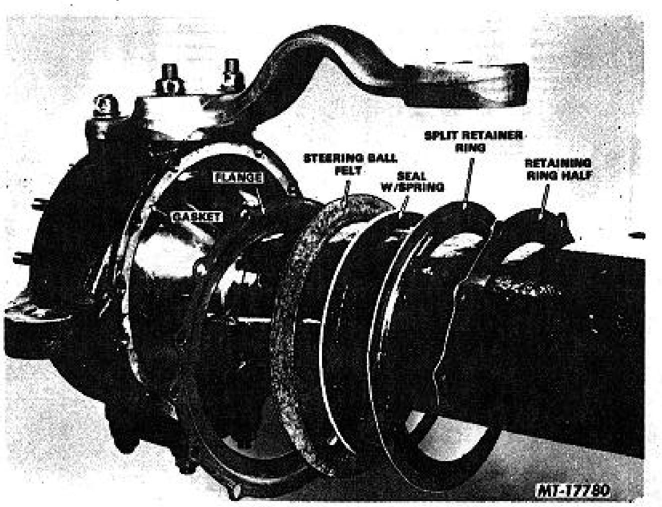

Fig. 21 Trunnion Housing Seals and Retainers

Install retaining half (halves) lockwashers and mounting bolts. Torque mounting bolts ,6 14 to 20 Newton Meters (10 to 15 ft lbs.).

6. Install axle shaft and universal joint assembly in axle housing indexing splined end of axle shaft with side gear of center unit (Fig. 22). When installing axle shaft and universal joint assembly care should be taken not to damage axle shaft oil seal.

7. Slide spindle over universal joint shaft and on to trunnion housing studs.

8. Fill axle housing end with lubricant through grease zerk located behind trunnion housing on top center of exposed portion of steering ball.

9. Axle end assembly is now complete. Spindle is retained to trunnion housing by brake group retaining nuts upon brake group reassembly.

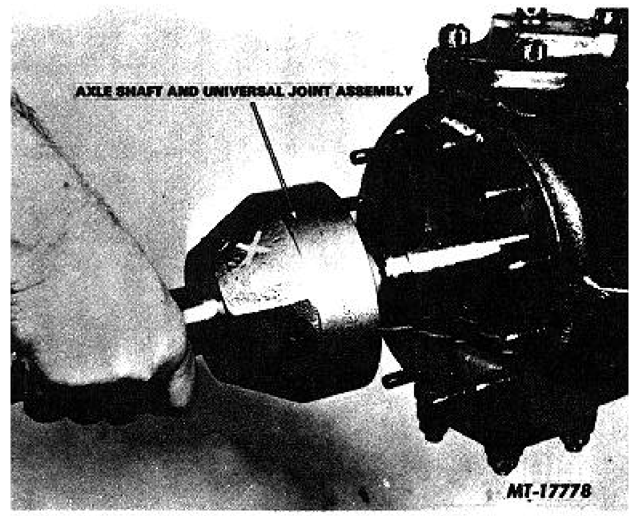

Fig. 22 Axle Shaft and Universal Joint Assembly

SPECIFICATIONS

IH Model	FA-64 FA-78
IH Code	02064 02078
Pinion:	
Drive	Hypoid
Nominal Dimension	82.6 mm (3.2530")
SE-1065-9 Disc	D (2)
Cage Rotating Torque (lbs.)	2.7-7.7 Kg (6-17 lbs.)
Differential:	
Bearing Preload	1 Notch Each Side
Housing:	
Lubricant Capacity	8.2 Liters (17.8 Pints)
Serial Number Location	On Bolt Circle of Differential

TORQUE CHART

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

	Newton Meters	(Ft.Lbs.)	
Pinion Shaft End Nut	441 N-m	(325 ft.lbs.)	
Pinion Cage to Carrier Bolt	136 to 163 N-m	(100 to 120 ft.lbs.)	
Carrier to Housing Bolt	47 to 61 N-m	(35 to 45 ft.lbs.)	
Differential Case Bolts	109 to 122 N-m	(80 to 90 ft.lbs.)	
Bearing Cap to Carrier	203 to 217 N-m	(150 to 160 ft.lbs.)	
Trunnion Cap and Steering Arm to Trunnion Housing Stud	95 to 109 N-m	(70 to 80 ft.lbs.)	
Trunnion Cap and Steering Arm to Trunnion Housing Stud Nut	81 to 95 N-m	(60 to 70 ft.lbs.)	
Seal Retainer Half to Trunnion Housing Bolt	14 to 20 N-m	(10 to 15 ft.lbs.)	
Spindle to Trunnion Housing Stud	41 to 54 N-m	(30 to 4Q ft.lbs.)	
Spindle to Trunnion Housing Stud Nut	34 to 47 N-m	(25 to 35 ft.lbs.)	
Drive Flange to Hub Assy.	Stud Nut	68 to 81 N-m	(50 to 60 ft.lbs.)
Tie Rod Clamp Bolt	88 to 109 N-m	(65 to 80 ft.lbs.)	
Wheel Bearing Adjusting Nut	Tighten inner adjusting nut to 271 to 339 N-m (200 to 250 ft.lbs.) then back off 1/8 to 1/6 turn and bend tab to lock nut in place. Install outer locknut and tighten to 271 to 339 N-m (200 to 250 ft.lbs.) and bend tab to lock nut in place.		

RIVET PRESSURES

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

LUBRICATION

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

LOCKING HUBS

CHAPTER I

WARN LOCKING HUBS

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DUALMATIC LOCKING HUBS

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CHAPTER I

DESCRIPTION

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

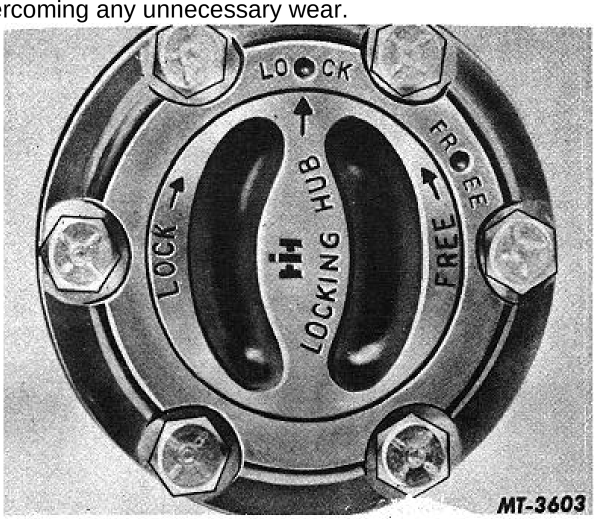

Fig. 1 Locking Hub (Manual Type)

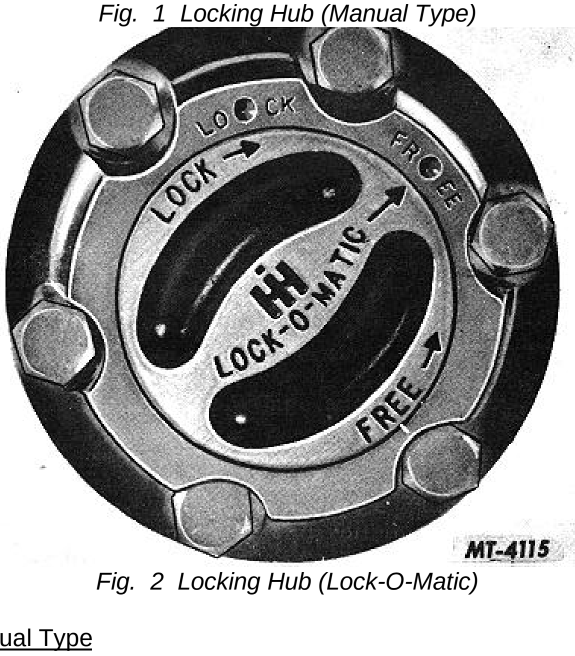

Fig. 2 Locking Hub (Lock-O-Matic)

Manual Type

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

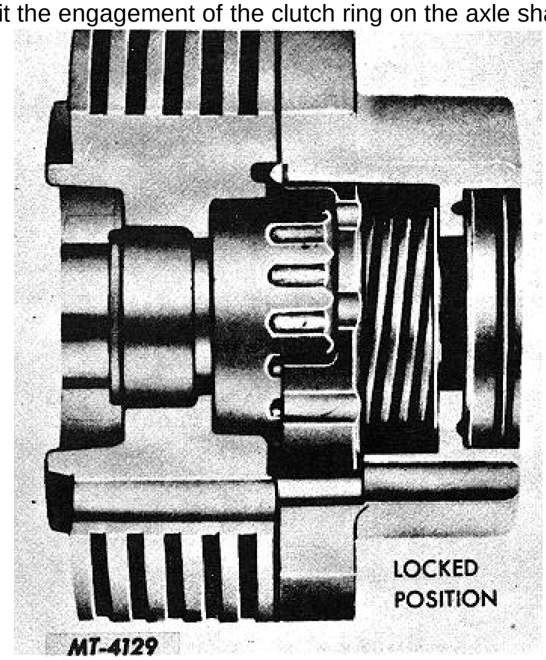

Fig. 3 Locking Hub Engaged ("LOCK") Position

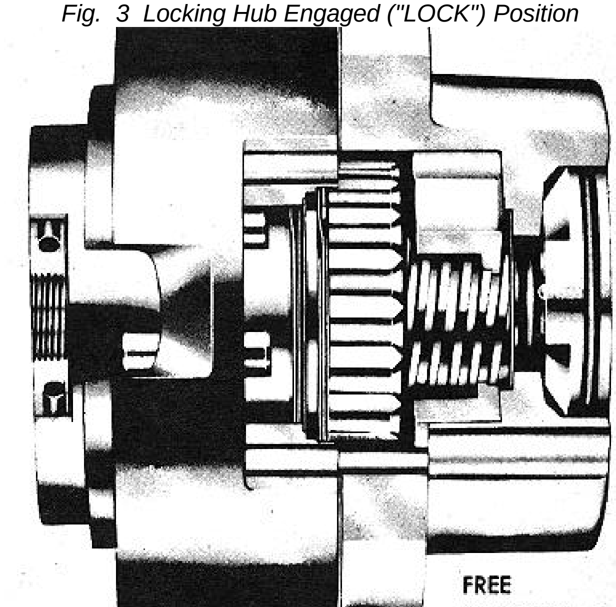

Fig. 4 Locking Hub Disengaged ("FREE") Position

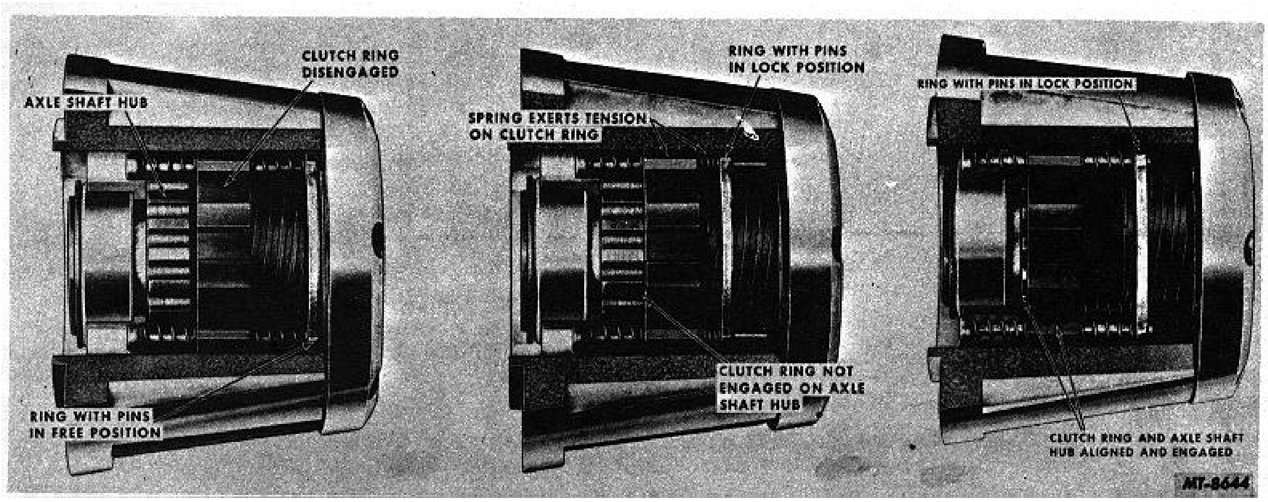

Fig. 5. Three Stage Operation of Spring Loaded Manual Locking Hub

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

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

Lock- O- Matic Type

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

OPERATION

Engaging Locking Hubs

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

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

Disengaging Locking Hubs

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

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

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

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

1. Use fingers only to turn controls. If control's do not move freely with your fingers, move vehicle slightly in either direction in two-wheel drive, standard gear range. If hubs do not now turn freely, look for external damage or dirt around brass controls. DO NOT force controls with tools.

2. DO NOT drive vehicle unless controls on both hubs are properly positioned and both are set the same.

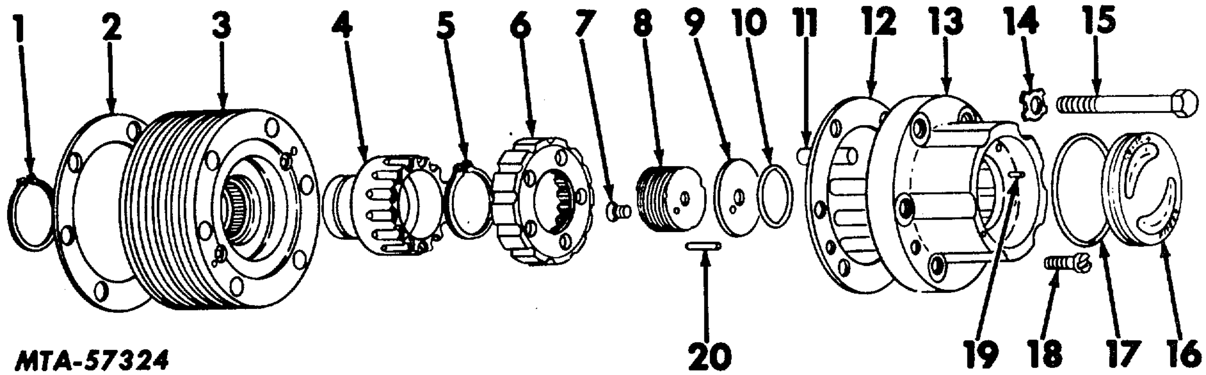

Fig. 6. Locking Hub (Manual Type with Hex Head Mounting Bolts) (Exploded View)

Key	Description
1	RING, Snap
2	GASKET, Hub
3	BODY, Hub
4	HUB, Axle Shaft
5	RING, Snap
6	RING, Clutch
7	SCREW, Flat Head, 1/4 NC
8	SCREW, Clutch
9	DISC 1-3/4
10	SEAL, O-Ring

Key	Description
11	PIN, Drive
12	GASKET, Clutch Body
13	BODY, Clutch
14	WASHER
15	BOLT, HexHead, 3/8 NF
16	CONTROL, Assembly
17	SEAL, Oil, Outer
18	Not Used
19	PIN, Stop
20	PIN, Dowel

3. To avoid excessive torque loads on the rear axle, DO NOT drive vehicle equipped with manual-locking hubs in low range of transfer case with hubs set in "FREE" position. This does not apply to the Lock-O-Matic hub, because it automatically locks the wheel with the axle shaft when torque is applied. Therefore, no increased load is placed on the rear axle.

4. During vehicle operation arrow in center of control must always point directly to one of the red dots on the rim of the hub. Also, both hubs must be set the same.

REMOVAL

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

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

DISASSEMBLY

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

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

Hub Body (Manual Type)

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

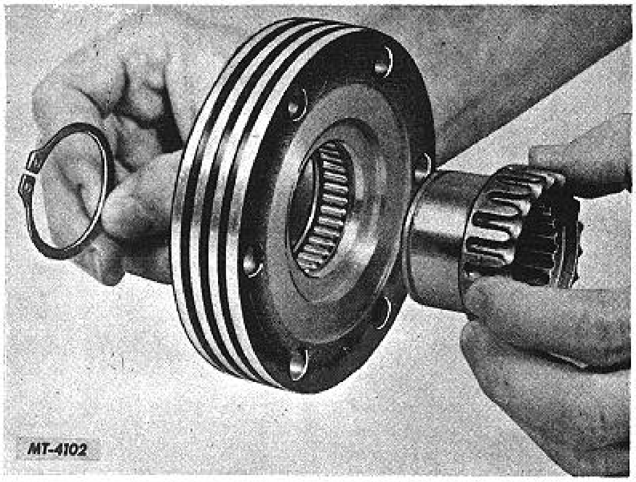

Fig. 7. Removing Axle Shaft Hub

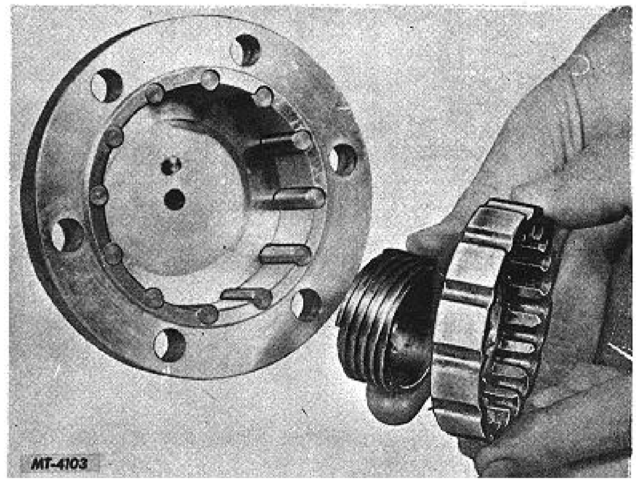

Fig. 8. Removing Clutch Ring and Screw

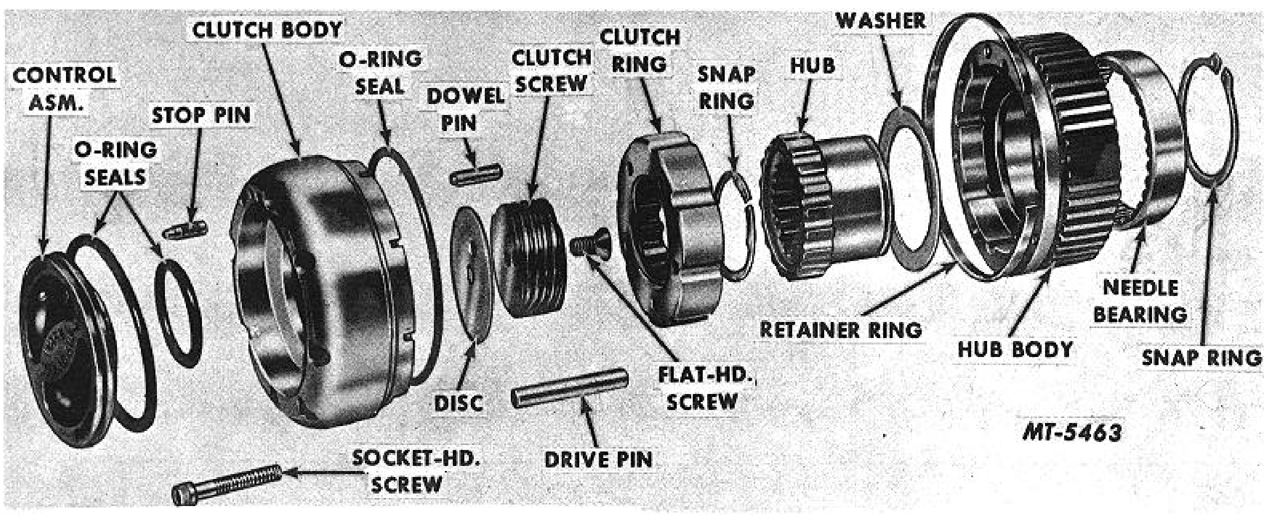

Fig. 9. Manual Type Locking Hub with Socket Head Mounting Screw (Exploded View)

Clutch Body (Manual Type)

Using a small chisel, remove the staked over metal retaining the flat head screw (7). NOTE: Be careful when removing this material not to damage the clutch screw (8). Remove the screw (7). Lift out clutch screw (8) and clutch ring (6). Clutch ring (6) may be separated from clutch screw (8) by unscrewing it, Fig. 8. Turn clutch body face down to take out the drive pins (11).

Remove disc (9) from bottom center of clutch body (13). Place thumb inside clutch body (13) on center of control assembly (16) and push outward, Fig. 10. Remove O-ring seal(l0)and outer oil seal (17) from control dial (16). Dowel pin (20) may be lifted out of control dial (16). The poppet ball and spring located in the control dial cannot be serviced therefore, if damaged, the-control assembly (16) must be replaced.

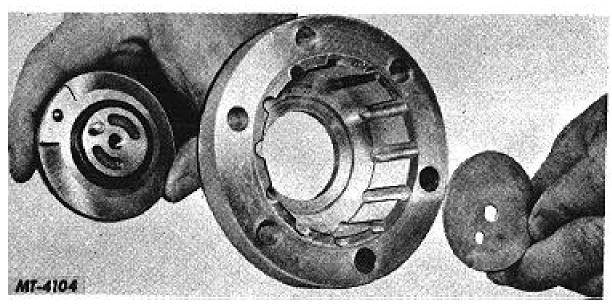

Fig. 10 Removing Control Assembly and Disc from Clutch Body

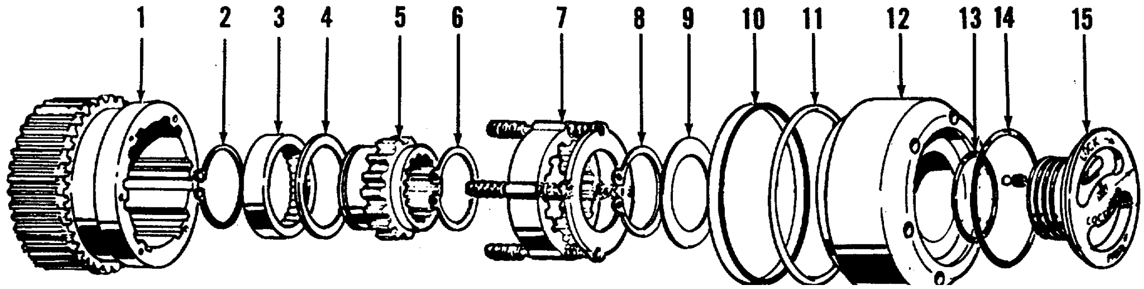

Fig. 11. Spring-Loaded Manual Type Locking Hub with Socket Head Mounting Screws

Legend for Fig. 11

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

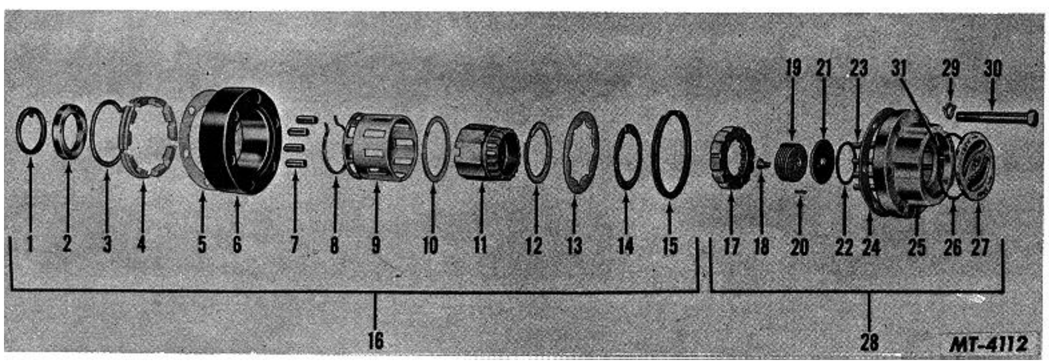

Fig. 12. Locking Hub (Lock-O-Matic) (Exploded View)

Legend for Fig. 12.

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

Hub Body (Lock-O-Matic)

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

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

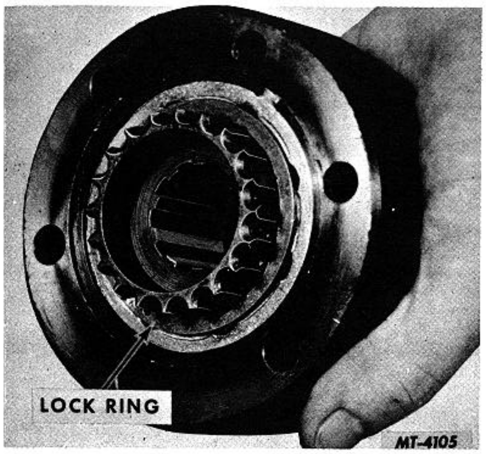

Fig. 13. Hub Body

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

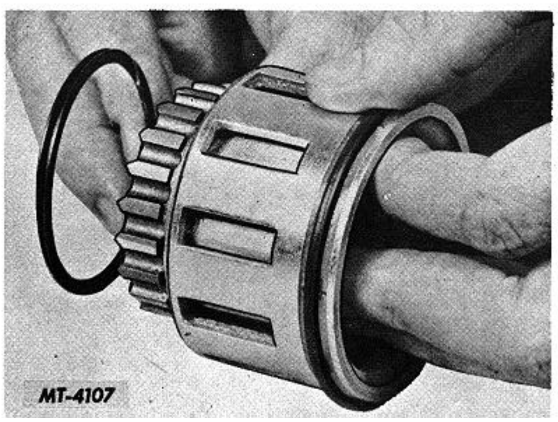

Fig. 14. Removing Centering Spring and Rollers

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

Pull the axle shaft hub (11) out of the roller cage (9) in the direction as illustrated in Fig. 16.

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

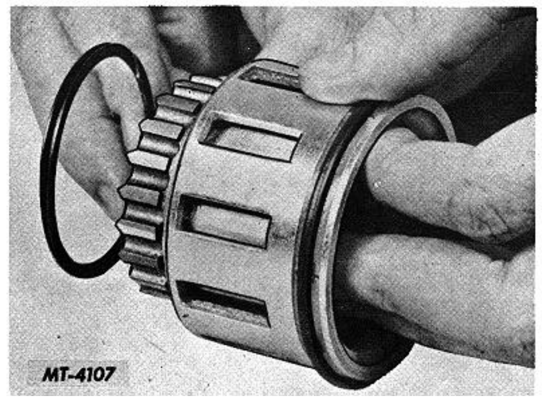

Fig. 15. Removing Spirolox Lock Ring

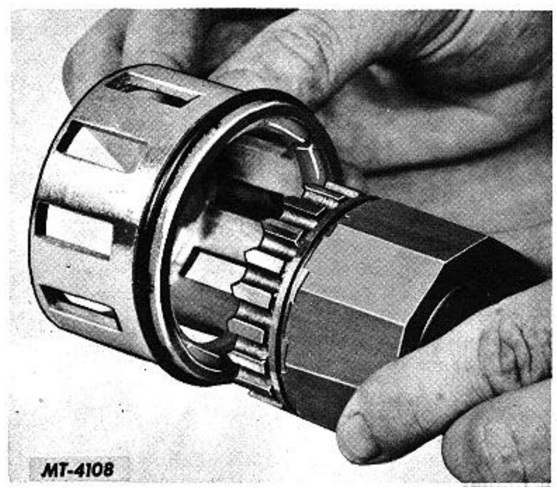

Fig. 16. Separating Axle Shaft Hub from Roller Cage

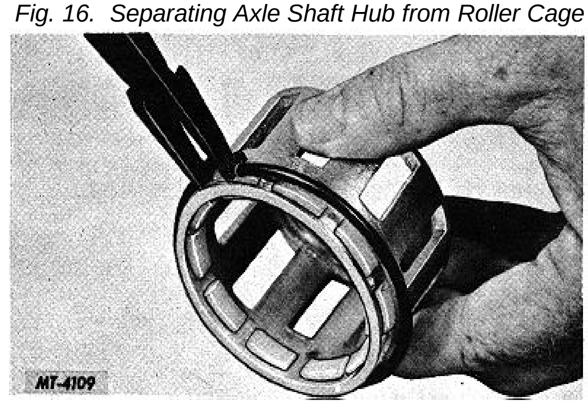

Fig. 17. Removing Friction Shoes and Spring

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

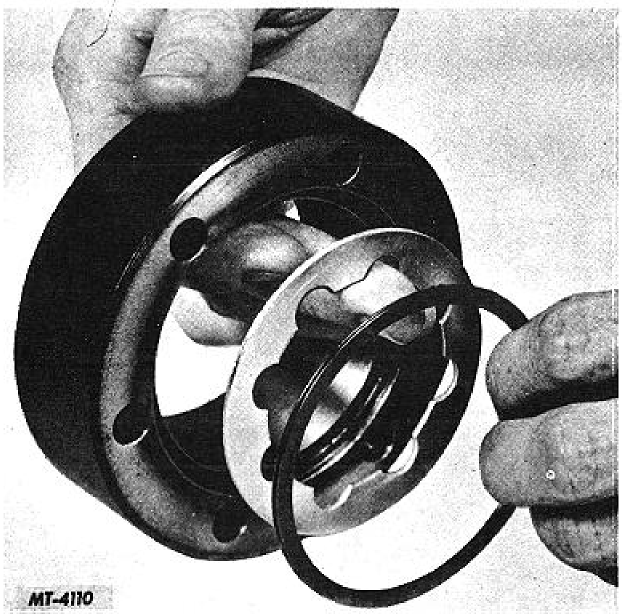

Fig. 18. Removing Spirolox Lock Ring and Thrust Washer

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

Clutch Body (Lock-O-Matic)

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

CLEANING, INSPECTION AND REPAIR

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

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

REASSEMBLY

Hub Body (Manual Type)

If hub body needle bearing has been removed, install new bearing being careful not to damage it.

Place axle shaft hub (4) into hub body (3) as shown in Fig. 7. Secure axle shaft hub (4) in body (3) by installing snap ring (1) in groove in end of axle shaft hub.

Clutch Body (Manual Type)

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

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

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

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

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

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

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

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

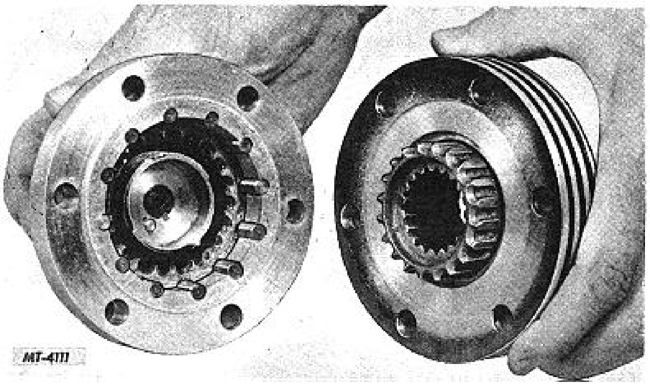

Fig. 19. Clutch Body and Hub Body Properly Assembled (Manual Type)

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

Hub Body (Lock-O-Matic)

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

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

Insert axle shaft hub (11) into roller cage (9) against Spirolox spring (10). See Fig. 16. NOTE: Points on axle shaft hub must be aligned with grooves in friction shoes to permit entry. Install Spirolox lock ring (12) into second groove on axle shaft hub (11). See Fig. 15.

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

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

Clutch Body (Lock-O-Matic)

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

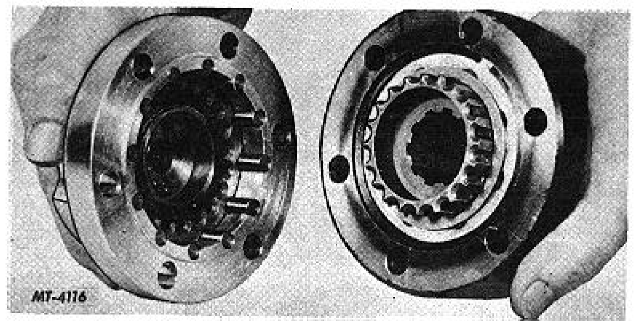

Fig. 20. Clutch Body and Hub Body Properly Assembled (Lock-O-Matic)

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

ADJUSTMENT

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

LUBRICATION

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

CHAPTER II

DISASSEMBLY:

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

REASSEMBLY:

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

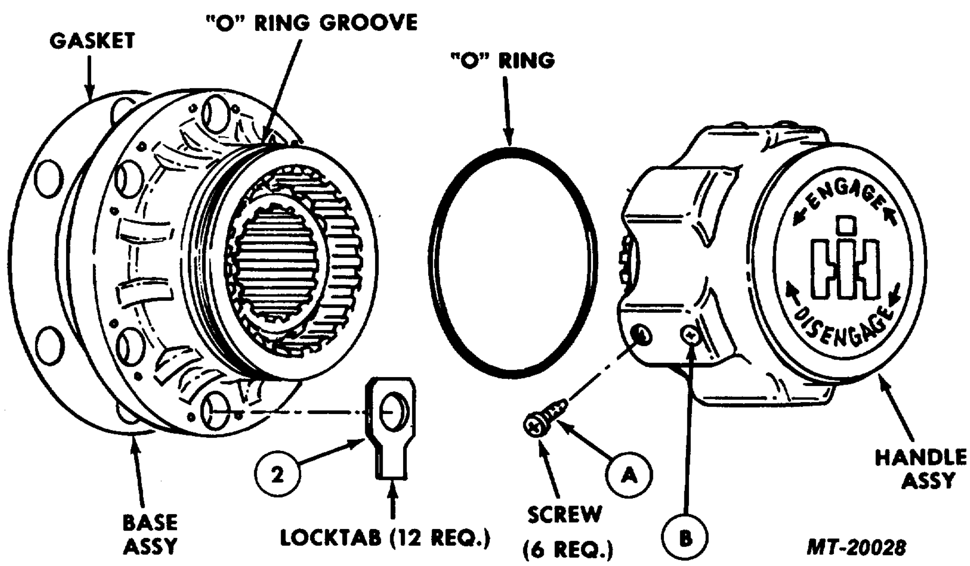

Fig. 1.

AXLES - FRONT
LOCKING HUBS
AUTOMATIC AND MANUAL

CONTENTS

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AXLES ¾ FRONT
CHAPTER I
AUTOMATIC HUB

CONTENTS

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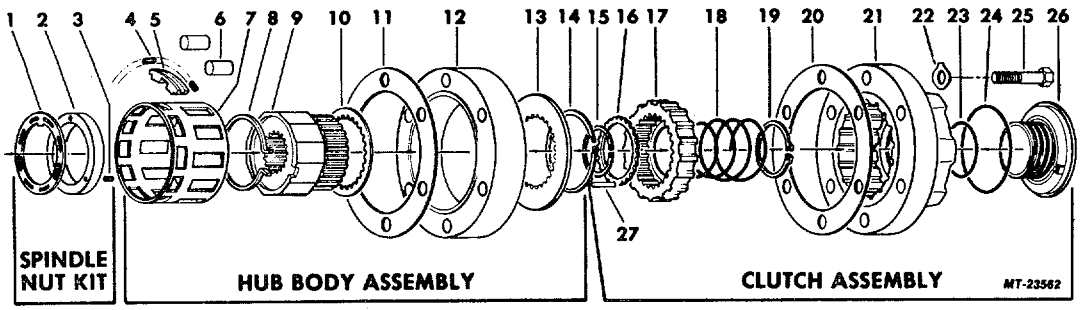


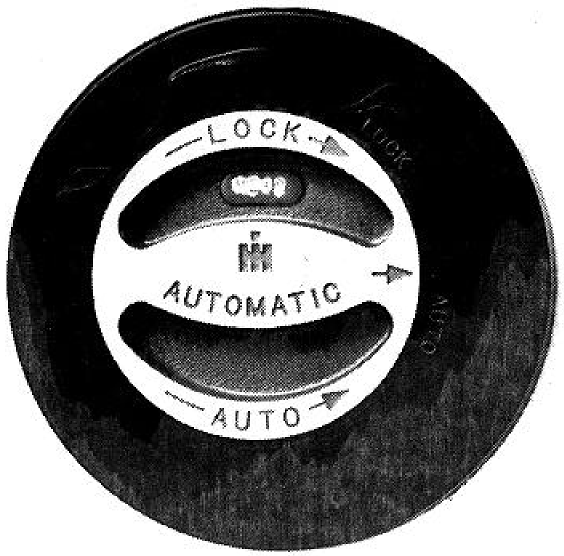
Fig. 1. Locking Hub (Automatic)

LEGEND FOR FIG. 1

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

OPERATION

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



MT-23607

Fig. 2. Dial Control

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

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

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

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

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

LUBRICATION

When reassembling the locking hub, lubricate as follows:

Lubricate dial, seals, splines, threads, rollers, cage, centering spring and body with IH 251 HEP grease.

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

SERVICING

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

To disassemble:

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

To reassemble:

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

TORQUE SPECIFICATION

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

AXLES - FRONT
CHAPTER II
MANUAL HUB

CONTENTS

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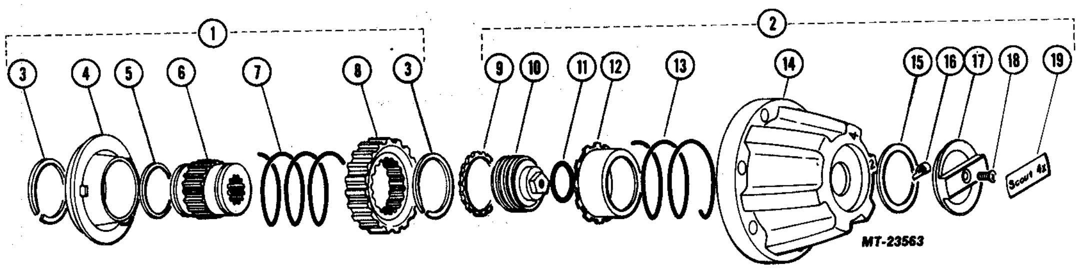


Fig.1. Locking Hub (Manual)

LEGEND FOR FIG. 3.

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

OPERATION

When the locking hubs are engaged in "4 x 4" and transfer case is in 4W, full power is transmitted to both wheels. When both front wheels are disengaged or in "4 x 2" position and transfer case in 2W, shafts and differential will remain idle, overcoming any unnecessary wear. For the first 320 km (200 miles) operate your new vehicle with the locking hubs in "4 x 4" position to assist in initial break-in of the front driving axle. Place transfer case control in 2wheel drive position.

MT-23608

Fig.2. Dial Control

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

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

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

LUBRICATION

When reassembling the locking hub, lubricate as follows:

Lubricate dial, seal, splines, threads, ring and bearing with IH 251 HEP grease.

SERVICING

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

To disassemble:

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

To reassemble:

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

TORQUE SPECIFICATION

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

AXLES - FRONT
CHAPTER III
DUALMATIC HUB

CONTENTS

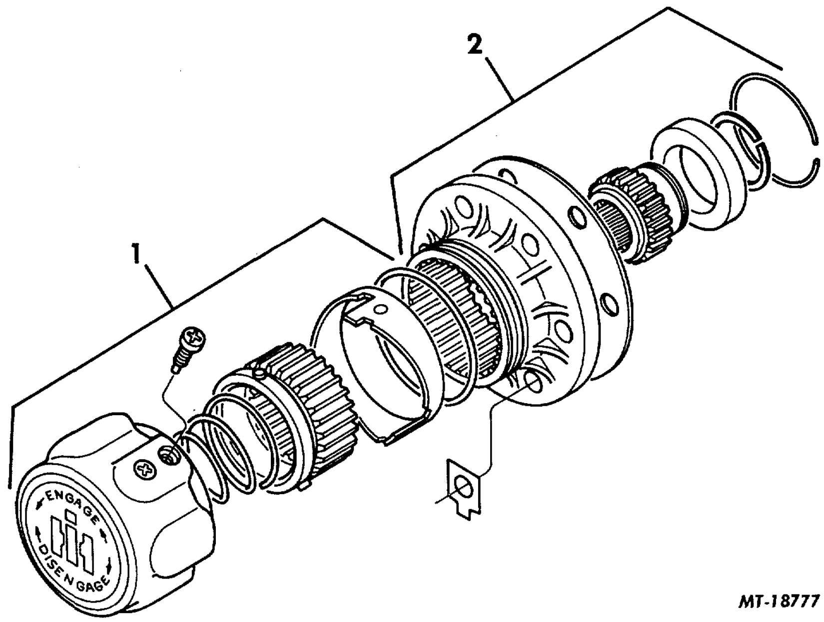


Fig. 1 Locking Hub (Dualmatic)

LEGEND FOR FIG. 1

NO.	DESCRIPTION
1	CLUTCH ASSY.
2	BODY ASSY.

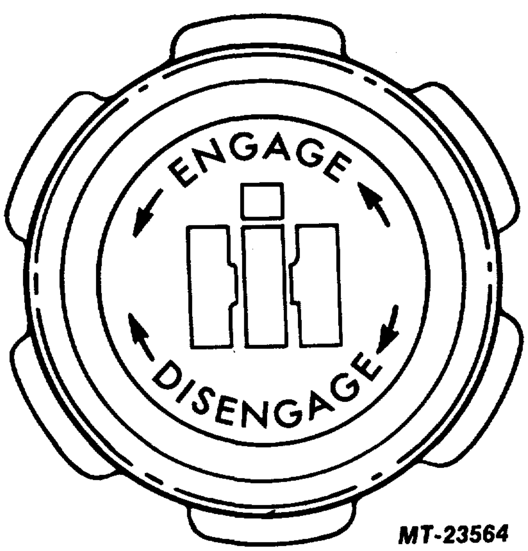


Fig. 2 Dial Control

OPERATION

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

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

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

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

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

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

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

SERVICING

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

DISASSEMBLY

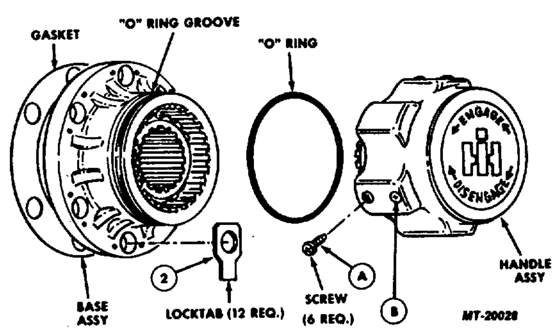
1. With handle in disengage position, remove handle assembly by removing the three screws "A". Do not remove the three screws "B".
2. If screws "B" are removed, misalignment could occur on reassembly causing damage to cam. There is no reason to ever remove screws "B".
3. Remove and retain retaining ring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

REASSEMBLY

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

TORQUE SPECIFICATION

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



AXLE REAR

I.H. MODEL	I.H. CODE
RA-15	14015
RA-20 *	14020
RA-25 *	14025
RA-29	14029
RA-30 *	14030
RA-39	14039

* These axles are equipped with NoSPIN differentials; for servicing procedures, refer to Chapter II.

CONTENTS

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AXLE REAR

CHAPTER I

CONTENTS

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CONTENTS (Cont'd.)

DESCRIPTION

The various axles contained in this section are full floating, single reduction units. Fig. 1 illustrates the single reduction differential assembly.

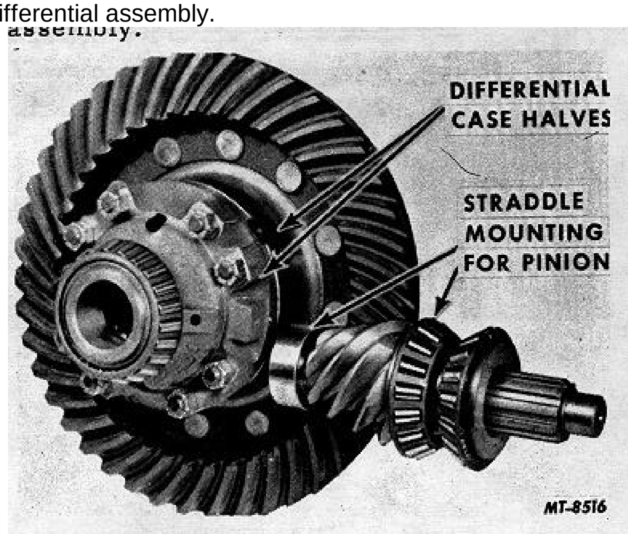

Fig. 1 Differential Assembly

The construction of rear axles may vary as to design, but the fundamental components of the axles perform similarly regardless of the type. The basic parts of the axle with which the serviceman will be concerned are the drive gears, the differential assembly, the axle shafts, and the housing.

MAINTENANCE

Lubrication

The most important item of axle maintenance about which the truck operator must be concerned is lubrication. For this reason factory recommendations on lubrication intervals, methods of filling, lubricant levels, draining and type of lubricant must be followed to assure long life and satisfactory performance. Inspect the axle frequently for lubricant leakage, especially around housing covers, pinion oil seal retainer and axle shaft flanges. When necessary, change gaskets or seals and keep nuts or bolts tight. See "Lubrication" section in the Operator's Manual provided with each truck.

Axle Housing Breather Valve

To prevent a pressure build-up in the axle housing when the' axle becomes warm after a short period of operation, a breather valve, Fig. 2, is provided in rear axles. Without this valve the resulting pressure could force the axle lubricant past the rear wheel oil seals and damage the brake linings. The valve is so constructed that warm air may pass out of the axle to relieve built-up pressure, yet dirt and moisture are prevented from entering.

The breather valve should be kept open and clean. When the truck is operated off highway on unimproved roads or in ice and snow, dirt may sometimes be forced under the valve cap and cause the valve to become ineffective. Remove valve occasionally and clean thoroughly in a cleaning solution.

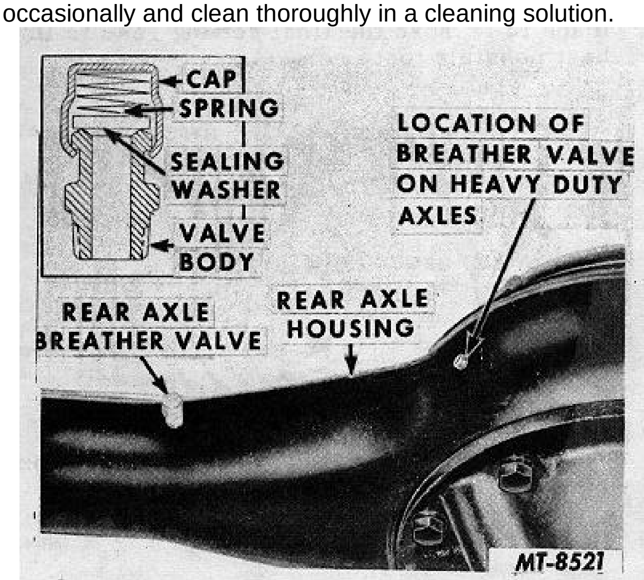

Fig. 2 Location of Breather Valve in Axle Housing

Alignment

The rear axle should also be checked at regular intervals to determine if there is any misalignment of the axle with frame or drive line. Evidence of misalignment may sometimes be noted at the U-bolts. To check for axle misalignment, lay a straightedge across and at right angles to the truck frame. The straightedge should be longer than the axle tread and clamped to the frame a short distance ahead of the rear axle. Measure the distance between the straightedge and identical points at each end of the axle assembly. When distances are not equal, misalignment is indicated, and rear springs and U-bolts must be checked for correct assembly.

Drive Gears

These IH rear axles have the hypoid type of drive as illustrated in Fig. 3.

Because of the offset type of construction, hypoid rear axles actually have a greater torque capacity than do the spiral bevel type. This is possible because the hypoid pinion is larger in diameter and has gear teeth that are larger than those of the spiral bevel pinion having the same number of teeth and same diameter ring gear. Hypoid pinions also have larger tooth areas and more teeth in longer contact with the ring gear. These design characteristics contribute to greater strength and quieter final drive operation. However, because of this greater tooth contact, more attention is required when securing a correct pinion setting at time of overhaul or when replacing differential bearings. Therefore, every effort must be made to be sure the final setting results in the best possible tooth contact.

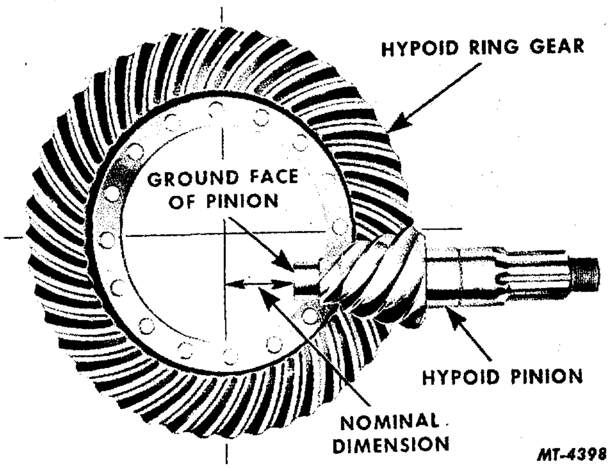

Fig. 3 Hypoid Type Drive

Axle Shafts

Many axle failures can be attributed to the axle shafts; therefore, it is most important that shafts be installed correctly, be of correct size and length for splines to engage fully, have wheel bearings adjusted properly, and be kept free from runout or bends.

Fig. 4 illustrates the axle shaft and bearing arrangement on a full-floating rear axle.

Axle Housing

In most cases the axle housing used for IH trucks is of one piece construction with opening in center for mounting the differential and carrier. The outer ends of the axle housing are welded in place to provide mounting for the brake backing plates. A bent axle housing can be the cause of early axle failure, and whenever an axle is rebuilt, this condition should always be checked before going ahead with the assembly. Fig. 5 gives a quick way of checking for a bent housing.

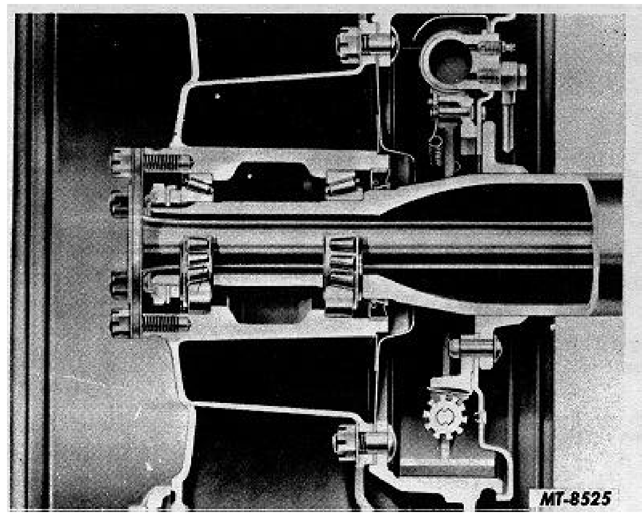

Fig. 4 Cross Section of Full-Floating Rear Axle

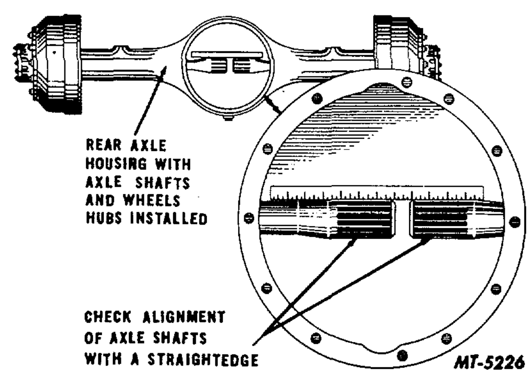

Fig. 5 Method of Checking For Bent Axle Housing

REMOVAL PROCEDURES

Axle Assembly

Whether the complete axle assembly will have to be removed from the truck for overhaul is determined by the extent of the repairs required. For most axle repairs complete removal of the axle will not be necessary; but in the event that it is, removal procedure will be similar to the following:

1. Jack up truck until load is removed from springs and place blocks under frame to safety secure truck weight off of rear wheels.

2. Drain differential housing.

3. Disconnect brake lines and parking brake cables (where used).

4. Disconnect propeller shaft at rear axle companion flange.

5. Support differential on portable floor jack and take off U-bolts.

6. Roll out axle from under truck.

Axle Shaft

The axle shafts can be removed without taking off the wheels. To remove the shafts, first remove the axle shaft nuts from the studs in the wheel hub. Next install puller screws in the two tapped holes provided in the axle shaft flange. As puller screws are turned in, flange of shaft will be forced away from wheel hub and out from axle housing.

Another type of axle shaft removal procedure is required on full-floating axles where the tapered dowel is used in addition to the studs and nuts for securing axle shaft flange to wheel hub. This procedure will be similar to the following:

1. Remove flange nuts from studs of wheel hub.

2. Using a heavy hammer, strike sharply on the center of the flange of the axle shaft, Fig. 6, This will unseat and loosen the tapered dowels in each stud hole.

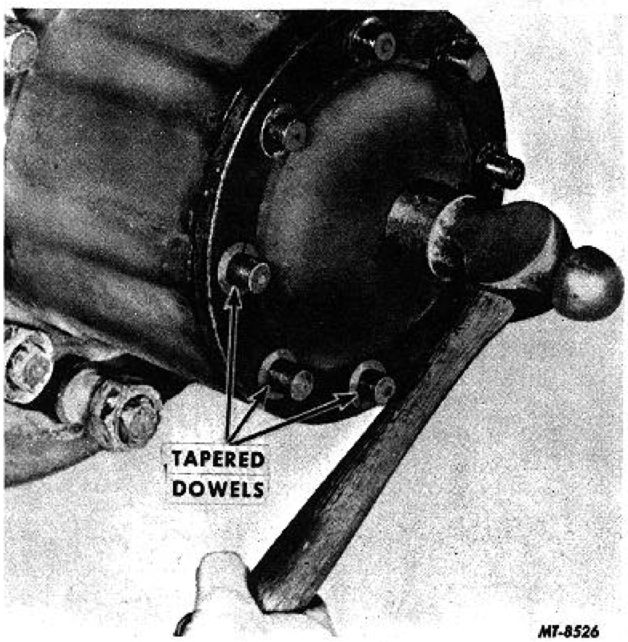

Fig. 6 Loosening Dowels in Axle Shaft

3. Remove the tapered dowels, Fig. 7.

NOTE:

When dowels are installed, there must be a slight clearance between the lockwasher and axle shaft driving flange. See inset, Fig. 7. Lack of clearance at this point will cause excessive wear on studs, dowels or holes.

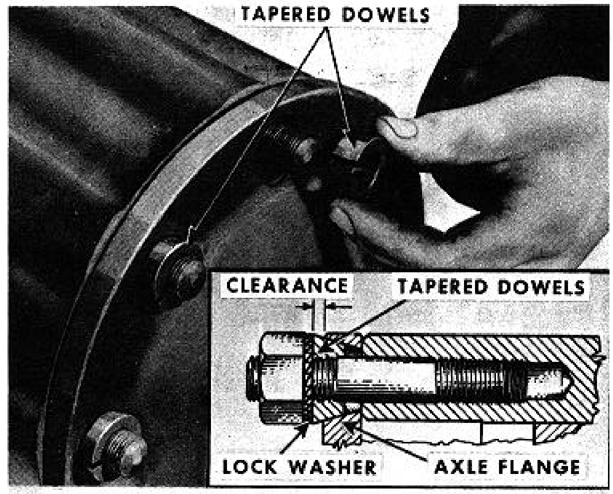

Fig. 7 Details of Taper Dowels

4. After all dowels have been removed, push the axle shaft flange back into position against the wheel hub and again strike a sharp blow in the center of the flange as shown in Fig. 6. This will cause the axle shaft to spring away from the wheel hub and allow removal of the axle shaft without resorting to the use of a pry bar or screwdriver. Any prying between axle shaft flange and wheel hub may damage the seal assembly or machined surfaces of the wheel hub or axle shaft flange.

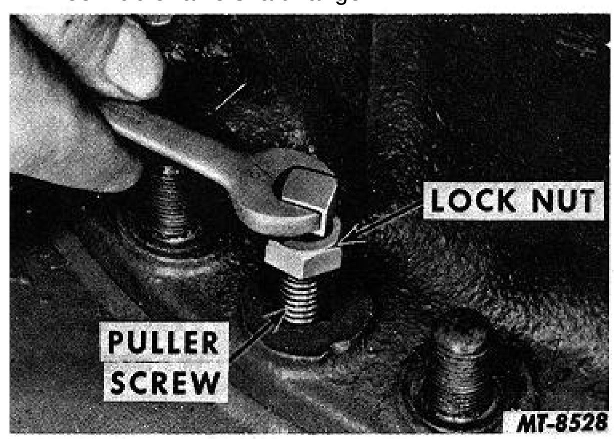

Fig. 8 Puller Screw Installation (Locknut is used if puller screw is to be kept with axle at all times.)

Differential

To remove the differential on some axles, it may be necessary to use the two extra tapped holes found in the differential housing. These are for installing puller screws, Fig. 8. To force carrier from housing, in some instances it may be necessary to break carrier loose from axle housing by striking the carrier with a heavy soft hammer (lead, plastic, rubber or leather). Be sure that the differential is securely supported on a portable floor lift before it is separated from the housing.

DISASSEMBLY

Mount differential assembly in a suitable holding fixture.

Remove Differential and Drive Gear Assembly

1. Remove cotter pins from bearing adjuster locks and remove locks from bearing caps, Fig. 9.

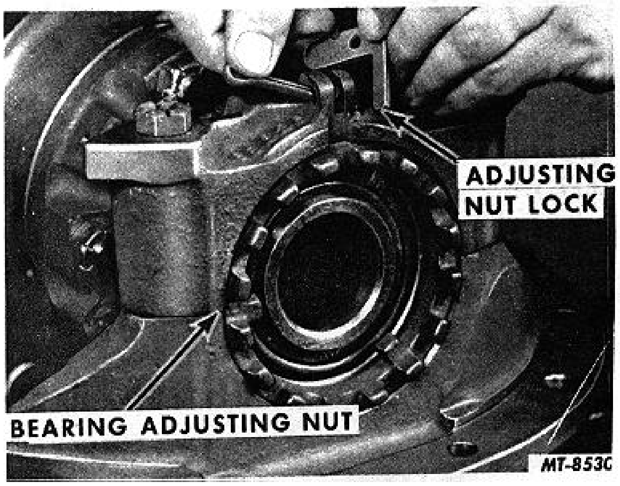

Fig. 9 Adjuster Lock Removal

2. Match mark one differential bearing cap and leg of carrier with punch or chisel, Fig. 10, to identify each for correct reassembly.

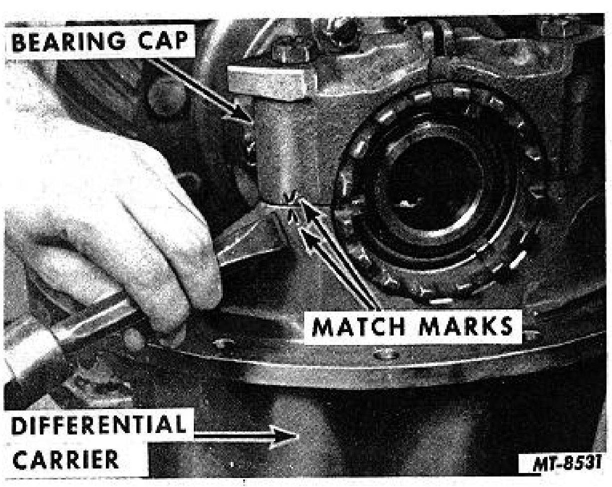

Fig. 10 Marking Bearing Cap for Identity

3. Remove bearing cap stud nuts or cap screws and take off the bearing caps and adjusting nuts.

4. Tip differential away from pinion and lift assembly out of the differential housing, Fig. 11.

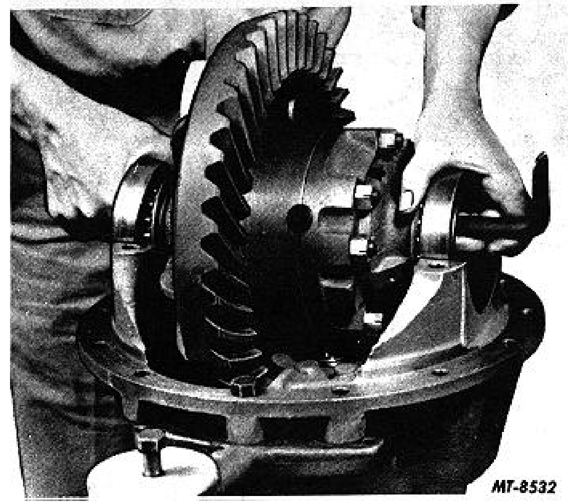

Fig. 11 Lifting out Differential and Gear Assembly

Disassemble Differential Case and Gear Assembly

1. Match mark differential case halves, Fig. 12, with a punch for correct alignment on reassembling.

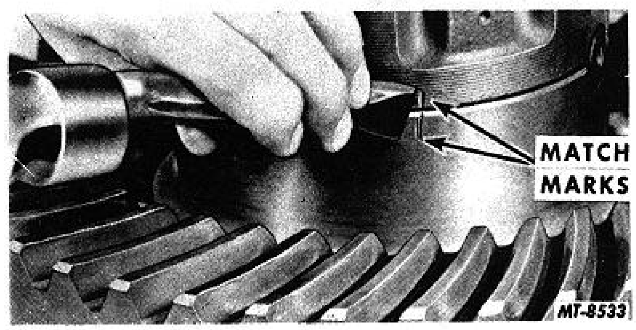

Fig. 12 Marking Differential Case Halves

2. Cut lock wire and remove capscrews or stud nuts to separate case halves, Fig.13.

NOTE

Some differential assemblies use self-locking capscrews and nuts.

3. Remove spider, pinions, side gears and thrust washers, Fig. 14.

4. To remove drive gear rivets, carefully center punch each rivet head. Next use a drill .8 mm (1/32") smaller than body of the rivet and drill through rivet head, Fig. 15. Use a

punch to press out remaining portion of the rivet.

NOTE

Never use chisel to cut off rivet heads or damage to differential case might result.

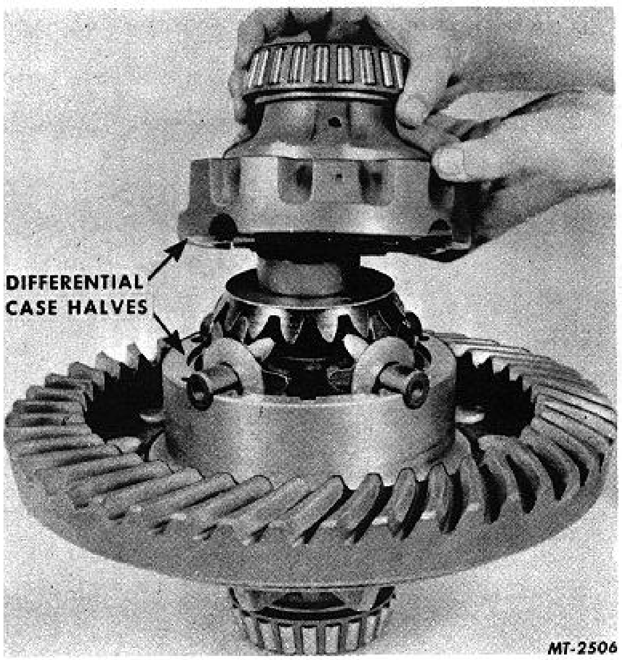

Fig. 13 Separating Differential Case Halves

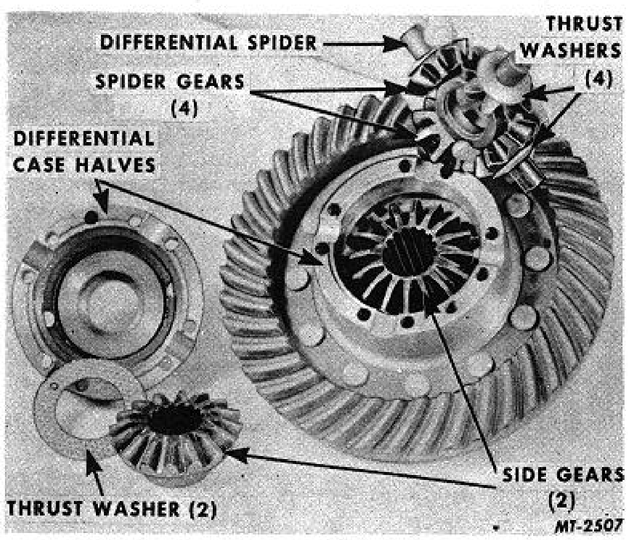

Fig. 14 Component Parts of Differential Case

5. When reinstalling ring gear, it is suggested that Riveting Fixture SE-2222 be used. This special tool is designed for use with either hydraulic or mechanical press equipment. Rivet pressures for ring gear installation should be in accordance with those given in the following chart.

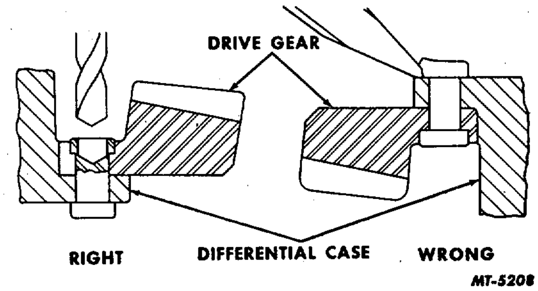

Fig. 15 Drive Gear Rivet Removal

Rivet Size		Pressure Per Rivet	
Inch	mm	U.S. Tons	Metric Tons
7/16	11.1125	18-20	16.3-18.1
1/2	12.7	20-25	18.1-22.7
5/8	15.8750	45-50	40.8-45.3

Remove Pinion and Cage from Differential Housing

There are two methods for removing the pinion and cage assembly and the method to be used will depend on whether puller screw holes have been provided in the pinion cage flange or not. When no puller screw holes are provided, removal is as follows:

1. Remove pinion cage capscrews which hold the cage to the differential carrier.

2. Remove pinion and cage assembly from the differential carrier, Fig. 16.

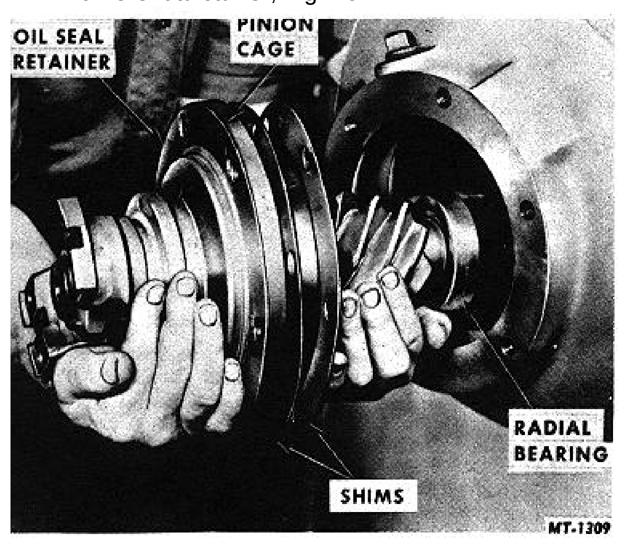

Fig. 16 Removing Pinion and Cage Assembly

3. Retain shim pack as an aid to adjustment on reassembly. Do not damage shims.

4. If difficulty is encountered in lifting the cage from the carrier, place a brass drift on the inner end of pinion and tap pinion and cage out of differential housing.

NOTE

Do not allow pinion and cage assembly to fall or damage may result.

When tapped holes for puller screws are provided, removal of the pinion and cage is as follows:

1. Hold the companion flange or yoke and remove pinion shaft nut and washer.
2. Remove flange with a suitable puller.
3. Remove pinion cage stud nuts or capscrews.
4. Remove bearing cover and oil seal assembly.
5. Insert puller screws in the cage flange and remove pinion and cage assembly.

NOTE

Using a drift to drive on inner end of pinion of this type axle will damage the bearing lock ring groove.

6. Retain shim pack as an aid to adjustment on reassembly.

Disassemble Pinion and Cage Assembly

1. If the companion flange or yoke has not previously been removed from pinion, mount the pinion and cage assembly in a vise. Remove the cotter pin and take off pinion and nut as shown in Fig. 17.

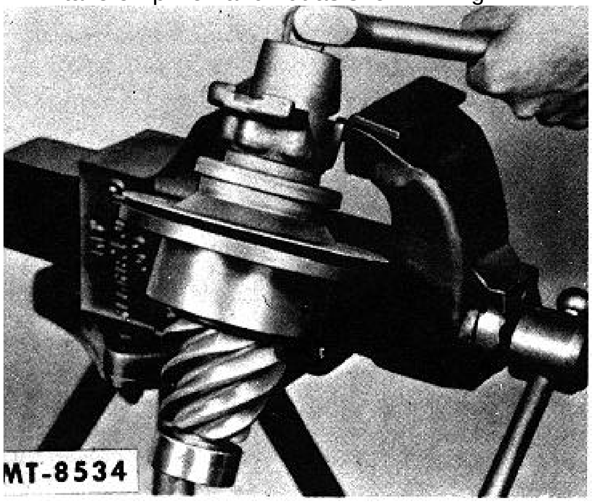

Fig. 17 Pinion and Cage Disassembly

2. Tap or drive the pinion assembly from flange and out of cage using a soft hammer.
3. Remove outer bearing from cage.
4. Remove spacer or spacer combination from pinion shaft, Fig. 18.
5. If it is necessary to remove the rear thrust bearing on the radial bearing, Fig. 18, remove these bearings with a suitable puller

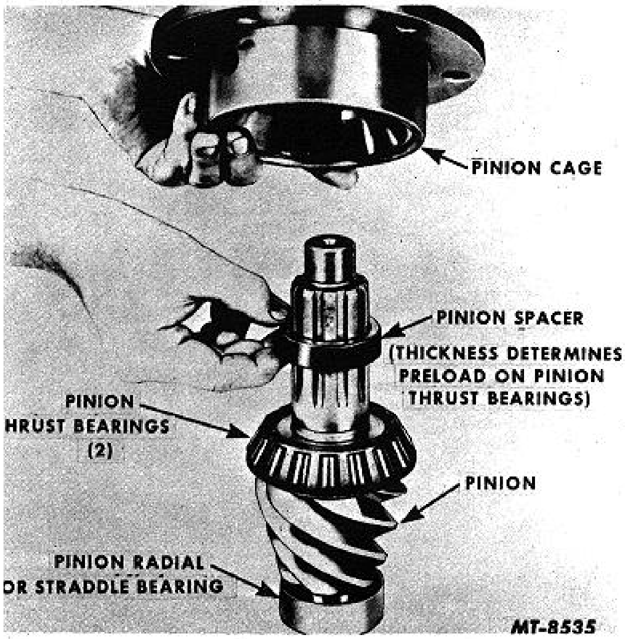

Fig. 18 Removing Pinion Bearing Spacer

6. Remove cork seal from pinion cage, Fig. 19. (This seal should be replaced at every disassembly.) If the pinion cage assembly is the type which is removed from the carrier by means of puller screws, remove the oil seal from bearing cover.

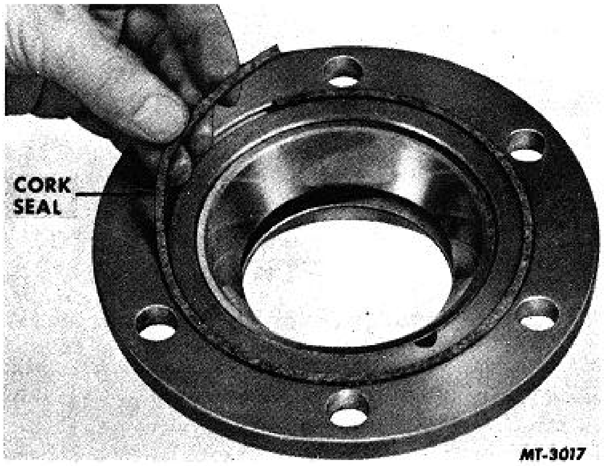

Fig. 19 Removing Pinion Cage Seal

CLEANING

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

INSPECTION

Examine all bearings for roughness, damage or wear by rotating each bearing slowly in hand. If in doubt as to bearing condition, replace. Ring gear, drive pinion, differential pinions and any other gears should be checked for damaged teeth, worn spots, or distortion. Inspect differential case assembly for cracks, damage or distortion. Make sure splined ends of axle shafts are neither twisted nor cracked. Shim packs should be of uniform thickness. Discard thrust washers and obtain new, even when only slight wear is indicated. Always use new gaskets.

The assembly of the differential carrier is accomplished in the reverse order of the disassembly. There are, however, various adjustments which must be secured as the assembly progresses. In addition to the adjustments there are also a few precautions to be observed. Among these are the following:

1. Prelubricate the pinion thrust bearings when reassembling the pinion cage.

2. If the ring gear was removed from the differential case half, be sure correct rivet pressures are used in reinstalling gear to case.

3. Prelubricate all parts of the differential assembly before bolting case halves together.

4. When installing differential bearing caps, make sure they are correctly aligned and that the bearing cups fit properly. If the bearing caps do not seat easily, the adjusting nuts may be cross threaded. Forcing caps into place will cause irreparable damage to the differential carrier or bearing caps.

5. Observe torque settings from specifications when tightening any parts.

When making axle repairs such as bearing or drive gear replacement, or when simply making an adjustment, it is most important that the ring gear and pinion be positioned correctly to obtain proper tooth contact. Once the adjustment is obtained, quiet and durable performance from the rear axle is assured.

Fundamentally, the correct tooth contact is obtained by moving the pinion toward or away from the ring gear as necessary, or by moving the ring gear toward or away from the pinion. The actual procedure has been reduced to five principal steps. Each step is vitally important to axle life and satisfactory performance, and for that reason, each step is covered more fully in succeeding paragraphs. The five steps and the order in which they should be performed are as follows:

1. **Preload pinion bearings** in pinion cage. This is determined by the thickness of spacer between the two pinion thrust bearings, Fig. 18.

2. **Establish pinion nominal dimension** , Fig. 1. Use the SE1065 Pinion Setting Gauge and add or remove shims to obtain this dimension.

3. **Set gear lash** between ring gear and pinion. Do this by moving the ring gear to or from the pinion by means of bearing adjusting nuts, Fig. 9.

4. **Preload differential bearings**. This is accomplished by tightening bearing adjusting nuts, Fig. 9.

5. **Check gear tooth contact**. Use the paint impression method for this.

PRELOAD PINION BEARINGS

Before the pinion and drive gear can be adjusted for correct tooth contact, the pinion bearing preload must be set. Preloading the pinion bearings is accomplished by selecting the correct size spacer, Fig. 18, located between the two pinion thrust bearings, and tightening pinion end nut to the specified torque.

Temporarily bolt up the pinion, cage and flange assembly, less oil seal and retainer, and clamp the assembly in a vise so as to hold the companion flange, Fig. 17. Pinion end nut should then be drawn tight to the torque shown in specifications. The applying of correct torque to the various pinion end nuts, etc. usually calls for torque limits beyond the capacity of the ordinary torque wrench. Where this is the case, the chart listed below may be used as a guide for obtaining the torque required. Fig. 20 illustrates the length of the wrench handle (A) and the effort that must be applied at (B) when tightening to secure the necessary torque.

The cage should be rotated while tightening the pinion end nut in order to seat and align the bearings. The rotation of the pinion bearings is important; otherwise, a false condition of bearing load could exist. The bearing rollers must be seated against the face of the bearing cone as shown in Fig. 21. After the pinion bearing load is established, good practice would be to check the ends of the bearing rollers to see whether they are in contact with the face of the bearing cone. Use a feeler gauge ribbon. There must be no clearance at the ends of the rollers.

Torque		Wrench	Effort on Wrench (Approx.)
Ft. Lbs.	N-m	A	B
200	270	1 foot .30 m	200 lbs. 90 kg
		2 feet .61 m	100 lbs. 45 kg
250	340	1-1/2 feet .46 m	170 lbs. 77 kg
		2 feet .61 m	125 lbs. 57 kg
300	410	1-1/2 feet .46 m	200 lbs. 90 kg
		2 feet .61 m	150 lbs. 68 kg
		3 feet .92 m	100 lbs. 45 kg
350	475	2 feet .61 m	175 lbs. 80 kg
		2-1/2 feet .76 m	140 lbs. 64 kg
		3 feet .92 m	118 lbs. 54 kg
		3-1/2 feet 1.07 m	100 lbs. 45 kg
450	605	2-1/2 feet .76 m	180 lbs. 82 kg
		3 feet .92 m	150 lbs. 68 kg
		3-1/2 feet 1.07 m	129 lbs. 58 kg
		4 feet 1.21 m	113 lbs. 51 kg
500	640	3 feet .92 m	167 lbs. 76 kg
		3-1/2 feet 1.07 m	144 lbs. 65 kg
		4 feet 1.21 m	125 lbs. 57 kg
		4-1/2 feet 1.37 m	112 lbs. 50 kg
550	675	3-1/2 feet 1.07 m	158 lbs. 71 kg
		4 feet 1.21 m	137 lbs. 62 kg
		4-1/2 feet 1.37 m	123 lbs. 56 kg
		5 feet 1.53 m	110 lbs. 49 kg
600	820	4 feet 1.21 m	150 lbs. 68 kg
		4-1/2 feet 1.37 m	134 lbs. 61 kg
		5 feet 1.53 m	120 lbs. 55 kg
		5-1/2 feet 1.68 m	110 lbs. 49 kg

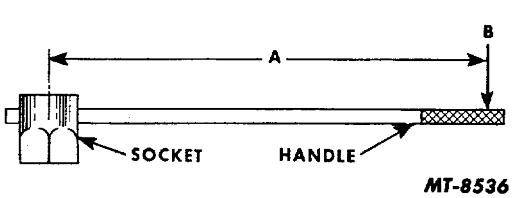

Fig. 20 Wrench Torque Chart and Diagram

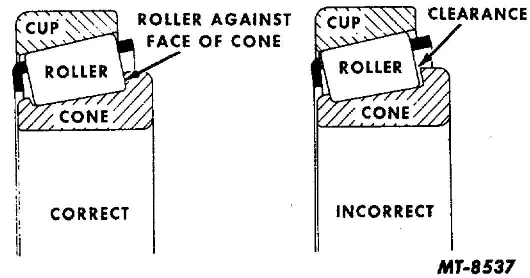

Fig. 21 Roller Bearing When Correct Adjustment is Obtained. (The rollers of the bearing must bear against the face of the cone as shown. Rotation of the bearing during adjustment is necessary to obtain this condition.)

To measure the preload, wrap a strong cord or soft wire about the pinion cage and attach end to the spring scale as in Fig. 22. Read scale only while pinion cage is turning. Compare this scale reading or pinion bearing preload with the figure found in the rear axle specifications.

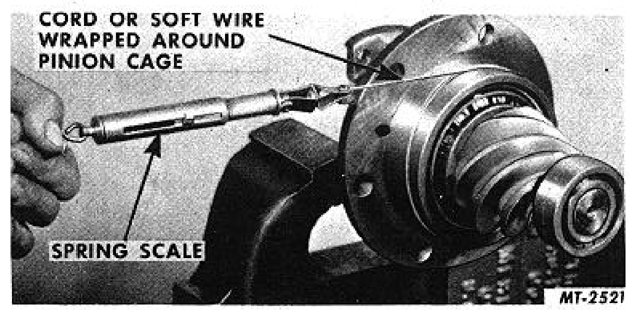

Fig. 22 Measuring Pinion Bearing Preload

When preload reading does not agree with the specifications, the bearing load may be increased by installing a thinner spacer or decreased by using a thicker spacer. Determine spacer thickness with a micrometer, Fig. 23, and make a new selection accordingly. Closer adjustment can be made by working spacer to the desired thickness using emery cloth on a flat surface. Wash spacer clean of emery cuttings before installing on pinion

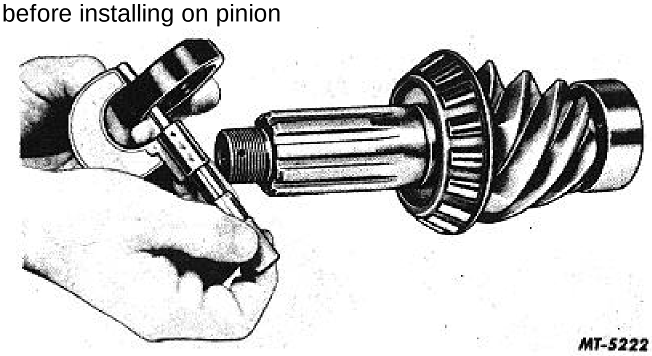

Fig. 23 Measuring Spacer Thickness

If the pinion radial or straddle bearing was removed from the end of the pinion during the disassembly, the bearing should be reinstalled at this time. Press the radial bearing onto the end of pinion and stake with a blunt point punch, as shown in Fig. 24, in six equidistant places. It is suggested that for locating punch positions for staking, the end of the pinion be painted with Prussian Blue and a circle be scribed on end of pinion about 3.175 mm (1/8") in from the pinion circumference. When staking the bearing, be careful to make the depth of the indentations or stake points uniform. Otherwise, the bearing might be damaged. Deep punch or stake marks are not necessary. Apply the staking operation at opposite sides of the pinion end until all stake points are obtained.

NOTE

Smaller pinions having the straddle bearings are staked in four places only. Where special staking tools are available, they can be used; otherwise, the use of a blunt or round-nose punch is satisfactory.

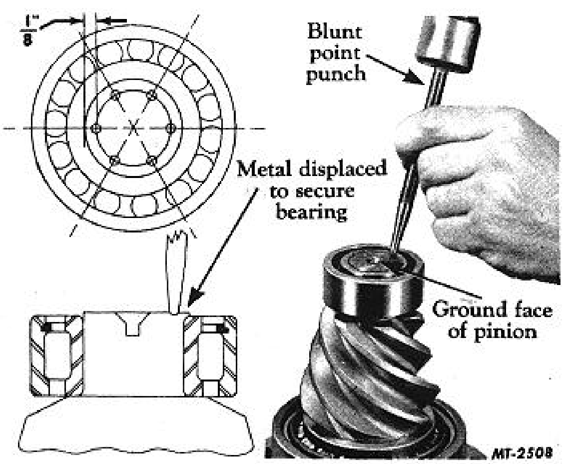

Fig. 24 Staking Pinion Straddle Bearing

ESTABLISH NOMINAL DIMENSION

The pinion setting gauge (SE-1065) is a precision gauge designed for locating the pinion as it meshes with the ring gear to the correct nominal dimension in the shortest possible time. A step plate and bracket, which are a part of the set, are used whenever hypoid type gears are to be adjusted. Essentially the pinion setting gauge is a direct reading depth micrometer mounted in an arbor. The span of the micrometer is 50-75 mm (2" to 3"), but extensions are provided with the kit to increase the reach. Two sleeves which hold adapter discs slip over the ends of the arbor. Adapter discs are held on the sleeves by knurled nuts. When installed in the differential case, the pinion setting gauge enables the mechanic to measure the distance from the face or finished end of the installed pinion to the centerline of the ring gear or cross shaft. The measurement which the mechanic reads should agree with the nominal dimension, which can be found in the axle specifications, or which in some instances is stamped or etched on the pinion itself. Usually there is a plus or minus correction also stamped on the pinion, Fig. 25, and this also must be figured in with the nominal dimension.

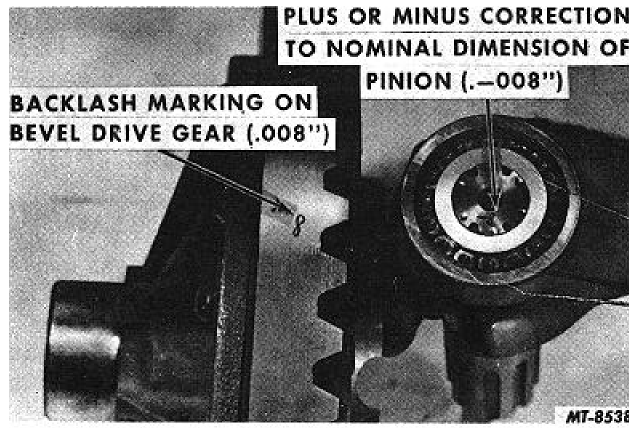

Fig. 25 Location of Pinion Setting Markings

The procedure for establishing the correct nominal dimension by means of the pinion setting gauge is as follows:

1. Install pinion, cage and bearing assembly in the differential carrier.

2. Attach the step plate clamp assembly to the carrier flange and locate step plate clamp screw over the center of the pinion as shown in Fig. 26.

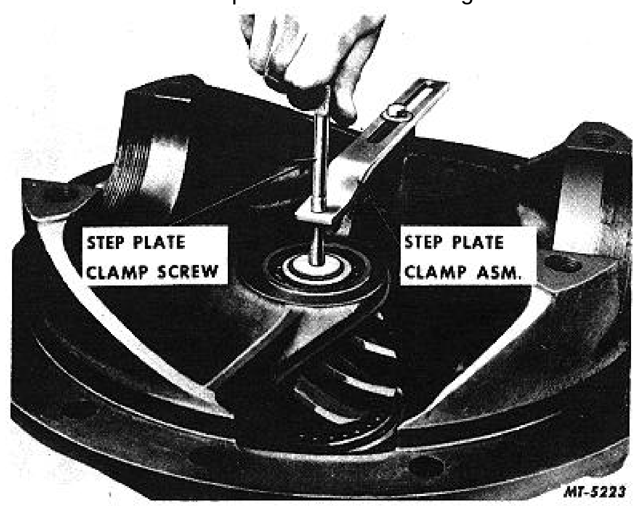

Fig. 26 Locating Step Plate Clamp

3. Install step plate under clamp screw and tighten screw to hold the step plate securely in position as shown in Fig. 27. The step plate is necessary in order to project the face of the pinion to where it can be measured by the gauge which is on the centerline of the ring gear.

NOTE

Be sure

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

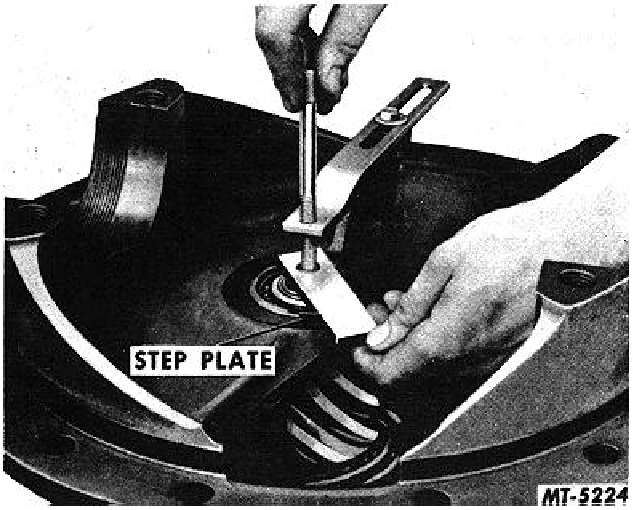

Fig. 27 Installing Step Plate

4. Mount assembled SE-1065 gauge in bearing bores of carrier as shown in Fig. 28. Make certain that bearing bores are clean and free of nicks and burrs. Adjust micrometer so it is directly over end at a 90 degree angle to the step plate. Take micrometer reading. Run the micrometer thimble down to measure the distance between the center of the ring gear and the step plate, or in the event of a spiral bevel type drive, measure the distance to the face of the pinion itself. Make a note of this measurement.

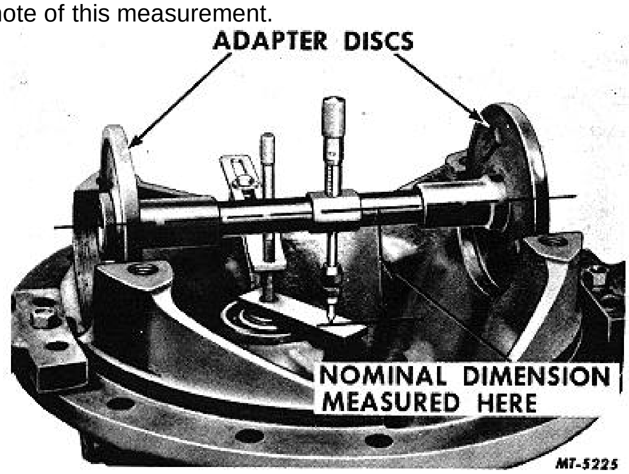

Fig. 28 Assembled Gauge in Position

5. Locate pinion nominal dimension (cone center specification) for the axle to be adjusted. On some axles this dimension may be shown on the pinion. Where this is not the case, it will be listed in the rear axle specifications. Write down this specification.

6. Also locate on pinion the etched marking which indicates a variation from zero cone center. If a minus figure, subtract from specified cone center, and if a plus figure, add to specified cone center.

NOTE

The plus or minus variation marked on the pinion will not necessarily show small variations such as -5, +3, or +7. On some pinions the variation marking will range to higher figures such as +56, +59 or perhaps higher.

Results of calculation give the corrected cone center or pinion nominal dimension to which the pinion must be set.

7. Comparison of corrected cone center (6) with the actual or measured cone center (4) indicates amount of change necessary for pinion position.

8. Remove gauge and install ring gear and differential carrier in the differential housing.

9. Adjust backlash according to marking on ring gear.

To further clarify the use of the SE1065 pinion setting gauge, the dimensions from the same type of axle as used in the aforementioned disassembly will be used as an example of the calculation involved.

Data:

Rear Axle Model-RA20
Rear Axle Code-14020
SE-1065-9 Adapter Disc-N (2)
Pinion Nominal Dimension-2.9839
Pinion Marked-(-5)

Procedure:

(a) Take micrometer reading with gauge 2.6239
Add .400 for thickness of step plate .... +.4000
Equals - Measured Nominal Dimension....................... 3.0239
(b) Record Pinion Nominal Dimension from Specifications or stamped on pinion 2.9839
Subtract the Pinion Correction
(-5) .... -.0050
Equals - Corrected Nominal Dimension or distance pinion should measure from center of ring gear..................... 2.9789
(c) Subtract correct Nominal Dimension (b) from actual measurement (a)
Equals - Amount pinion must be moved in 0.0450

SET GEAR LASH

A special effort should be made to set the backlash between pinion and ring gear to the same amount as was originally built into them, 0.1-0.15 mm (.004 to .006) on small gears or 0.15-0.2 mm (.006 to .012) on larger gears. Generally the amount of backlash is stamped or etched on the ring gear, Fig. 25. When installing new gears, backlash is measured with a dial indicator mounted on differential housing, as in Fig. 29. To adjust the backlash, move the ring gear toward or away from the pinion by means of the differential bearing adjusting nuts.

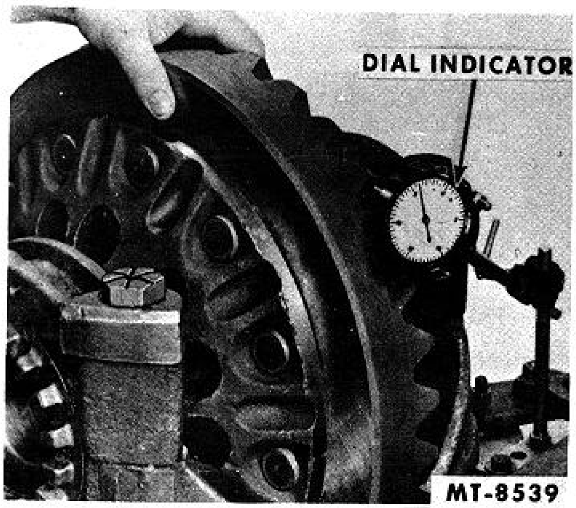

Fig. 29 Using Dial Indicator to Set Correct Backlash

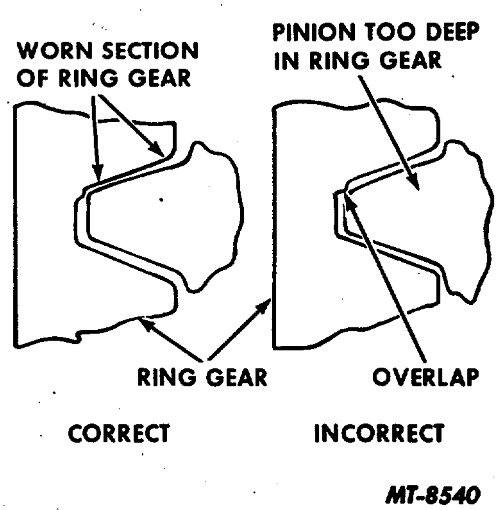

Fig. 30 Right and Wrong Adjustment of Ring Gear and Pinion When Worn Gears Are Reinstalled

When original gear and pinion sets are being reinstalled, the wear pattern of the gear teeth must be considered in the backlash adjustment. Gears that have been in service for long periods form running contacts which should not be greatly changed. If, in checking backlash, the amount measured is in excess of the amount shown on the ring gear, the lash may be reduced only in the amount that will avoid overlap of the worn tooth section, Fig. 30. A slight overlap at the worn section will cause gear operation to be noisy and rough.

PRELOAD DIFFERENTIAL BEARINGS

After the ring gear has been adjusted for position, another adjustment, the differential bearing preload, is also accomplished by these same differential bearing adjusting nuts. To set the preload, mount dial indicator at side of ring gear, Fig. 31, and continue the adjustment as follows:

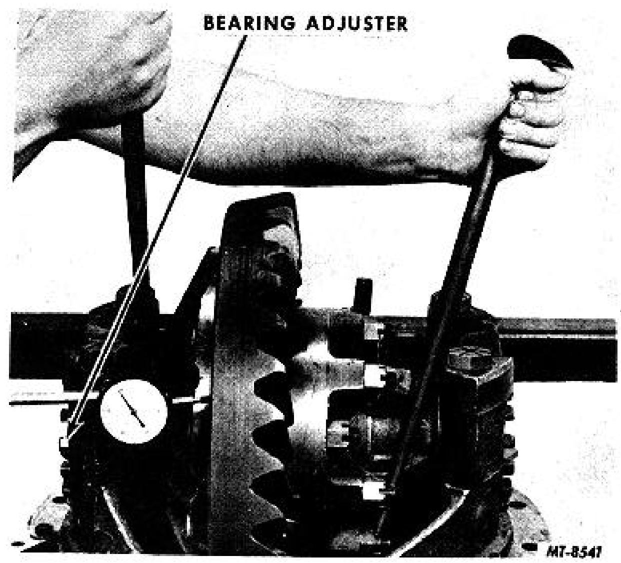

Fig. 31 Adjusting Differential Bearing Preload

1. With the side bearing cap capscrews loosened to permit bearing movement, loosen adjusting nuts only enough to notice end play on indicators.
2. Tighten adjusting nuts only enough to obtain . 000" end play reading on indicator. NOTE: While gear is held in .000" end play and before loading bearings, check gear for runout by revolving ring gear. If runout exceeds 0.2 mm (.008"), remove differential and check for cause.
3. Tighten both adjusting nuts from . 000" end play to preload the differential bearings. Tightening nuts one notch each usually gives bearings the correct preload.

4. Tighten bearing cap capscrews or stud nuts to specified torque.

5. Recheck gear lash to make certain that the lash setting has not been changed during the preloading operation.

6. Install adjusting nut locks.

CHECK GEAR TOOTH CONTACT

The following instructions cover the paint impression method of checking tooth contact and are especially for the benefit of those not equipped with an SE-1065 pinion setting gauge. The instructions may also be used as a check on the adjustment obtained with the gauge. By this method the mechanic temporarily bolts up the pinion and cage to the differential carrier and coats the drive gear teeth with oiled red lead, as in Fig. 32. When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape, and location of the contacts. If these contacts are not acceptable, shims must be added to or taken from the shim pack located between the pinion cage flange and differential carrier housing. In this manner, a satisfactory adjustment is accomplished. Bear in mind that the accuracy of the adjustment obtained with the paint impression method is dependent upon the skill and experience of the mechanic. It may be necessary to make several trials at the right selection of shims to obtain the correct tooth contact.

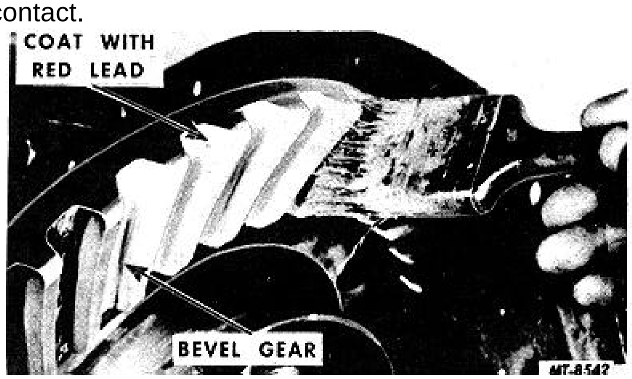

Fig. 32 Painting Gear Teeth for Obtaining Tooth Contact Impressions

Sharper tooth contact impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the ring gear teeth. Coast side contact should be automatically correct when drive side contact is correct. As a rule, coating about twelve teeth is sufficient for checking purposes.

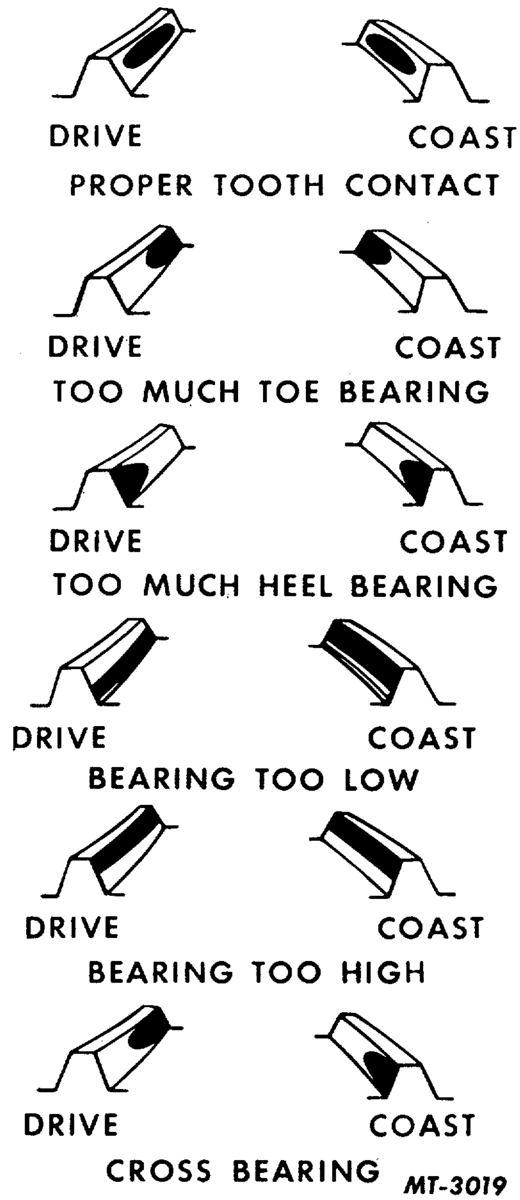

Fig. 33 Location, Size and Shape of Correct Tooth Contacts

With adjustments properly made, a correct tooth contact similar to that shown in Fig. 33 will be secured. The area of contact starts near the toe of the gear and extends about 62-1/2 percent of the tooth length. This adjustment results in a quiet running gear and pinion set, which, because the load is distributed over the teeth within the proper area, will deliver all the long service built into it.

When checking paint impressions on gear teeth of an axle under heavy load, the impressions usually spread out somewhat longer than the patterns obtained from a bench test. This can be considered as normal. Ring gears, when mounted, should show a bearing toward the toe or small end of the tooth, but never at the heel or large end. The reason is that it is practically impossible to make gears and gear mounting so rigid that no deflection will occur when full torque is applied. This deflection causes the bearing to approach the heel of the tooth. And when gears are adjusted so that the bearing is toward the heel of the tooth, it results in a concentration of load on the top corner of the heel, and breakage will follow.

Loctite Plastic Gasket Material

On those axles which utilize Loctite Plastic Gasket material in place of the more common gasket, the plastic gasket material should be applied as follows:

1. Thoroughly clean the mating surface to remove foreign matter.

2. Spread a thin, even coating on one surface. On large or rough surface apply to both surfaces.

3. Assemble parts. Bolt mating parts together.

4. Loctite Plastic Gasket will dry in four to six hours under normal temperatures. If it is not possible to wait the four to six hours, apply Locquic Primer Grade T, which will reduce drying time required to approximately one hour. This primer must be bought locally.

TROUBLE SHOOTING

Quite often serious trouble in a rear axle can be "headed off" and prevented if sufficient attention is given to the various causes of trouble and the proper remedy is applied. The following list gives most of the common kinds of axle trouble and suggests a possible cause to be corrected.

It should be noted that noises from other units of the truck, such as propeller shafts, universal joints, tires, and even transmissions, are often incorrectly diagnosed as rear axle noise. This possibility should not be disregarded when trouble shooting.

PROBLEM	CAUSE
Constant Noise	1. Lubricant not to specified level. 2. Incorrect kind and weight of lubricant. 3. Wheel bearings out of adjustment or defective. 4. Drive gear and pinion not in adjustment for correct tooth contact. 5. Teeth of drive gear and pinion chipped or worn. 6. Too much or too little pinion-to-gear backlash. 7. Loose or worn pinion bearings. 8. Loose or worn side bearings.
Intermittent Noise	1. Ring gear does not run true. a. Uneven pressures on drive gear rivets. b. Warped drive gear. 2. Loose or broken differential bearings.
Noisy on Turns Only	1. Differential pinion gears tight on cross or pinion shaft. 2. Side gears tight in differential case. 3. Differential pinion or side gears defective. 4. Thrust washers worn or damaged. 5. Excessive backlash between side gears and pinions.
Lubricant Leaks	1. Loss through axle shafts. a. Lubricant above specified level. b. Incorrect kind and weight of lubricant. c. Restricted axle housing breather valve. d. Worn or incorrectly installed axle shaft oil seal. 2. Loss at pinion shaft. a. Lubricant above specified level. b. Incorrect kind and weight of lubricant. c. Restricted axle housing breather valve. d. Pinion oil-seal worn or incorrectly installed. e. Lubricant return passage in differential carrier housing restricted. f. Universal joint companion flange loose on pinion shaft.
Rear Wheels Do Not Drive (Propeller Shaft Rotating)	1. Broken axle shaft. a. Loose wheel bearings. b. Axle shaft too short. c. Loose flange studs or nuts. d. Bent housing. 2. Drive gear teeth stripped. 3. Side gear or differential pinion broken. 4. Differential pinion shaft or cross broken.

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REAR AXLE SPECIFICATIONS					
I.H. MODEL	RA-15	RA-20	RA-25	R-30	RA-29 RA-39
I.H. CODE	14015	14020	14025	14030	14029 14039
PINION					
Nominal Dimension (in.)	2.9830	2.9830	3.2530	3.2530	3.4725
(mm)	75.79	75.79	82.63	82.63	88.20
SE-1065-9 Disc	N(2)	N(2)	D (2)	D(2)	D(2)
Cage Rotating Torque					
Pounds Pull	3-8	3-8	3-8	3-8	3-8
(Kg)	1.4-3.6	1.4-3.6	1.4-3.6	1.4-3.6	1.4-3.6
DIFFERENTIAL					
Bearing Preload	1 Notch Ea. Side	1 Notch Ea. Side	1 Notch Ea. Side	1 Notch Ea. Side	1 Notch Ea. Side
HOUSING					
Lub. Capacity (Pints U.S.)	6-1/2	6-1/2	6-1/2	6-1/2	23
(Liters)	3.1	3.1	4.5	8.4	11
SERIAL NO. LOCATION	On Bolt Circle of Diff.	On Bolt Circle of Diff.	On Bolt Circle of Diff.	On Bolt Circle of Diff.	On Bolt Circle of Diff.

REAR AXLE TORQUE CHART

IH MODEL	RA-15 Ft. Lbs.	RA-15 N-m	RA-20 Ft. Lbs.	RA-20 N-m	RA-25 Ft. Lbs.	RA-25 N-m	RA-30 Ft. Lbs.	RA-30 N-m	RA-29, RA-39 Ft. Lbs.	RA-29, RA-39 N-m
Pinion End Nut	7/8-16		7/8-16		1-1/8-18		1-1/8-18		1-1/8-18	
	250*	340	250*	340	325*	440	325*	440	325*	440
Pinion Cage to Carrier	3/8-16		3/8-16		9/16-12		9/16-12		9/16-12	
	30-40	41-54	30-40	41-54	100-120	135-162	100-120	135-162	100-120	135-162
Carrier to Housing	1/2-20		1/2-20		7/16-20		7/16-20		1/2-20	
	80-90	108-122	80-90	108-122	50-70	68-95	50-70	68-95	80-90	108-122
Differential Case	3/8-24		3/8-24		1/2-20		1/2-20		1/2-20	
	40-50	54-68	40-50	54-68	80-90	108-122	80-90	108-122	80-90	108-122
Bearing Cap to Carrier	1/2-20		1/2-20		9/16-18		9/16-18		9/16-18	
	80-90	108-122	80-90	108-122	150-160	200-220	150-160	200-220	150-160	200-220
Drive Flange to Wheel Hub	1/2-20		1/2-20		5/8-11		5/8-11		5/8-11	
	80-90	108-122	80-90	108-122	150-160	200-220	150-160	200-220	150-160	200-220

*Minimum pinion end nut torque with cross type (+) cotter pin holes. Continue to tighten until cotter pin can be inserted. Do not back off pinion end nut to insert cotter pin.

All bolt threads are to be coated with Loctite I.H. No. 576018-C1 before torque is applied.

AXLE REAR

CHAPTER II

LOCKING TYPE DIFFERENTIAL

CONTENTS

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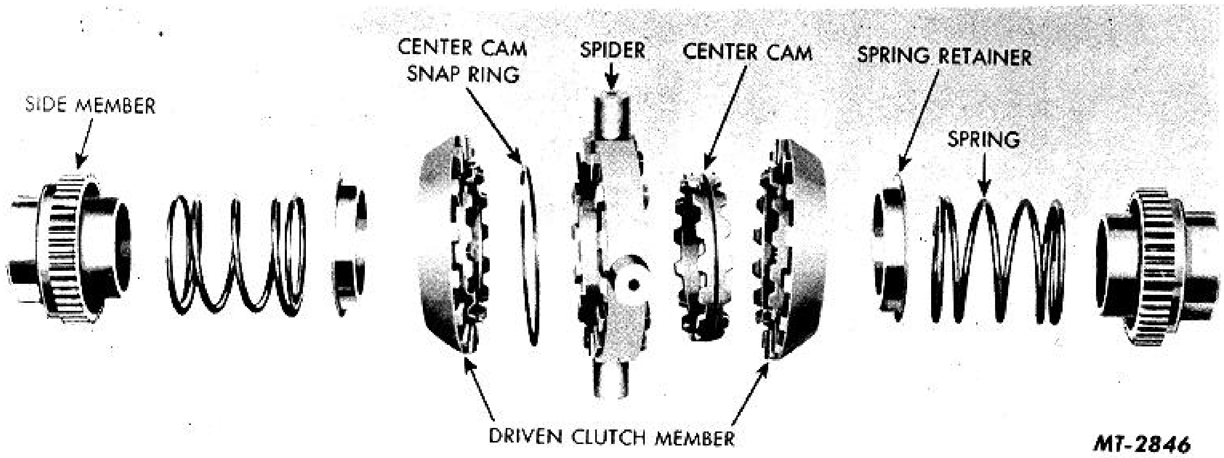

Fig. 34 Internal Spring Design differential Locking Unit (Exploded View)

DESCRIPTION

The NoSPIN differential (Figs. 34 and 35) provides equal amounts of drive line torque to each rear driving wheel and also permits differential action for turning corners.

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

CONSTRUCTION

Two types of NoSPIN differentials have been used on IH vehicles; they are (a) Internal Spring Design, Fig. 34, and (b) External Spring Design, Fig. 35.

The difference in the two units is explained in the text; however, the disassembly will cover the internal design locking unit.

The differential locking unit consists of several parts, all assembled around the spider.

Spider and Center Cam Assembly

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

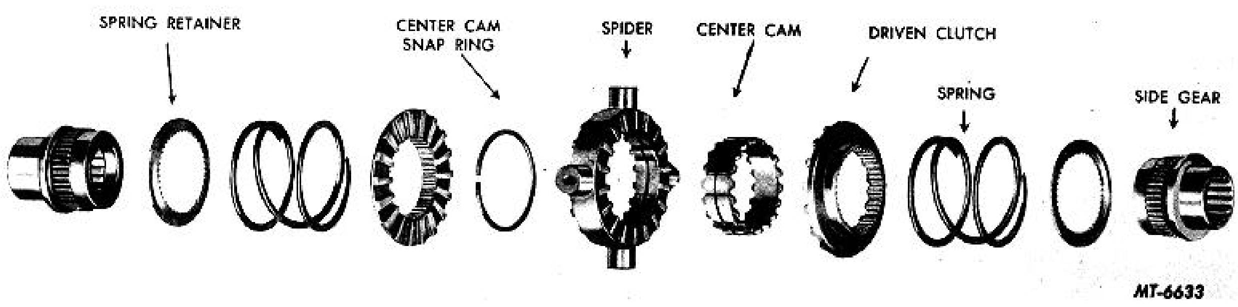

Fig. 35. External Spring Design Differential Locking Unit (Exploded View)

Driven Clutch Members

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

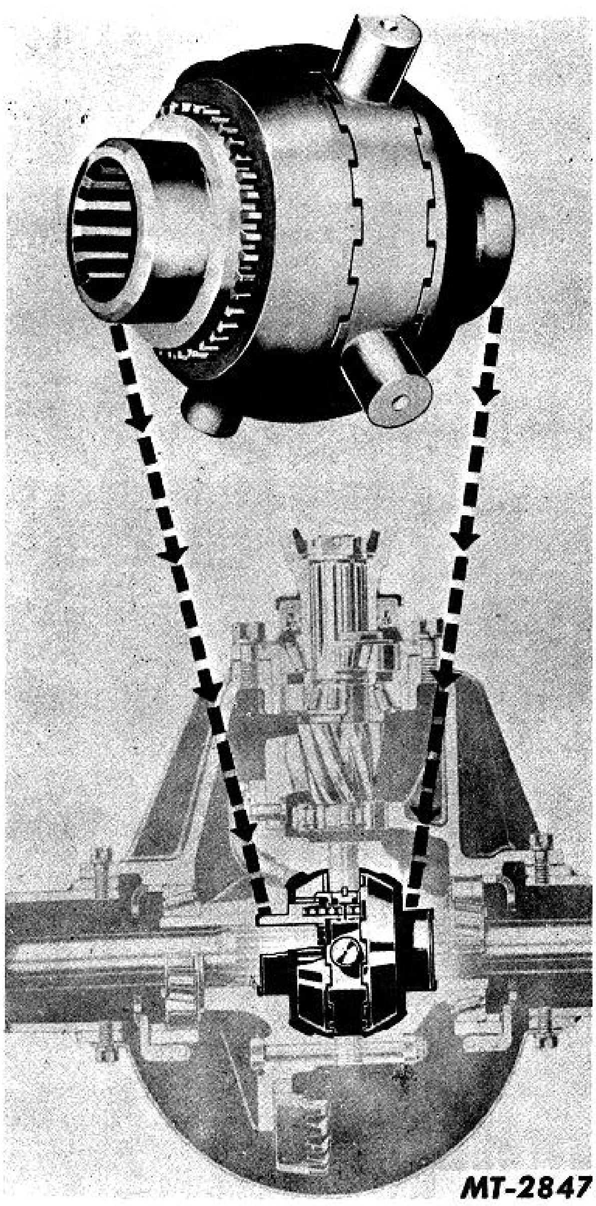

Fig. 36 Typical Installation of NoSPIN Unit (Cross Sectional View)

Spring Retainers and Springs

Models with Internal Springs:

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

Models with External Springs:

Spring retainers fit over the side gear, passing through external splines to seat against the shoulder on the side gear. Springs fit between the driven clutch and outer flanged surface of the spring retainer. Splined Members These two splined side members are splined internally to receive the truck axle shafts. The inner hubs of the splined side members are inserted in the outer ends of the springs. The external splines of the splined side rembers engage the internal splines of driven clutch members on each side of the completed assembly.

OPERATION

Straight Forward Driving

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

Engagement of the driving and driven clutch teeth is assured by the pressure of the two springs which force the driven clutch members inwardly against the spider and also by the positive locking action developed by the mating undercuts on the driving faces of the clutch teeth, Fig. 37.

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

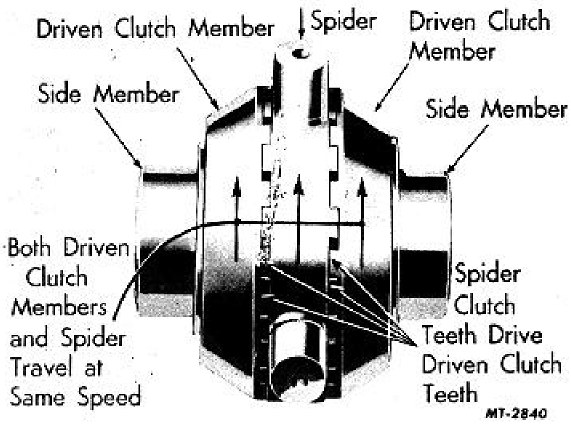

Fig. 37 Straight Forward Driving

Straight Rearward Driving

When driving a vehicle in a straight rearward direction, both driven clutch members are held in full engagement with the spider and center cam as described for straight forward driving. However, in this case, the spider rotates in the reverse direction and shifts the driving force to the opposite set of driving faces on the mating clutch teeth. Again we have the assembly operating as a unit with each wheel being forced to rotate at ring gear speed.

Right-Hand Turn Forward Direction

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

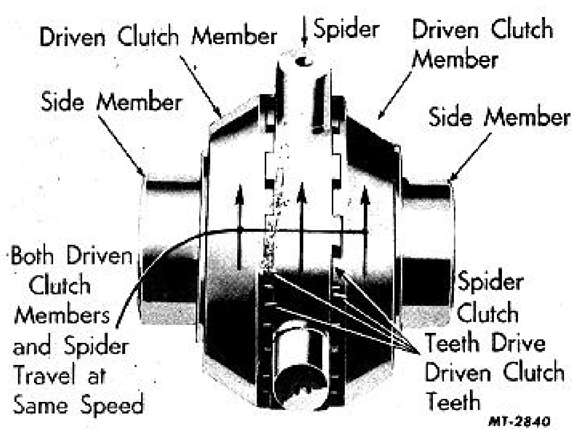

Fig. 38. Right-Hand Turn--Forward Direction

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

When negotiating a right-hand turn in a forward direction, the right-hand driven clutch member remains fully engaged with the spider clutch teeth and the corresponding cams, Fig. 38.

The driving clutch teeth of the spider transmit the driving force to the driven clutch member, which in turn drives the right-hand (inside) wheel constantly at right gear speed, thus propelling the vehicle. The left-hand (outside) wheel covers a greater arc than the right-hand (inside) wheel and driven by the traction of the road, must turn faster than ring gear speed. Likewise, the left-hand driven clutch member must turn faster than the spider. In other words, it permits differences in wheel speeds or differential action. Fig. 39 illustrates how this is accomplished.

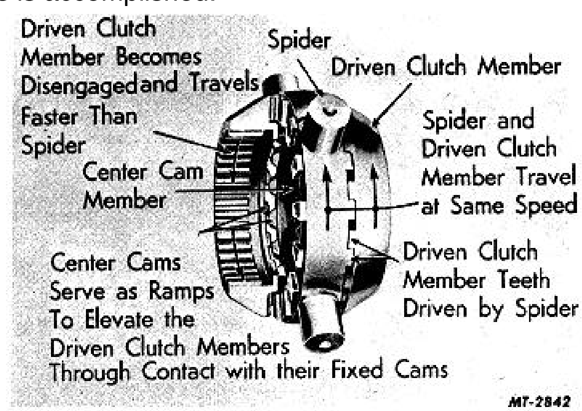

Fig. 39. Forward Right-Hand Turn (Cross Sectional View)

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

This engagement and disengagement or indexing operation continues throughout the turn with a rapidity that is in direct relation to the speed of the overrunning wheel.

As the vehicle completes the turn and is again driven in a straight forward direction, differential action no longer being required, both driven clutch members become fully engaged with the clutch teeth of the spider; then the operation, as described in "Straight Forward Driving, " is resumed.

Forward Right-Hand Turn Braking Condition

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

The symmetrical design of the differential makes it possible to function in the manner described above, which is, in effect, directly opposite to that described as "RightHand Turn--Forward Direction."

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

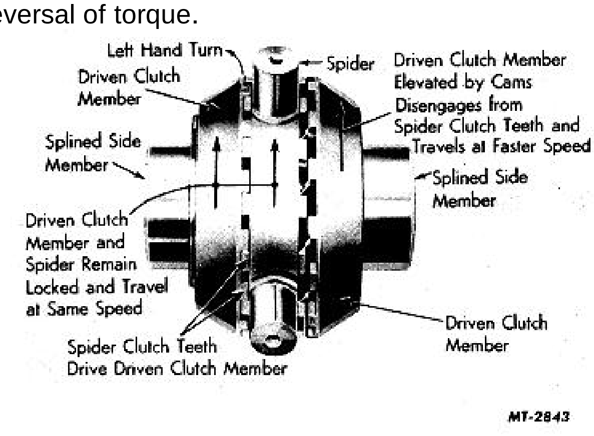

Fig. 40 Left-Hand Turn--Forward Direction

Left-Hand Turn Forward Direction

In making a left-hand turn with the vehicle driven in a forward direction, the left-hand wheel is on the inside of the turn and the power is applied to it so that it must rotate at ring gear speed. The right-hand wheel travels through the greater arc, being on the outside of the turn. Its driven clutch member becomes disengaged from the spider clutch teeth, permitting it to be rotated by ground traction faster than the ring gear, Figs. 40 and 41.

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

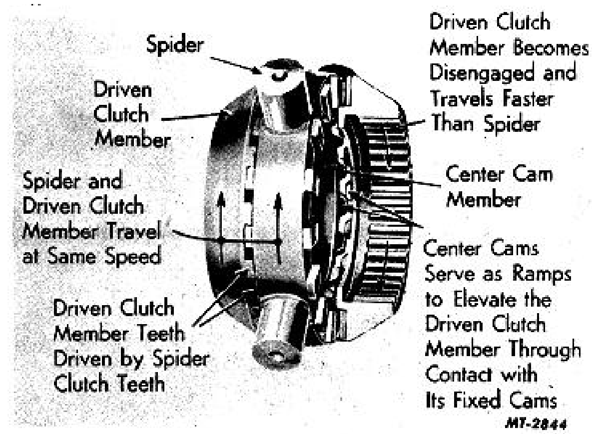

Fig. 41 Forward Left-Hand Turn (Cross Sectional View)

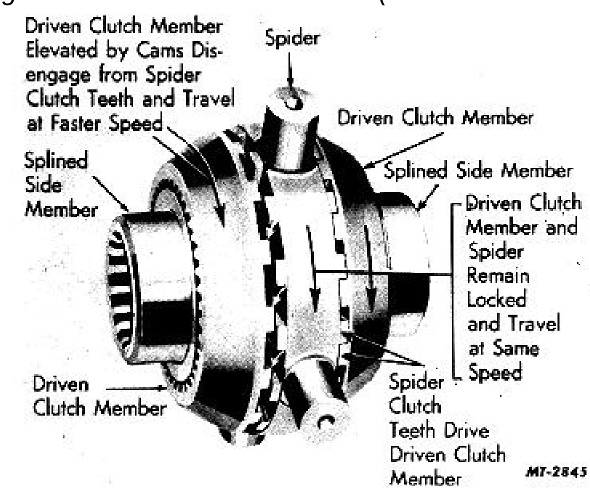

Fig. 42 Right-Hand Turn--Rearward Direction

Rightand Left-Hand Turns Rearward Direction

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

Fig. 42 shows the operation of the differential when a right-hand turn in a rearward direction is being negotiated.

DIFFERENTIAL REMOVAL

The procedure for removing the differential is the same as used for a conventional differential. IMPORTANT PRECAUTION: Before disassembling the differential case, insert a bolt through the center of the NoSPIN unit (axle shaft openings) with a flat washer on each end against the side members, Fig. 43.

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

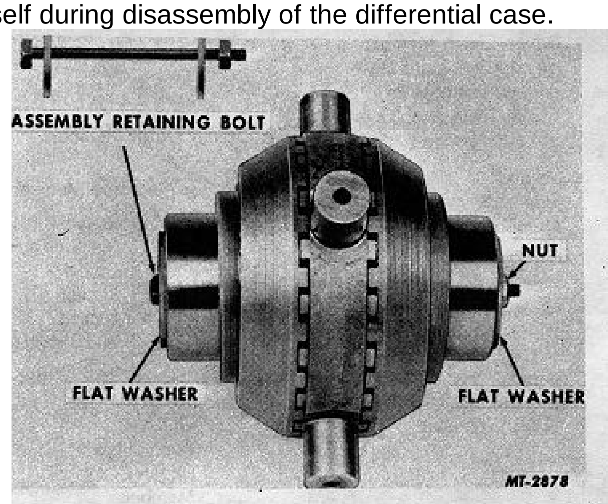

Fig. 43 Inserting Assembly Retaining Bolt

DISASSEMBLY

Remove the bolts from the differential case and lift out the NoSPIN unit. Mount unit in a small press, Fig. 44.

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

Remove unit from press.

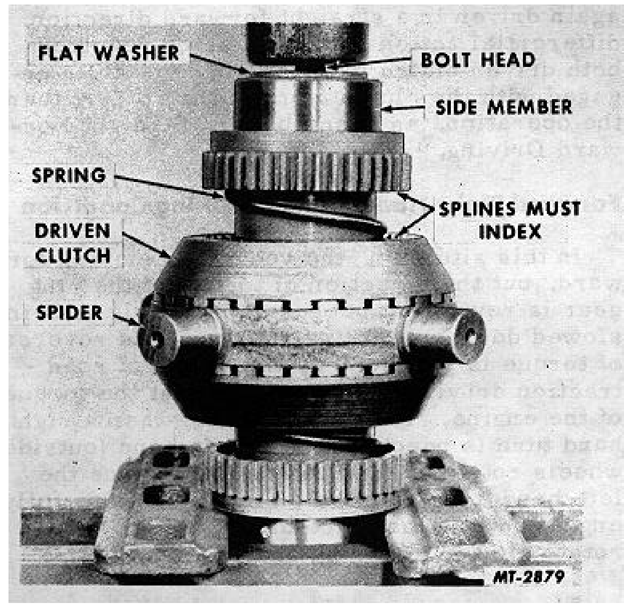

Fig. 44 Release of Spring Pressure

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

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

CLEANING, INSPECTION AND REPAIR

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

REASSEMBLY

Reassembly is essentially the reverse of disassembly. Lubricate all parts with SAE-30 oil during reassembly. Place side member upright and install spring on same. Place spring retainer on spring with flange end toward side member. Install driven clutch member on spring retainer. Place spider on driven clutch member, indexing teeth of same. Install other driven clutch member, spring retainer, spring and side member on spider.

Insert a bolt through the center of the NoSPIN unit with a flat washer against side member. Mount unit in press as shown in Fig. 44. Compress springs by pressing on head of bolt and index splines of side members with those of driven clutch members. NOTE: Keep entire unit aligned in press to prevent it from kicking out while springs are being compressed. Compress unit until side member splines are completely indexed and flush with driven clutch member. Install flat washer on bolt against side member and thread nut on bolt, finger tight, so that it has the appearance of Fig. 43 when removed from the press.

Remove unit from press.

Place unit in differential case and install differential case bolts.

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

IMPORTANT PRECAUTION

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

LUBRICATION

The NoSPIN unit is lubricated with the same lube used in conventional differentials. Fill differential carrier through filler hole until oil is level with hole.

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

COMFORT CONTROL
(BLEND AIR)
HEATING AND AIR CONDITIONING SYSTEM

S-SERIES
VEHICLES

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

CONTENTS (Continued)

PRINTED IN UNITED STATES OF AMERICA

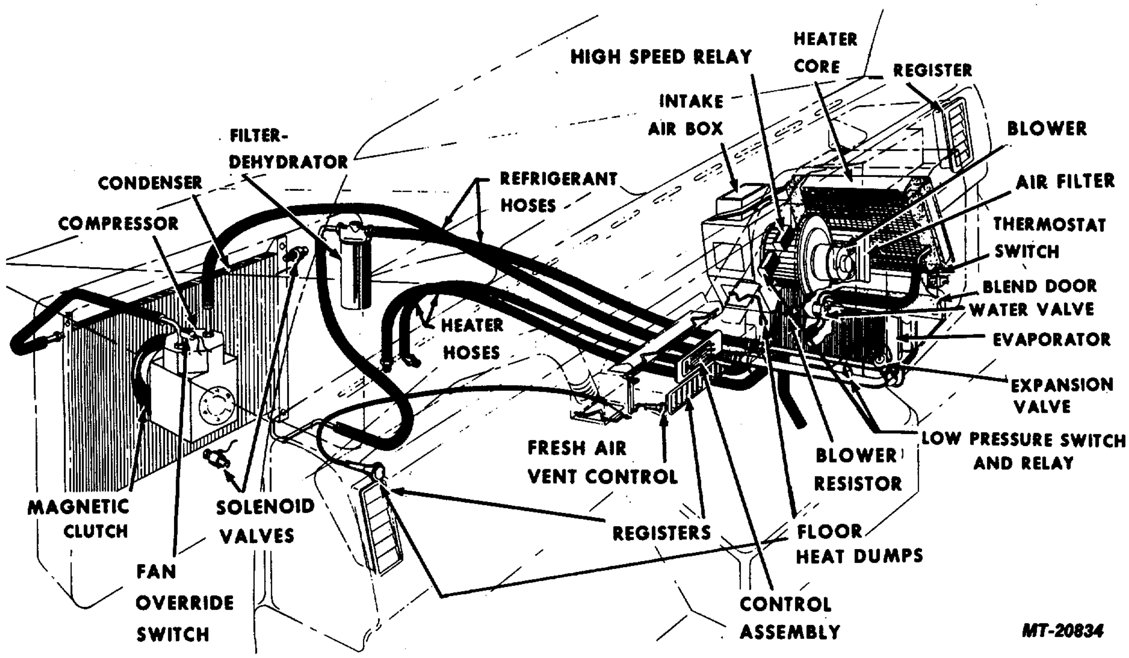

Fig. 1. Comfort Control Heating and Air Conditioning System

DESCRIPTION

The Comfort Control, blend air type heater or combination heater and air conditioner is used in the S-Series medium and medium heavy vehicles.

In the combination system, both the heater core and the air conditioning evaporator are housed in the same unit and utilize the same air ducts, blower and controls. The functions of each system, however, are separate and different. This combination system features compactness, convenience, good air distribution and service accessibility. All components are readily accessible for service resulting in care of maintenance and low service costs.

The heater and air conditioning systems have common distribution ducts with an independently controlled ventilation system. Through control arrangement and common ducting of treated air, the vehicle operator can select any degree of cab interior air temperature in a wide range of cab heating, defrosting, cooling (air conditioning), dehumidification and ventilation modes.

All of the air treated by the heater and air conditioning system comes into the unit through the air intake box. The air intake box has three gravity closed recirculation doors as well as fresh air supply connections to the fresh air chamber which is connected to the fresh air scoop.

From the air intake box, the air goes to the blower and is "pushed" through the evaporator and heater cores. In vehicles with A/C, a replaceable filter is placed ahead of the evaporator to prevent plugging of evaporator with lint or dirt. Once the air goes through the filter and evaporator it can either go through the heater core or bypass the core through the opened blend door. (Hence the term "blend air".) Temperature control is achieved through the blend door and water valve working in combination. Both the water and the air that goes through the heater core is controlled, resulting in a nearly linear temperature response and therefore the best possible cab comfort condition. Once the air leaves the unit, it has been filtered and either cooled, dehumidified or heated depending on operator need.

From the heater/evaporator unit, air enters the duct system where it can be sent to the defroster chamber, various register outlets or the floor heat dumps.

HEATER AND AIR CONDITIONING SYSTEM COMPONENTS

The heater portion of the system employs basic components of any automotive hot water heating system. These include:

1. Heater Core.
2. Hot Water Flow Control Valve.

3. Air Blower. *
4. Heater Hoses.
5. Hot Water Control Cable.
6. Air Ducts* and Defroster Ducts.
7. Intake Air Box. *

* Common with air conditioning system, where equipped.

Major components of the air conditioning system are:

1. Compressor and Clutch Assemblies.
2. Condenser.
3. Filter-Dehydrator (with Sight Glass).
4. Evaporator Core.
5. Air Filter.
6. Expansion Valve.
7. Thermostatic Temperature Control Switch.
8. Low Pressure Switch.
9. Engine Fan Drive Override Switch.
10. Fan Drive Solenoid Valve.
11. Shutter Override Solenoid Valve.
12. Air Blower. **
13. Refrigerant Hoses.
14. Control Cables. **
15. Air Ducts. **
16. Intake Air Box. **

** Common with heater system.

Fig. 2 Combination (Blend Air) Unit

Combination (Blend Air) Unit

The combination heater-air conditioner unit (Fig. 2) is mounted on the dash panel at the right side of the cab.

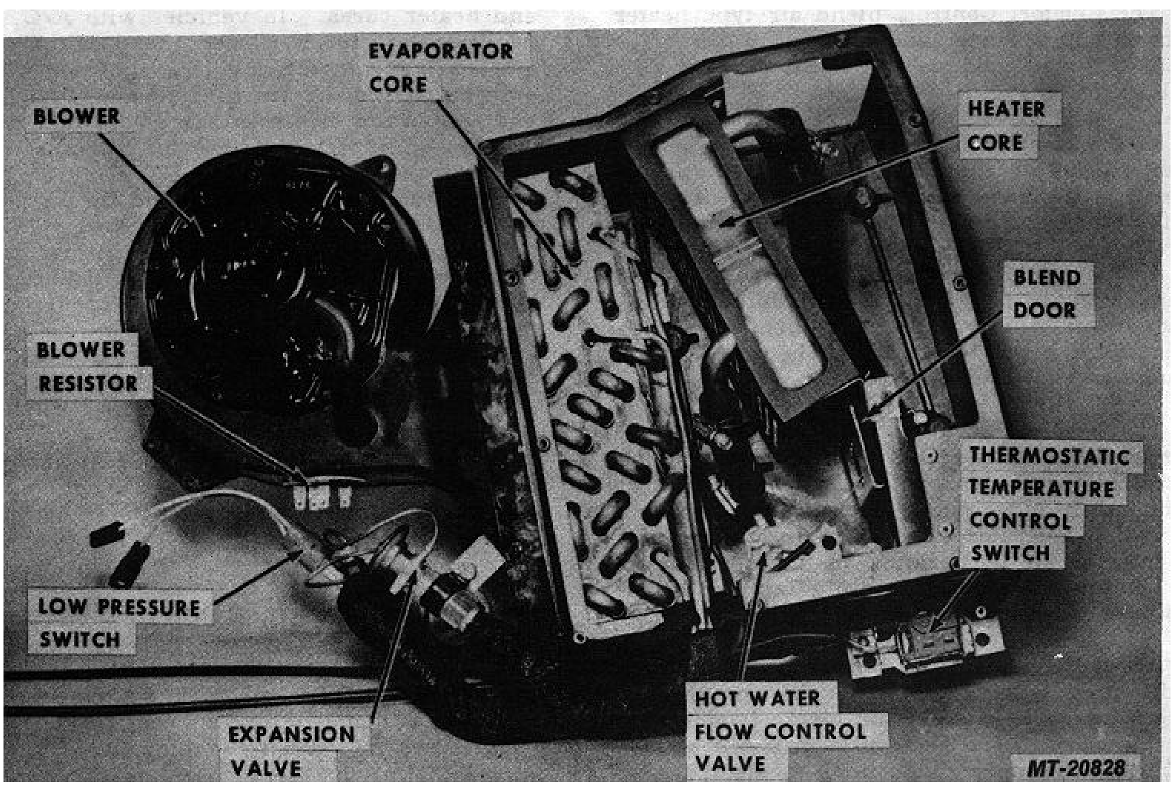

Fig. 3 Components of Combination Unit

Relative positions of heater core, evaporator core, blower fan and motor and other components located in the combination unit are shown in Fig. 3. These components are described in detail later in this .section.

Control Panel Assembly

Major functions of the heater and air conditioning systems are controlled from the control panel assembly (Fig. 4). The control panel has three levers (two levers on vehicles with heater only) and a blower switch.

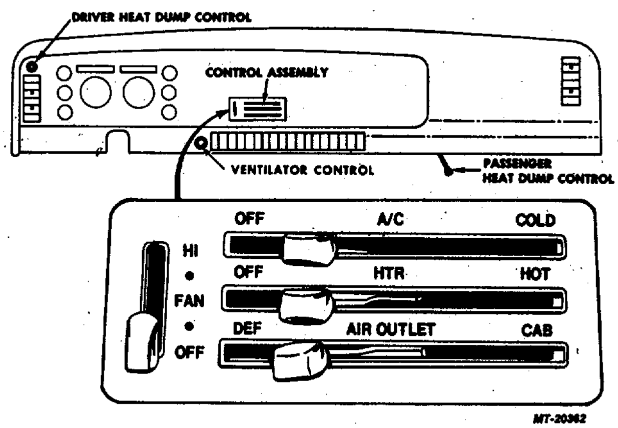

Fig. 4 Control Assembly

The top (A/C) lever operates the air conditioning thermostatic control switch to regulate cab cooling (air conditioning). The center lever (HTR) operates the hot water flow control valve and the blend door to regulate cab heating. The lower (AIR CONTROL) lever divides air flow between DEFROST and CAB AIR outlets.

Separate controls (not in control panel) are provided for operating the fresh air ventilation system and the driver and passenger floor heat dumps.

The three speed blower switch has five terminals. Feed current from a 20 amp fuse enters the switch through terminal "B". Whenever switch lever is moved from the "OFF" position, current is provided through the terminal "A/C" to the thermostat control switch. Terminals "L", "M" and "H" refer to low, medium and high speeds and are energized when the switch lever is moved to their corresponding positions. On vehicles with heater only, the "L", "M" and "H" terminals are wired to the resistor terminals "4", "3" and "1" respectively. On vehicles with air conditioning, the "H" terminal is wired to terminal "4" of the high speed relay. (See wiring circuit diagrams, Figs. 16 and 17.)

The ventilation system is controlled by rotating the "VENT" knob located just to the left of the center instrument panel air outlets. The driver floor heat dump is cable operated from a push-pull control located at the upper left hand corner of the instrument panel. The passenger floor heat dump is operated by a hand lever located under the instrument panel.

Heater Core

The heater core (Fig. 3) is mounted in the combination unit housing. The core is of honeycomb construction. Engine coolant is circulated through the core water passages and heat from the coolant is dissipated to air circulated through the core fins.

Hot Water Flow Control Valve

The hot water flow control valve regulates the flow of hot engine coolant through the heater core. The control valve operates in conjunction with the blend door (Fig. 3).

This arrangement is controlled through cable connected to the second (HTR) lever on the control panel assembly. In the "OFF" position, no coolant is allowed to flow through the heater core and the blend door is in the full open position, bypassing air around the heater core. As the lever moves toward the maximum heat position, the flow of coolant through the core is increased and the air bypassing the core is reduced until at maximum lever travel (HOT) all air flows through the core.

Blower

The blower fan (Fig. 5) provides air circulation through the heater and evaporator cores and delivers the treated air to the cab interior.

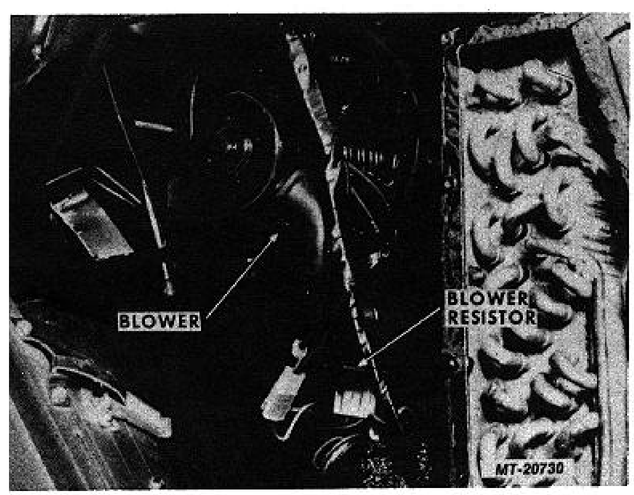

Fig. 5 Air Blower and Resistor

Vehicles with air conditioning have a powerful permanent magnet type blower motor which utilizes a vent tube for efficient motor cooling. On vehicles with heater only, a smaller permanent magnet type motor is used.

A resistor assembly is used in the blower motor circuit to provide three speed settings, "LOW", "MEDIUM" and "HIGH". The resistors are located in the blower air stream to prevent overheating.

On vehicles with air conditioning, a high speed relay is used to accommodate the high current demand of the larger blower motor. This avoids a high current flow through the switch during high speed operation. When the blower is operated on "LOW" or "MEDIUM" speed, current flows from terminal "2" of the resistor assembly to terminal 12" of the relay and out through terminal "1" of the relay to the motor. When the switch is turned to "HIGH", relay terminal "4" is energized, allowing current to flow from a 30 amp fuse to terminal "3" of the relay and out through terminal "1" to the motor. (See wiring circuit diagram, Fig. 17.)

Refrigerant Compressor

The compressor (Fig. 6) is a two-cylinder reciprocating type unit. It is mounted on the engine and belt driven through an electromagnetic clutch mounted on the compressor crankshaft. The compressor compresses and superheats refrigerant gas received from the evaporator and propels the refrigerant through the system.

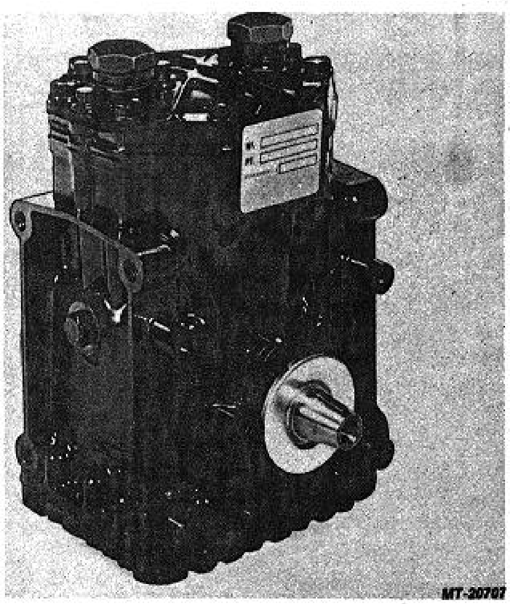

Fig. 6 Refrigerant Compressor

Magnetic Clutch

The electro-magnetic clutch (Fig. 7) is used to couple and uncouple the compressor from the V-belt drive. It cycles the compressor "ON" or "OFF" in response to signals from the thermostatic temperature control switch. When thermostatic switch demands cooling, the clutch is engaged setting the compressor in motion. When cab interior temperature satisfies thermostatic switch, the clutch field coil is de-energized releasing clutch plate from pulley, ceasing compressor operation. Use of a cycling clutch system reduces engine load, maximizes compressor life and enhances fuel economy.

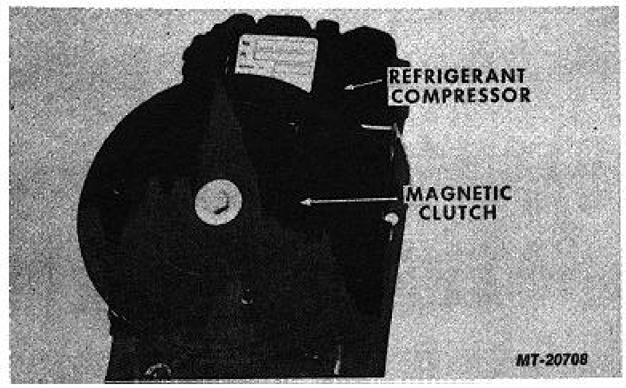

Fig. 7 Magnetic Clutch

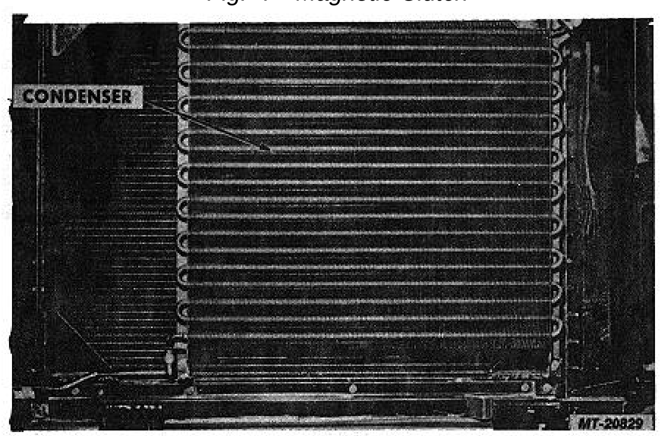

Fig. 8 Refrigerant Condenser

Condenser

The refrigerant condenser (Fig. 8) is mounted at the front of the vehicle between engine cooling system radiator and grille. As refrigerant passes through the condenser, heat that was picked up in the evaporator and during compression is given up to the cooler air flowing through the condenser fins. Refrigerant condenses from a high pressure gas to a high pressure liquid.

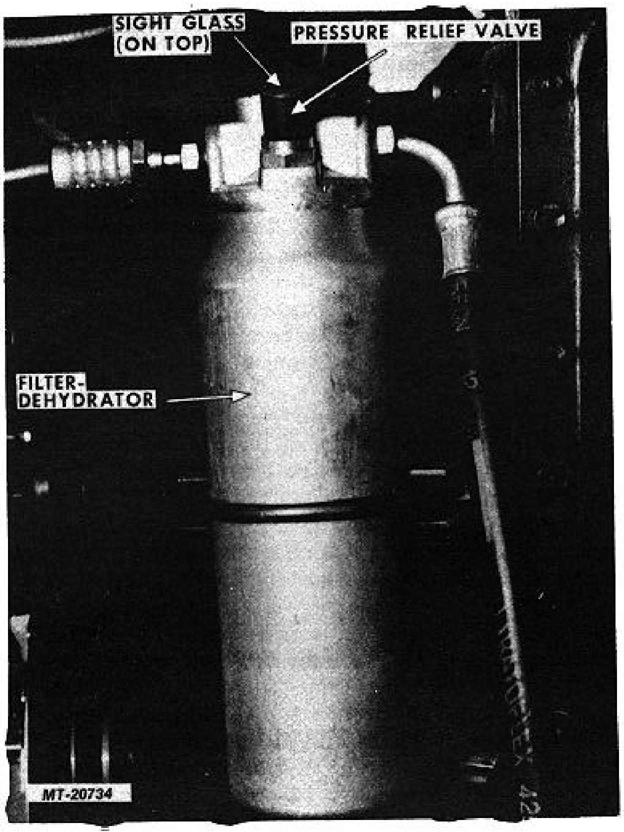

Fig. 9 Filter Dehydrator

Filter-Dehydrator

The filter-dehydrator (Fig. 9) receives the high pressure liquid refrigerant from the condenser and removes any foreign material or moisture which may have entered the system. This unit also serves as a reservoir to store liquid refrigerant until it is needed by the evaporator.

The filter-dehydrator unit incorporates a pressure relief valve which discharges refrigerant into the atmosphere if pressure exceeds 3100 kPa (450 psi). The valve reseals itself automatically when pressure drops below 2750 kPa (400 psi) and does not expel the entire refrigerant charge.

A sight glass used to determine need for adding refrigerant is located at the top of the filter-dehydrator.

Expansion Valve

The expansion valve (Fig. 10) is located between the filter-dehydrator and the evaporator and regulates the flow of refrigerant entering the evaporator.

Leaving the expansion valve, the refrigerant starts to evaporate and expand entering the evaporator as a low pressure liquid-gas mixture.

Attached to the top of the expansion valve is a capillary tube with a feeler bulb which is clamped to the outlet (suction) pipe of the evaporator. The sealed bulb and tube are filled with gas which expands and contracts according to temperature surrounding the bulb. The feeler bulb senses temperature of refrigerant leaving the evaporator. A second capillary tube is attached under the valve diaphragm and is connected to the evaporator outlet (suction) pipe. This is an equalizer line which senses suction pressure. Together, they regulate the amount of refrigerant entering the evaporator.

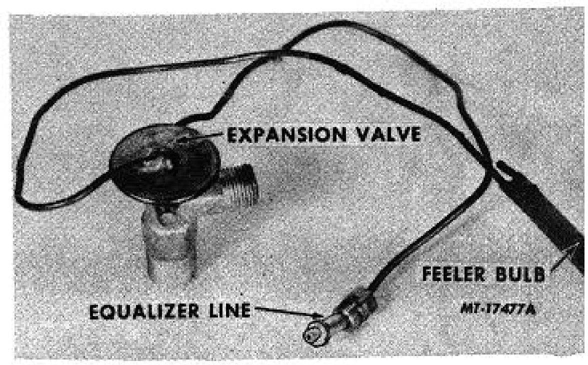

Fig. 10 Expansion Valve

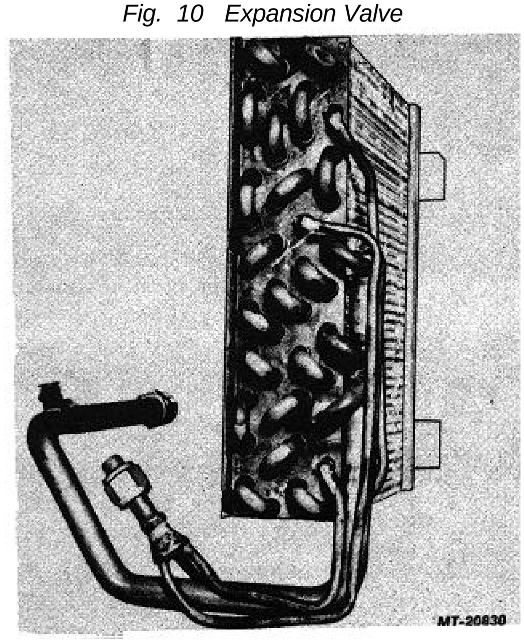

Fig. 11 Evaporator Core

Evaporator

The evaporator core (Fig. 11), mounted in the combination heater-evaporator-blower unit, is of fin-tube construction. Refrigerant entering the evaporator through the expansion valve vaporizes and absorbs heat from the walls of the evaporator tubes and fins which, in turn, draw heat from the air forced through the evaporator by the blower. This absorbing of heat by the refrigerant results in a flow of cool air from the system. Moisture from the air condensing on the evaporator is drained to the exterior of the vehicle via a drain tube.

Air Filter

On vehicles equipped with air conditioning, a replaceable air filter is located between the blower and the evaporator to keep the evaporator fins clean to assure efficient heat transfer.

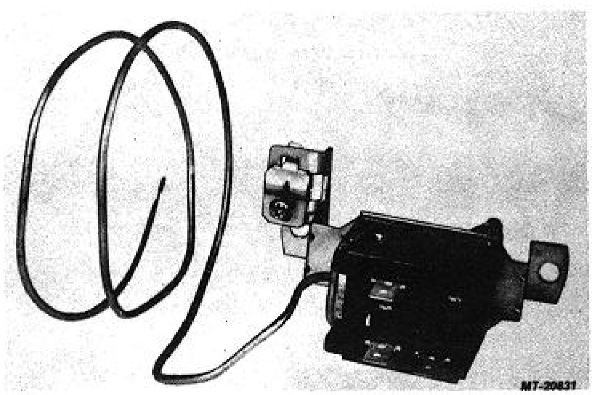

Fig. 12 Thermostatic Temperature Control Switch

Thermostatic Temperature Control Switch

The thermostatic temperature control switch (Fig. 12) is located in the bottom of the combination unit. This switch performs these functions:

1. Turns air conditioning system "ON" and "OFF".
2. Engages and disengages magnetic clutch to start and stop operation of the refrigerant compressor as needed to maintain desired cab cooling.
3. Overrides the engine's radiator shutter control to open the shutters whenever air conditioning system is turned on.
4. Supplies current to the engine fan drive override switch (where equipped).

The thermostatic switch is controlled through a cable connected to the top (A/C) lever of the control panel assembly. With the control lever in the "OFF" position, the magnetic clutch will not engage (air conditioning system will not operate).

As the lever moves from the "OFF" position, two sets of contacts close. The smaller set of contacts, which remain closed through all remaining lever travel, connect feed terminal "2" to terminal "3" supplying current to the shutter override solenoid valve and the fan drive override switch (where equipped). (See wiring circuit diagram, Fig. 17.) The larger set of contacts connect feed terminal "2" to terminal "1" to supply current, via terminals "1" and "2" of the low pressure switch relay, to engage the magnetic clutch. (See Fig. 17.) Compressor cycling (engaging and disengaging the magnetic clutch) is accomplished by making and breaking the larger set of contacts.

Cycling temperature setting is determined by position of the air conditioning control (A/C) lever. Moving the lever to the right decreases the control temperature with maximum cooling obtained when lever is in "COLD" position.

Making and breaking of the larger set of contacts (to engage and disengage the magnetic clutch) is controlled by a bellows connected to a capillary tube filled with refrigerant.

The other end of the capillary tube is located in evaporator core where it senses evaporator fin temperature.

When the fin temperature in the evaporator is higher than the control temperature setting, the refrigerant in the capillary tube expands moving the bellows, overcoming spring pressure and closes the contacts to engage the clutch (operate the compressor). When temperature of the air flow is decreased sufficiently the refrigerant in the capillary tube contracts allowing spring pressure to open the contacts and disengage the clutch.

This compressor on-compressor off cycle repeats as often as necessary to maintain the desired cab temperature.

Low Pressure Switch

A low pressure switch (Fig. 13), located in the evaporator outlet tube, is used to protect the refrigerant compressor from damage in the event of refrigerant loss or if ambient temperature is too low to provide sufficient evaporation of refrigerant.

Insufficient evaporation could result in "slugging" - drawing of liquid refrigerant into the compressor. Also an insufficient flow of refrigerant does not provide adequate compressor lubrication.

If evaporator outlet pressure drops to approximately 34 kPa (5 psi) the low pressure switch closes, throwing the low pressure switch relay, to break the feed circuit to the magnetic clutch and disengage the clutch. (See wiring circuit diagram, Fig. 17.)

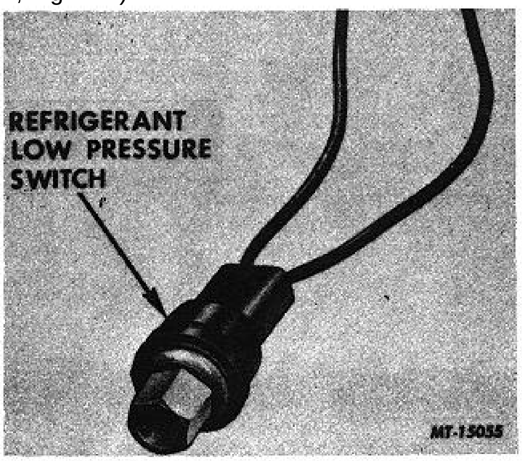

Fig. 13 Low Pressure Switch

Fan Drive Override Switch

Vehicles equipped with an engine cooling fan clutch have a fan drive override switch located in the refrigerant compressor discharge service port.

If compressor discharge pressure exceeds approximately 2070 kPa (300 psi), this switch engages the engine fan drive clutch to provide maximum air flow through the condenser.

The fan drive override switch is similar in appearance to the low pressure switch illustrated in Fig. 13.

Solenoid Control Valves

Two identical solenoid operated control valves (Fig. 14) may be used in conjunction with the air conditioning system to assure that there is sufficient air flowing through the condenser to prevent excessive refrigerant compressor head (discharge) pressure.

The shutter control valve, activated by the thermostatic temperature control switch, opens the radiator shutter and keeps it open (overriding the engine's shutter control) while the air conditioning system is "ON".

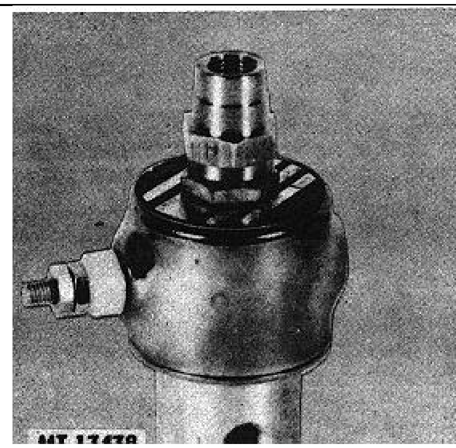

Fig. 14 Solenoid Valve

On engines equipped with an engine cooling fan clutch, the fan drive solenoid valve, responding to activation by the fan drive override switch, engages the fan clutch whenever compressor discharge pressure becomes excessive.

Refrigerant Hoses

Hoses and tubing are used to carry the refrigerant from the compressor to the various components of the air conditioning system and back to the compressor. The hoses (Fig. 15) must withstand certain temperatures and pressures. Therefore it is very important that only hoses of the correct sizes and types be used in the air conditioning system.

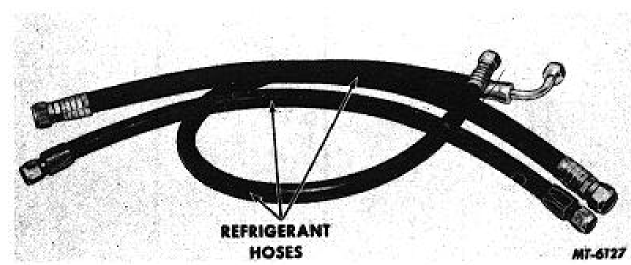

Fig. 15 Refrigerant Hoses

Refrigerant

The refrigerant is the substance which absorbs and removes the heat from the cab. It must be a substance that can be easily converted from a liquid to a vapor and back to a liquid at reasonable temperatures. In other words, it must vaporize at normal ambient temperatures so that it can absorb the heat while passing through the evaporator.

The type of refrigerant used in IH air conditioning systems is R-12.

Wiring Circuit Diagrams

Heater and air conditioning system wiring circuit diagrams are illustrated in Figs. 16 and 17.

For complete vehicle wiring circuit diagrams, refer to ELECTRICAL, Section CTS-2719 of the Truck Service Manual.

COMPONENT IDENTIFICATION CODE
(For Figures 16 and 17)

Key	Component	Key	Component
AA	Heater and A/C Connector	J	Bulkhead Connector
AB	A/C Relays	L	Fuse Block
AC	Blower Motor	Q	Instrument Panel Connector
AD	Thermostatic Temperature Control Switch	R	Key Switch
AE	Blower Switch	V	Feed Stud

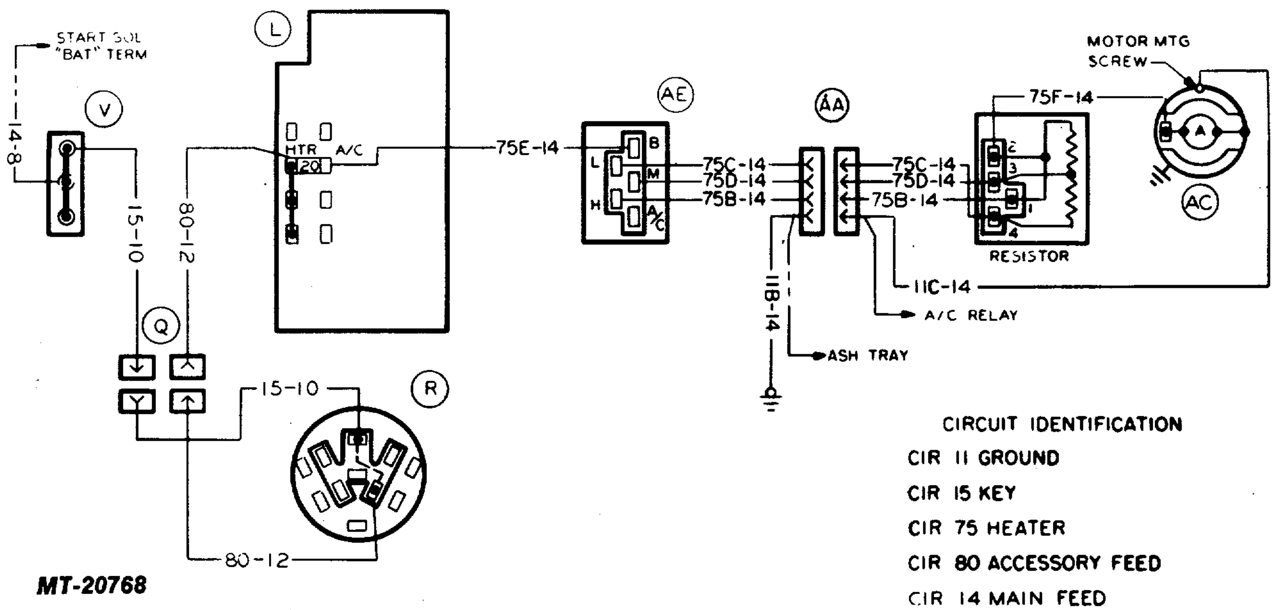

Fig. 16 Heater Wiring Diagram

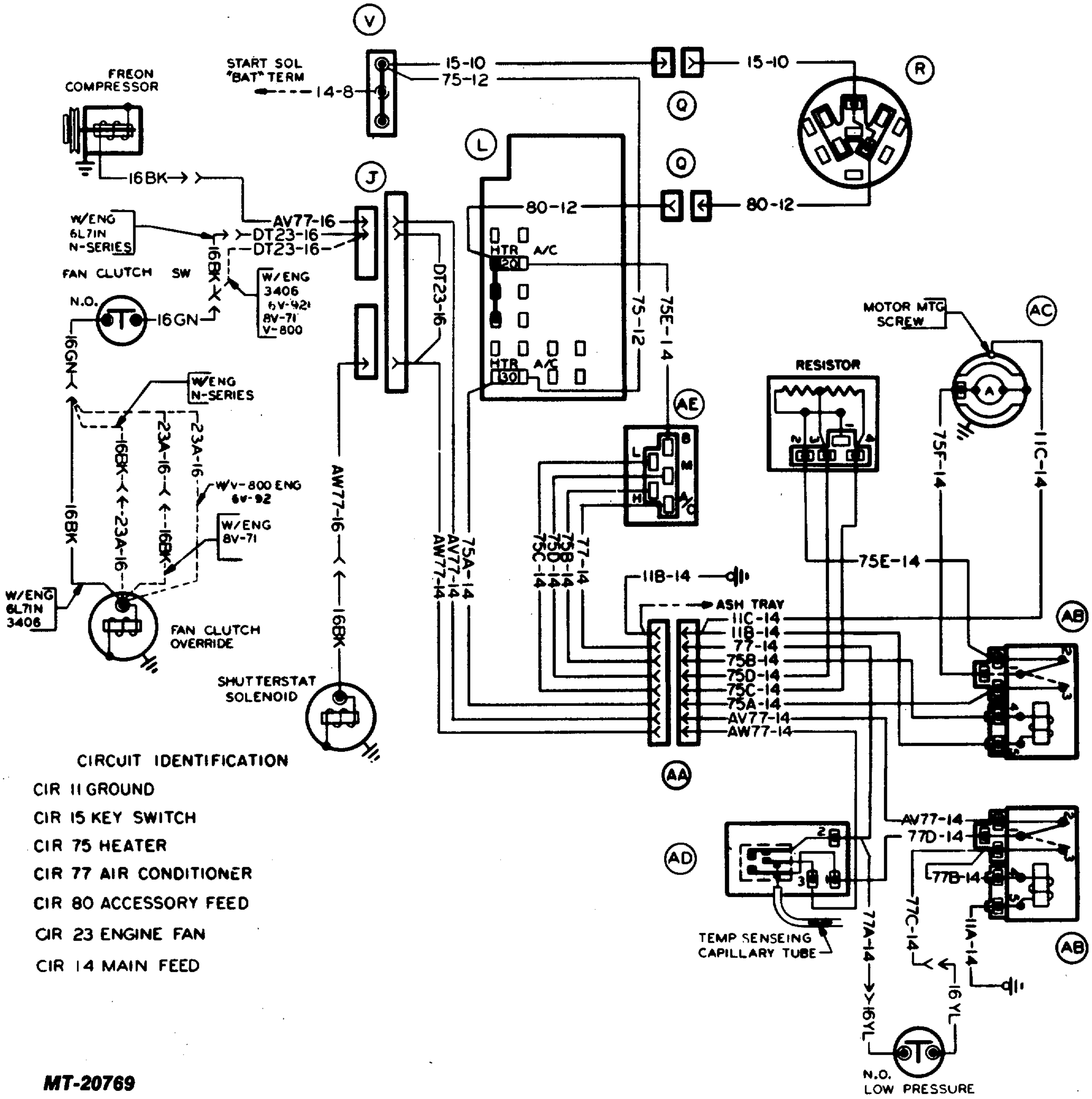

Fig. 17 Heater and Air Conditioner Wiring Diagram

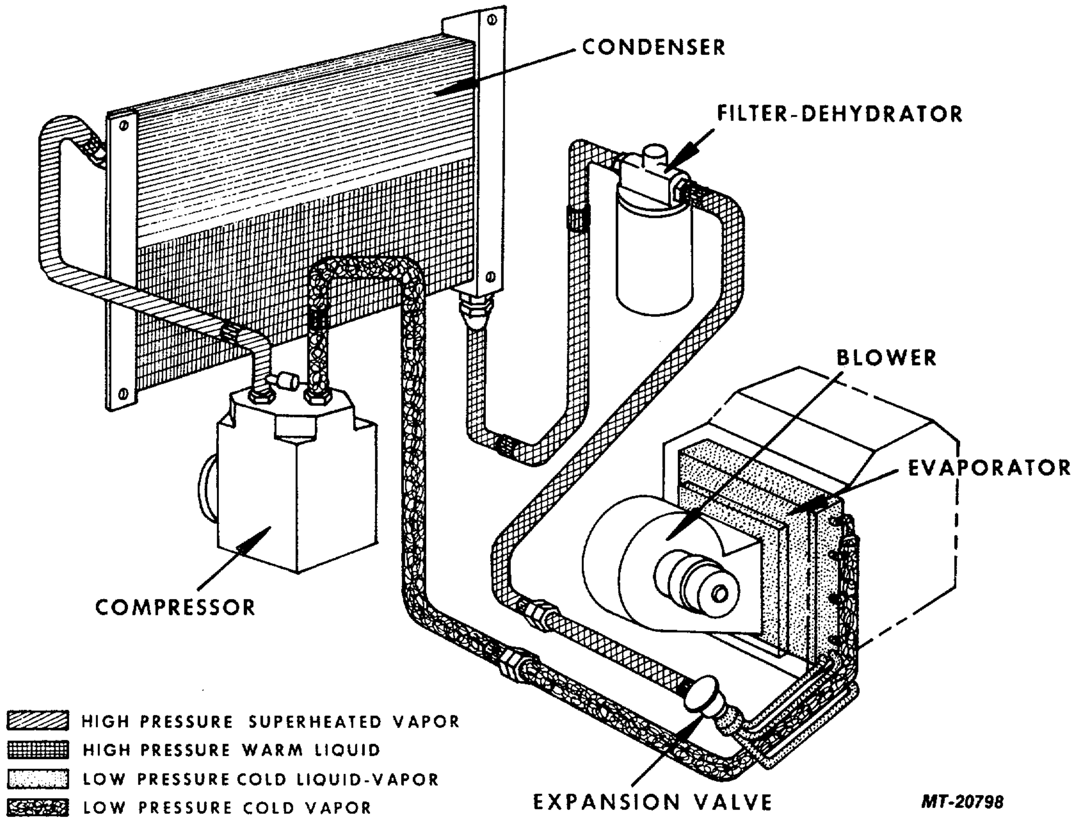

Fig. 18 Refrigerant Flow Through Air Conditioning System

AIR CONDITIONING PROCESS

Operation of the cab air conditioner is basically the same as any mechanical refrigeration system, such as the familiar home refrigerator.

The air conditioning process is a cycle in which the refrigerant (heat absorbing agent) is propelled through a closed system to an area where is absorbs heat from the cab and is then carried to a point where the heat is dissipated to the atmosphere. Let's follow the course of the refrigerant through the various components of the air conditioning system (Fig. 18).

The compressor draws refrigerant vapor from the evaporator and compresses it to high pressure. The temperature of the vapor is increased considerably (superheated) by the compression process. Compressing the refrigerant raises the temperature at which it will condense to liquid. In fact it is raised so high that the vapor under pressure can be cooled sufficiently to condense by a flow of air at normal outside temperatures.

The compressed and superheated vapor flows into the condenser. The air blowing across the condenser fins removes the heat from the refrigerant causing it to condense back to liquid.

Upon leaving the condenser, the liquid refrigerant, under high pressure, is forced into the filter-dehydrator where the drier agent removes any moisture from the refrigerant.

The expansion valve controls the flow of liquid refrigerant into the evaporator. As the refrigerant passes the expansion valve, pressure is reduced suddenly and it vaporizes and expands.

The expansion valve is controlled by a temperature sensing bulb and capillary tube attached to the outlet of the evaporator. If the temperature of the vapor leaving the evaporator becomes too low, the gas in the bulb contracts. This lowers the pressure on the diaphragm and allows spring pressure to close the valve, reducing the flow of refrigerant into the evaporator. If the temperature of the vapor leaving the evaporator increases, the gas within the bulb expands and increases the pressure above the diaphragm in the expansion valve. This action opens the valve to admit more refrigerant into the evaporator and increases the cooling effect.

The refrigerant entering the evaporator expands and begins to vaporize. Complete vaporization requires heat. The refrigerant absorbs heat from the air surrounding the evaporator coils and fins. As heat is absorbed the refrigerant vaporizes.

The blower draws warm air from the cab and circulates it past the evaporator where the heat is absorbed by the refrigerant. Air exhausted by the blower is cool because the heat has been removed.

From the evaporator, the refrigerant is drawn by suction into the compressor. This completes the refrigerant cycle which is repeated continuously until the temperature of the cab interior is lowered to the desired temperature.

Cab interior temperature is controlled by the thermostatic control switch. This control is adjustable to permit the vehicle operator to select the temperature level desired in the cab. The blower has a multi-speed control which permits the vehicle operator to regulate the amount of air circulation.

OPERATION

HEATING

For proper cold weather operation the heat should be directed toward the floor level; therefore, close all instrument panel outlets and fully open both floor dump outlets.

Adjust the temperature "HTR" (heat) lever as required to give the desired degree of heat. The full right "HOT" position provides the maximum heat. Move the "AIR OUTLETS" control lever either to the full cab position or to any of the other three detented positions in order to obtain the desired air flow distribution between cab heat and defrost requirements. For the maximum air flow, move the fan switch to the "HI" position. The heater will also operate with the fan motor in the "OFF" position due to the ram air introduced during vehicle operation.

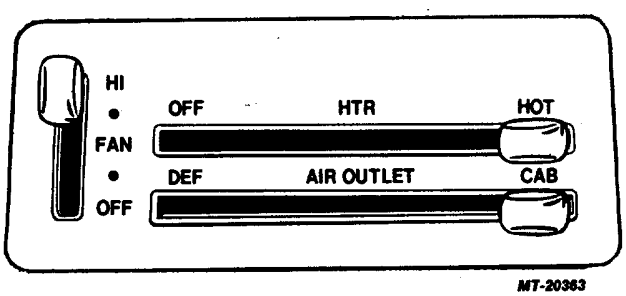

Fig. 19 Heater Controls Set for Maximum Heat

DEFROSTING

To obtain maximum defrosting, move the "HTR" lever to the "HOT" position and place the "AIR OUTLETS" lever on "DEF". Adjust the fan speed to provide the desired air flow.

To clear system of humid air, operate blowers for 30 seconds at "HI" speed before moving the "AIR OUTLETS" lever to the "DEF" position. This will minimize rapid fogging of glass, which can occur if humid air is blown onto a cool windshield.

To improve defroster efficiency, remove ice and/or snow from glass area.

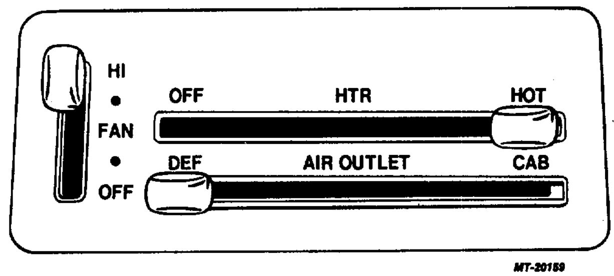

Fig. 20 Heater Controls Set for Defrosting

FRESH AIR VENTILATION

Fresh air enters the cab through either an independent ventilation system or through the heater system itself.

When the "VENT" knob is turned counterclockwise, air enters the cab from the hood scoop and flows through the instrument panel outlets and floor dumps. Except for the ventilation mode, the knob should be rotated to its full clockwise position (vent door closed) for all other modes of operation.

To increase the quantity of air entering the cab in the ventilation mode, the fan may be used to power ventilate. Adjust the fan speed and air outlets for the desired air flow.

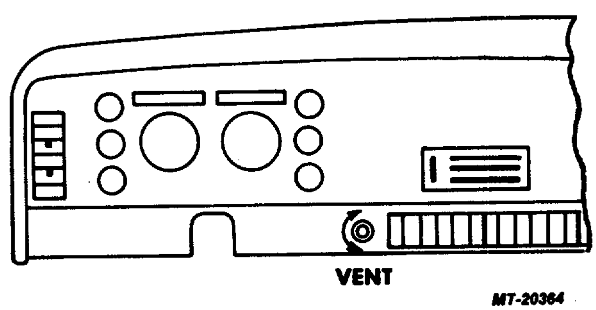

Fig. 21 Ventilator Control

AIR CONDITIONING

To properly air condition your cab in warm weather close both the driver and passenger floor heat dumps and open the instrument panel outlets. Close all windows and ensure the vent knob is turned to its full clockwise position (vent door closed). Set the "HTR" lever on the "OFF" position and "A/C" lever on "COLD". For maximum cooling move the "FAN" switch to the "HI" position. (The fan must be on for A/C operation.) Place the "AIR OUTLETS" lever on the "CAB" position, then adjust the instrument panel outlets to evenly distribute the air around the occupants' head, chest and belt areas. If foot areas feel warm, partially open heat dumps to achieve desired comfort level.

<u>Initial Cooling</u> - Always park in the shade when possible. But if your vehicle has been parked in open sun with the windows up, remove overheated air inside by driving with the windows down for one or two city blocks. You can turn on the air conditioner controls at the time you start the vehicle engine. After a short distance with the windows down, roll them up again -- all the way -- adjust air flow and temperature to your liking.

<u>Stale Air and Smoke</u> - To remove stale air or smoke while air conditioner is operating, you may want to open a window vent slightly for a short period of time.

Small amounts of water draining out of air conditioner's drain tube is normal. This is condensed moisture which has been removed from the air inside your vehicle.

The air conditioning system incorporates a low pressure switch which throws a relay to disengage the compressor clutch if evaporator outlet pressure falls below a certain level. To restart the air conditioning after an automatic shut-down has occurred, the operator must do one of the following:

1. Place "A/C" lever in "OFF" position and then back "ON",

OR

2. Place blower switch in "OFF" position and then back "ON".

If system continues to shut down automatically, it will be necessary to diagnose the system for the cause of low pressure.

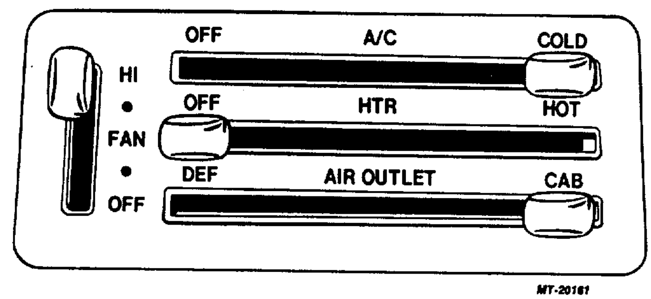

Fig. 22 Air Conditioning Controls Set for Maximum Cooling

DEHUMIDIFICATION

The heater-defroster systems can be operated simultaneously with the air conditioner during mild weather and high humidity conditions for dehumidification of the moist air. To obtain maximum dehumidification, set the "A/C" lever to "COLD", place the fan switch on "HI" and move the "HTR" lever towards "HOT" until a comfortable temperature is maintained. The air conditioner will remove the humidity while the heater keeps the cab comfortable.

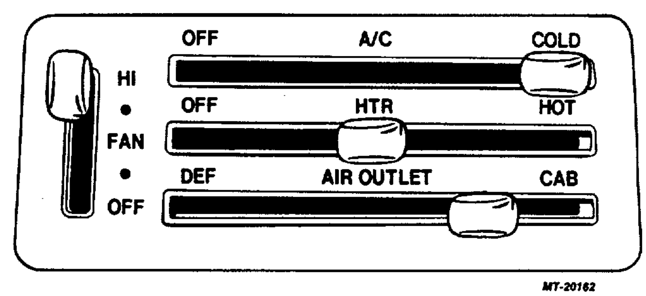

Fig. 23 Controls Set for Dehumidification of Cab

PERIODIC MAINTENANCE

To assure optimum operating efficiency, heating and air conditioning systems must be properly maintained. (See MAINTENANCE OPERATIONS.)

SAFETY PRECAUTIONS

Refrigerant 12 is classified as a safe refrigerant; however, certain precautions must be observed to protect the parts involved and to prevent personal injury to the serviceman.

One of the most important safety measures to be taken while servicing the air conditioning system is adequate and constant protection of the eyes. Safety goggles or other adequate eye protection must be worn. The temperature of liquid refrigerant is a -29.5 deg. C (-21.7 deg. F). Serious injury or blindness could result from refrigerant contacting the eyes.

If refrigerant should contact the eyes, DO NOT rub them. Splash the eyes with cold water to gradually get the temperature above the freezing point. Consult a doctor or eye specialist immediately.

Should liquid refrigerant come in contact with the skin, the resulting injury should be treated the same as though the skin has been frostbitten or frozen.

Liquid refrigerant evaporates so rapidly that the resulting gas may displace the oxygen surrounding the work area, especially if that area is relatively small and enclosed.

To prevent possible suffocation in an enclosed area, always discharge the refrigerant from the air conditioning system out-of-doors or into an exhaust collector system. Be certain that good ventilation is always maintained around the work area when discharging the system.

Do not smoke or allow any type of fire or flame in the immediate area while servicing the refrigeration system. Refrigerant 12 is not combustible; however, in the presence of fire it changes to a highly poisonous and deadly phosgene gas. This gas will also tarnish bright metal surfaces.

Never weld, solder, steam clean or use any excessive amount of heat on any of the refrigerant lines or components of refrigeration system while the system is charged. Heat applied to any part would cause the pressure of the refrigerant within the closed system to become excessive.

Be certain that pressurized refrigerant containers are never exposed to open flame or temperatures above 51 deg. C (125 deg. F). Do not discard empty refrigerant containers where they are likely to be subjected to the heat of trash burners, etc.

Always use correct refrigerant hoses (freon type) when replacing them. Do not use hoses other than those specified for refrigeration use.

SPECIAL SERVICE TOOLS

Servicing the air conditioning system effectually requires proper tools and equipment especially designed for this work. Recommended tool equipment is shown below.

For further information and sources of this equipment refer to Service Tool Manual, CTS-1147.

High Vacuum Pump

The SE-2446 High Vacuum Pump (Fig. 24) is used to evacuate air and moisture from the air conditioning system prior to charging the system with refrigerant. This pump is capable of removing all moisture and non-condensable gases from the system.

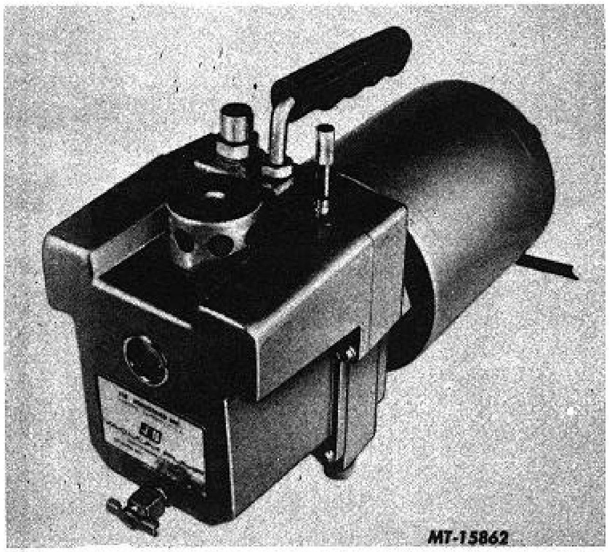

Fig. 24 High Vacuum Pump (SE-2446)

High Vacuum Meter Kit

The SE-2447 High Vacuum Meter Kit (Fig. 25) is used in conjunction with the high vacuum pump. This meter provides a continuous visual monitor on the evacuating operation and serves as a guarantee that the air conditioning system is adequately dehydrated (moisture removed), degassed (non-condensable gases removed) and free from leaks.

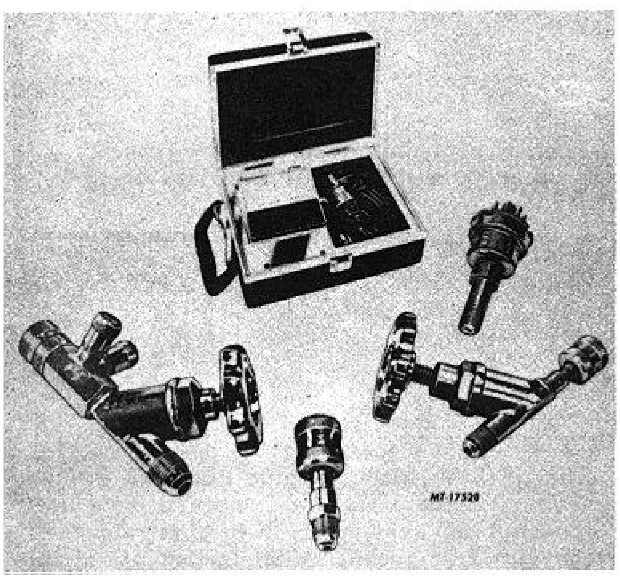

Fig. 25 High Vacuum Meter Kit (SE-2447)

Manifold and Gauge Set

The SE-2444 manifold and gauge set (Fig. 26) incorporates the necessary pressure and vacuum gauges, control valves and fittings for evacuating, charging and testing the air conditioning system.

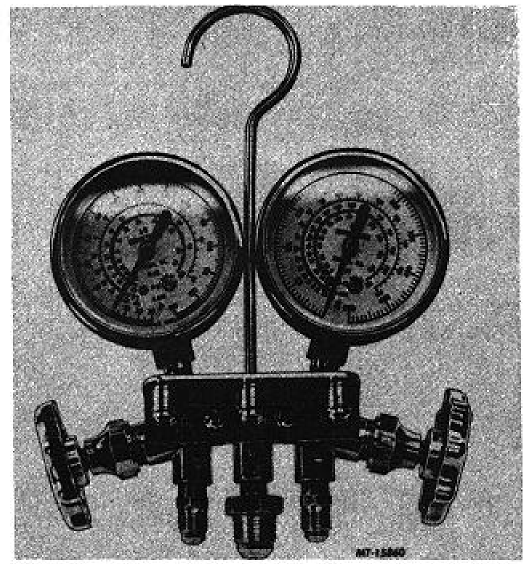

Fig. 26 Manifold and Gauge Set (SE-2444)

Service Hose Set

The SE-2445 service hose set (Fig. 27) is used to connect the manifold and gauge set, vacuum pump and refrigerant containers (or charging cylinder) to vehicle air conditioning system service ports.

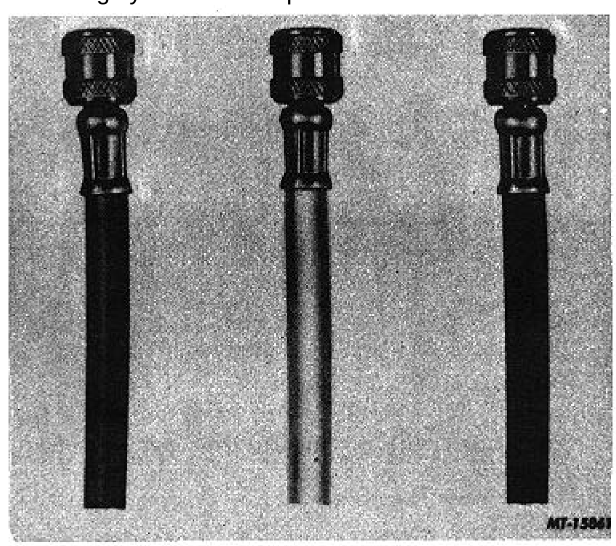

Fig. 27 Service Hose Set (SE-2445)

Heated Charging Cylinder

The SE-2448 Heated Charging Cylinder (Fig. 28) heats the refrigerant to permit quicker charging of the air conditioning system. Use of this tool also permits purchase of refrigerant in large, economical drum containers.

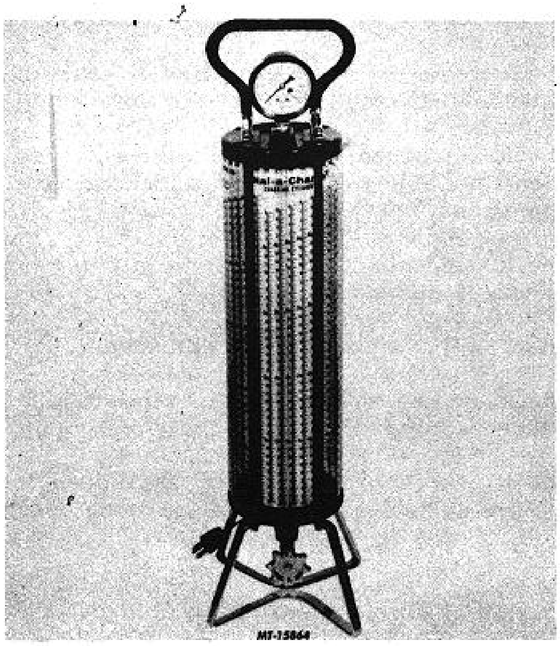

Fig. 28 Heated Charging Cylinder (SE-2448)

Electronic Refrigerant Leak Detector (Audible Type)

The SE-2449 Refrigerant Leak Detector (Fig. 29) is used to check for refrigerant leaks throughout the entire air conditioning system. When this detector senses a refrigerant leak, an audible signal (sound) is emitted.

Fig. 29 Electronic Refrigerant Leak Detector -Audible Type (SE-2449)

Electronic Refrigerant Leak Detector (Visual Type)

The SE-2272 Refrigerant Leak Detector (Fig. 30) has the leak sensor and a neon signal light mounted in a probe. When the probe encounters a refrigerant leak, the signal light blacks-out. The neon lamp glows steadily if a leak is not present.

Fig. 30 Electronic Refrigerant Leak Detector -Visual Type (SE-2272)

Refrigerant Can Adapter Valve

The SE-2450 Refrigerant Can Adapter Valve (Fig. 31) is used to connect either flat top or screw top type one-pound refrigerant containers to the manifold and gauge set for charging or adding refrigerant to the air conditioning system.

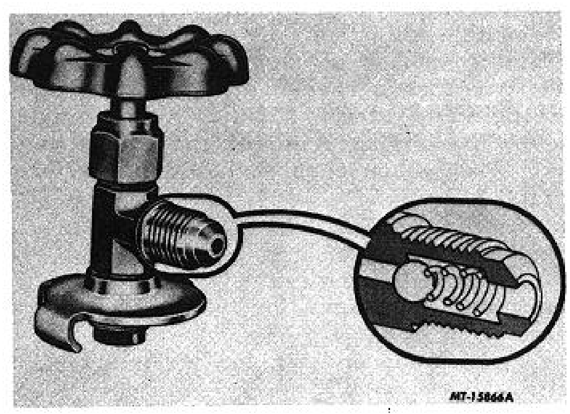

Fig. 31 Refrigerant Can Adapter (SE-2450)

Portable Air Conditioning Service Station

The SE-2443 Portable Air Conditioning Service Station (Fig. 32) consists of Manifold Gauge Set (SE-2444), Service Hose Set (SE-2445), High Vacuum Pump (SE-2446) and High Vacuum Meter Kit (SE-2447) mounted on a convenient cart. Space is also provided for mounting the Heated Charging Cylinder (SE-2448).

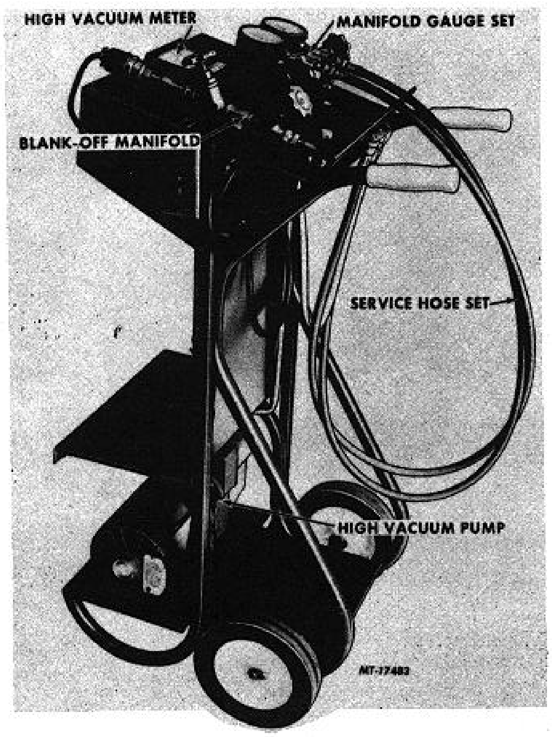

Fig. 32 Portable Air Conditioning Service Station (SE-2443)

MAINTENANCE OPERATIONS

PRE-SEASON CHECKS

Experience has shown that many problems incurred with heating and air conditioning systems result from lack of regular maintenance. Complete pre-season check outs of heating and air conditioning systems will aid in obtaining satisfactory performance during the operating seasons. Pre-season checks should be performed as outlined below.

With Heater Only:

1. Check unit mountings for looseness.
2. Check condition and tension of all drive belts.
3. Check cleanliness of coolant. Clean cooling system if necessary and add new coolant.
4. Check to see that radiator core fins are not plugged with bugs or leaves, etc.
5. Check heater core fins for lint or other material that could restrict air flow.
6. Check adjustment of control cables. (See "Control Cable Adjustment" under Service Operations.)
7. Check operation of blowers. Clean blower wheels if necessary.
8. Check water control valve adjustment.
9. Check cooling system shutter operation (where equipped).
10. Check condition of heater hoses and engine cooling system hoses. Replace if necessary.

With Heater and Air Conditioner:

1. Perform pre-season check of heater portion of system as outlined above under "With Heater Only".
2. Check compressor belt alignment and tension. (See "Compressor Belt Tension Check".)
3. Check condition of refrigerant hoses and tubing. Look for cracks, chafing or other damage and replace as needed. Inspect all tubing and hose connections. All connections must be clean and tight.
4. Install new air filter. (See "Air Filter Replacement".)
5. Clean condenser, radiator, evaporator core and blowers of all dirt, lint or other foreign material. Cleanliness of these components cannot be overemphasized. Lack of proper attention in this area is one of the major causes of unsatisfactory unit operation. As often as necessary, squirt water through condenser towards radiator and through radiator towards condenser to flush debris out of fins. Do not cover the condenser with a screen wire.
6. Operate air conditioning system with controls set for maximum cooling (A/C lever on "COLD", blower switch on "HIGH") for about five (5) minutes.

   With system operating:

a. Determine that system is operating properly. (See "Physical Checks" under SERVICE OPERATIONS.)

b. Observe sight glass for bubbles (Fig. 33). Sight glass should appear clear (no bubbles). Bubbles indicate a low refrigerant charge. Add refrigerant. (See "Adding Refrigerant to System" under SERVICE OPERATIONS.)

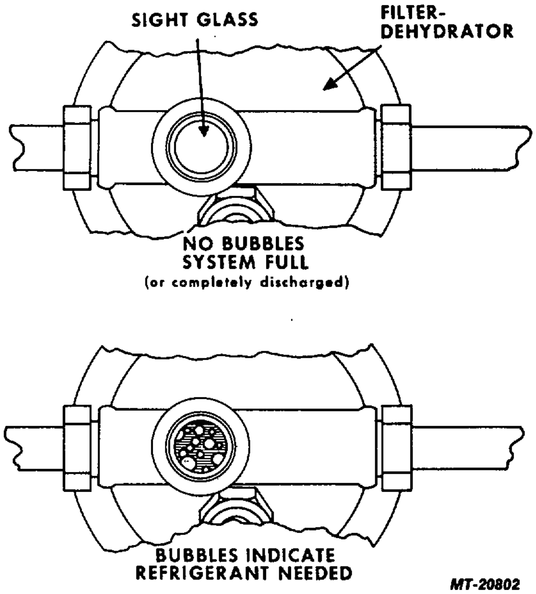

Fig. 33 Sight Glass Indications

7. Shut off engine and check air conditioning system for refrigerant leaks using an electronic leak detector. Follow equipment manufacturer's instructions.

OFF SEASON CARE

Heater

It is a good practice to operate the heater occasionally during the summer season. This will circulate coolant through the heater core to remove any trapped air and flush out possible accumulations of sediment.

Air Conditioner

An important facet of off-season care of the air conditioning system is periodic operation of the unit. Operating the unit for five minutes twice a month after engine warm-up keeps the compressor seals lubricated. If the seals dry out, they may crack and leak.

Also, if the system is not operated periodically, clutch and compressor bearings could become brinnelled. This is caused by the continual hammering effect on the bearing surface in the same spot from normal vibration during vehicle operation. Do not remove the compressor drive belt during the off-season.

In general, the system will function with less trouble if it is not permitted to remain idle over long periods.

AIR FILTER REPLACEMENT

The air conditioning system air filter element should be replaced every year at the beginning of the operating season. More frequent replacement may be required on vehicles operated in dusty areas.

Replace air filter as follows:

1. Remove cover from right side of instrument panel.

2. Remove cover from heater/evaporator unit.

3. Remove seal mounting strip (with seal) from blower housing (Fig. 34).

4. Remove old filter element.

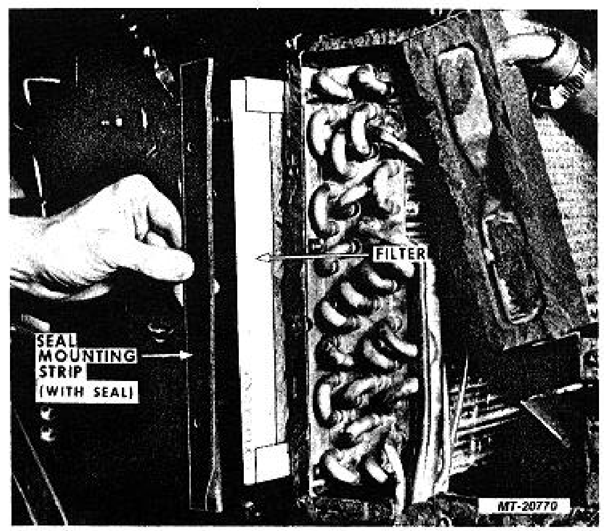

Fig. 34 Replacing Air Filter

5. Install new filter element. Be sure arrow on element frame points in direction of air flow (away from blower).

6. Inspect seal and replace if damaged. Attach new seal to mounting strip with weatherstrip adhesive.

7. Install seal mounting strip (with seal) on blower housing.

8. Install covers on heater/evaporator unit and instrument panel.

COMPRESSOR DRIVE BELT ALIGNMENT AND. TENSION CHECK

Air conditioning (freon) compressor drive belt alignment and tension should be checked prior to the air conditioning season and at least three or four times during the year.

1. Inspect drive belt(s) and replace if worn or damaged.

2. Check belt and pulley alignment and make any necessary corrections.

3. Using belt tension gauge, check belt tension mid-way between the compressor pulley and driving pulley. For specified belt tension, see SPECIFICATIONS.

Belt tension adjustment procedures vary between engine models. Some installations require movement of the compressor on its mounting to adjust belt tensions. Some have adjustment screws to manipulate the compressor for belt adjustment. Others require movement of the alternator.

SERVICE OPERATIONS

IMPORTANT

Certain precautions must be observed when servicing the air conditioning system. (See SAFETY PRECAUTIONS and also "Service Hints" under COMPONENT REMOVAL AND INSTALLATION.)

PHYSICAL CHECKS

Heater and Defroster

1. With heater control (HTR) lever and blower switch "OFF", operate engine until normal operating temperature is obtained.

2. With engine warmed up, heater inlet hose should feel hot to the touch and heater outlet hose should feel cool (or only slightly warm). If both hoses are hot, check for a faulty or mis-adjusted heater control cable or a faulty water flow control valve.

3. Set heater controls for maximum heat (HTR lever on "HOT", blower switch on "HIGH") and operate engine and heater for a few minutes to permit system to normalize. Both inlet and outlet heater hoses should flow from heater outlets. If neither hose feels hot or if only the inlet hose is hot, refer to "No Heat" in TROUBLE SHOOTING GUIDE.

4. Manipulate AIR CONTROL lever between "DEF" and "CAB" positions and check for warm air flow from defroster and heater outlets. If air flow is not correct in relation to lever position, check for faulty or mis-adjusted control cables or faulty air door seals.

Air Conditioning System

1. With air conditioning controls set for maximum cooling, (A/C lever on "COLD", blower switch on "HIGH"), operate engine and air conditioning system for about five (5) minutes or until initial heat has been removed from cab and an average flow of cold air is achieved.

If system does not cool, refer to "No Cooling" in TROUBLE SHOOTING GUIDE.

2. With system operating, feel all air conditioning system components and refrigerant lines for proper operating temperatures.

   From the discharge side of compressor along high pressure line, through condenser, filter-dehydrator tank and up to expansion valve, everything should be hot or warm to the touch. The expansion valve, evaporator and all of the lines on the low pressure side leading back to the compressor should be cool to the touch. Any deviation from the above conditions indicates a malfunction in the system.

   A stoppage or severe restriction in the refrigerant system can be located in this manner. Malfunctions or stoppages may be indicated by extreme cold or frosted areas (e.g., a cold filter-dehydrator tank frosted part way up indicates a stoppage or serious restriction in the tank).

CAUTION

Avoid contact with moving belts, pulleys and fan when making this check. Beware of extremely high temperatures at compressor outlet (discharge) hoses and tubing.

AIR CONDITIONING PERFORMANCE CHECK (PRESSURE TEST)

This performance test can be used to determine if the air conditioning system is properly charged and functioning correctly.

The procedure for making the performance check utilizing the SE-2443 Portable Service Station is outlined below.

1. Park vehicle in an area with low air movement. Place transmission in neutral and apply brake.

2. Open cab doors. Close all cab ventilators. Raise hood.

3. Connect SE-2443 Service Station to air conditioning system service ports as follows: (See Fig. 35)

   a. Close manifold suction and pressure gauge valves. (Turn fully clockwise.)

   b. Remove cap from compressor suction service port. Connect manifold suction gauge hose to compressor suction service port.

   c. Remove cap or engine fan drive override switch (if equipped) from compressor discharge service port.

   Connect manifold discharge gauge hose to compressor discharge service port.

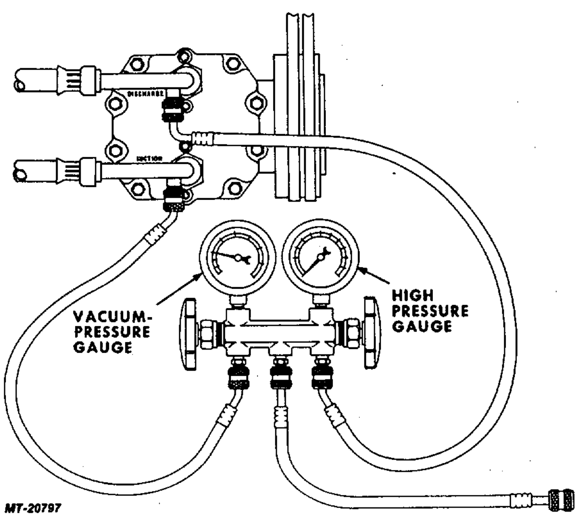

Fig. 35 Manifold and Garage Set Connected to Compressor Service Port

4. Position a thermometer about 305-610 mm (12-24") in front of vehicle grille to measure ambient temperature of air entering condenser.

5. Insert another thermometer through center of passenger air conditioning air outlet. Do not let thermometer touch side of air duct.

6. Set air conditioning controls for maximum cooling (A/C lever at "COLD", blower switch on "HIGH").

7. Operate engine at RPM specified in "Engine Speed Chart" under SPECIFICATIONS for about ten (10) minutes. Then:

   a. Observe and record ambient temperature of air centering vehicle grille.

   b. Observe and record cool air outlet temperature.

   c. Observe and record discharge and suction pressure gauge readings.

8. To evaluate air conditioning system performance, compare readings obtained in Step 7 with those listed in the "Operating Pressure Test Chart" under SPECIFICATIONS.

   If readings obtained from vehicle are not within limits specified in the chart, refer to TROUBLE SHOOTING GUIDE for causes of abnormal pressures. Make necessary repairs.

9. After pressure test is completed disconnect manifold and gauge set hoses from compressor service ports. Install cap on compressor suction service port. Install cap or fan drive override switch (if equipped) on compressor discharge service port.

IMPORTANT

To keep foreign material out of manifold and gauge set hoses, always attach ends of hoses to bracket on service station when not in use.

10. Check air conditioning system for refrigerant leaks using an electronic leak detector. Follow equipment manufacturer's instructions.

11. Close hood and cab doors.

DISCHARGING THE AIR CONDITIONING SYSTEM

Whenever it becomes necessary to open the air conditioning refrigerant system to remove or service components, the refrigerant charge must be removed from the system.

To discharge the system, utilizing the SE-2443 Portable Service Station, proceed as outlined below:

1. Raise hood.

2. Connect SE-2443 Service Station to air conditioning system service ports as follows:

    a. Close manifold suction and discharge gauge valves (turn fully clockwise).

    b. Remove cap from compressor suction service port. Connect manifold suction gauge hose to compressor suction service port.

    c. Remove cap or engine fan drive override switch (if equipped) from compressor discharge service port. Connect manifold discharge gauge hose to compressor discharge service port.

    d. Route the service hose from the center manifold fitting into the shop exhaust removal system or out of doors.

3. Open the manifold gauge valves a slight amount and allow refrigerant to discharge SLOWLY.

    Do not allow refrigerant vapor to discharge too rapidly as it will carry out the compressor oil as well.

    When refrigerant has been discharged, both manifold gauges will read zero.

4. After refrigerant has been removed, air conditioning system components can be removed for service.

CHECKING COMPRESSOR OIL LEVEL

The compressor is designed to provide a pressurized oiling system where required, without the use of a mechanical pump. As long as a refrigerant flow is maintained, a certain amount of oil will circulate with the refrigerant through the system. When the compressor is operating, there is a pressure difference between the top of the cylinder and the crankcase. This pressure difference causes some oil to be forced down the cylinder wall, thus lubricating some of the compressor parts.

Since some of the oil from the compressor pump is picked up and circulated through the system with the refrigerant, it is very important that the compressor oil level be checked whenever the system is opened for service.

To check compressor oil level, proceed as follows:

1. Discharge refrigerant from system. (See "Discharging the Air Conditioning System".)

2. Remove oil fill plug from side of compressor (Fig. 36).

    In some cases it may be necessary to remove compressor from engine to gain access to oil fill plug.

Fig. 36 Compressor Oil Fill Plug

3. Insert dipstick through oil fill hole until it bottoms in compressor crankcase.

    It may be necessary to rotate compressor crankshaft slightly to permit entrance of dipstick. Be certain that dipstick is bottomed in crankcase.

    Dipstick can be made locally from a 3.175 mm (1/8") diameter steel rod as shown in Fig. 37, or is available under service tool number SE-2392-3.

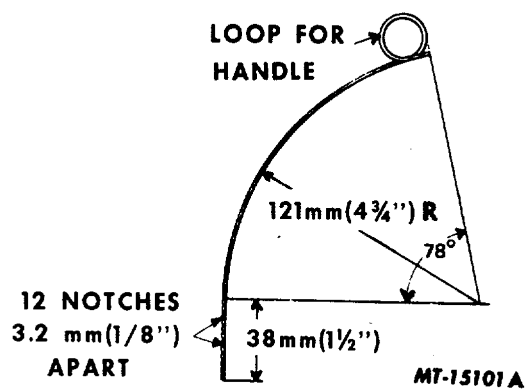

Fig. 37 Dimensions for Making Oil Level Dipstick

4. Remove dipstick and measure wetted portion to determine oil level in compressor. Compare oil level reading with specified oil level listed in SPECIFICATIONS.

   If necessary, add refrigeration oil to obtain specified level. (Refer to SPECIFICATIONS for oil type.)

   If oil level is higher than specified, draw out excess oil to obtain correct level.

   After establishing correct oil level, reinstall oil fill plug and gasket. Tighten plug to torque value listed in TORQUE CHART

   Reinstall compressor on engine, if removed.

EVACUATING THE AIR CONDITIONING SYSTEM

Whenever the air conditioning refrigerant system has been opened, it is necessary that the system be completely evacuated of air and moisture before being recharged.

Outlined below is the procedure for evacuating the system using the SE-2443 Portable Service Station.

1. Connect SE-2443 Service Station to air conditioning system service ports as follows:

   a. Close all valves on service station (turn fully clockwise).

   b. Connect suction gauge hose to compressor suction service port.

   c. Connect discharge gauge hose to compressor discharge service port.

   d. Connect hose from center fitting on manifold to vacuum pump suction fitting on service station.

   e. Open manifold suction and discharge gauge valves (turn fully counterclockwise).

2. Start vacuum pump and SLOWLY open pump blank off valve.

3. After suction gauge on manifold shows that vacuum is being established in the system, open vacuum gauge valve on service station and continue to operate vacuum pump for ten (10) minutes.

4. Close pump blank off valve and observe electronic vacuum gauge for one (1) minute. The meter should not indicate a rise of more than 5 millimeters of mercury. If gauge rises more than 5 millimeters of mercury in one (1) minute, system has a leak which must be repaired.

5. Open pump blank off valve and continue to operate vacuum pump for an additional twenty (20) minutes. Then close pump blank off valve and observe electronic vacuum gauge. If meter reading stays below 4 millimeters of mercury for two (2) minutes, system is ready to be charged.

6. With vacuum pump still operating, close both manifold gauge valves, pump blank off valve and vacuum meter valve. Turn off vacuum pump.

   Do not disconnect manifold gauge hoses from compressor service ports prior to charging the system.

CHARGING THE AIR CONDITIONING SYSTEM (FULL CHARGE)

In preparation for charging, the air conditioning system must be evacuated of all air and moisture and be completely leak free. (See "Evacuating the Air Conditioning System".)

To charge the system, utilizing the SE-2443 Portable Service Station and SE-2448 Heated Charging Cylinder, proceed as follows:

1. Manifold suction and discharge gauge hoses remain connected to compressor service ports from evacuating operation.

2. Fill SE-2448 Charging Cylinder with 2.25 kg (5 lbs.) of refrigerant. (Follow equipment manufacturer's instructions.) Make sure all valves on charging cylinder are closed after filling.

3. Connect service hose from center manifold fitting to bottom valve on charging cylinder.

4. Open bottom valve on charging cylinder and loosen center hose connection at manifold for 10 seconds, or until hose fitting becomes cold, to purge air from hose; then tighten hose connection.

5. With the engine shut off, open manifold discharge gauge valve and fill air conditioning system with 2 kg (4.5 lbs.) of refrigerant. (Follow charging cylinder manufacturer's instructions.)

   <u>DO</u> <u>NOT</u> overcharge the system. Excessively high head pressures during operation will result from overcharging.

6. When system is fully charged, close manifold discharge valve and bottom valve on charging cylinder. Slowly loosen hose connection at bottom valve on charging cylinder and allow refrigerant pressure to bleed off; then disconnect hose from valve.

7. Pressure test air conditioning system to check performance. (See "Air Conditioning Performance Check".)

8. After pressure test is completed disconnect manifold gauge hoses from compressor service ports. Install cap on compressor suction service port. Install cap or fan drive override switch (if equipped) on compressor discharge service port.

9. Close hood and cab doors.

ADDING REFRIGERANT TO AIR CONDITIONING SYSTEM

When the air conditioning system is low on refrigerant, it can be refilled using the SE-2443 Portable Service Station and SE-2448 Heated Charging Cylinder as outlined below.

1. Raise hood.

2. Connect SE-2443 Service Station to air conditioning system service ports as follows:

   a. Close manifold suction and discharge valves (turn fully clockwise).

   b. Remove cap from compressor suction service port. Connect manifold suction gauge hose to compressor suction service port.

   c. Remove cap or engine fan drive override switch (if equipped) from compressor discharge service port. Connect manifold discharge gauge hose to compressor discharge service port.

3. Fill SE-2448 Charging Cylinder with 2.5 kg (5 lbs.) of refrigerant. (Follow equipment manufacturer's instructions.) Make sure all valves on charging cylinder are closed after filling.

4. Connect service hose from center manifold fitting to valve on top of charging cylinder.

5. Open refrigerant supply valve on top of charging cylinder.

6. Loosen service hoses at compressor service ports. Open gauge valves and allow refrigerant to escape for 10 seconds to purge air from hoses. Tighten hose connections. Close gauge valves.

7. Set air conditioning controls for maximum cooling (A/C lever at "COLD", blower switch on "HIGH"). Open both cab doors.

8. Operate engine at RPM specified in "Engine Speed Chart" under SPECIFICATIONS.

9. SLOWLY open suction gauge valve to add refrigerant to system. Do not allow liquid refrigerant to enter compressor. Observe sight glass and add refrigerant until no frothing or bubbles appear in sight glass.

   Continue adding refrigerant until .5 kg (1.1 lbs.) has been added to system after sight glass has cleared. Do not overcharge system.

10. Close suction gauge valve and close refrigerant supply valve on top of charging cylinder.

11. Pressure test air conditioning system. (see "Air Conditioning Performance Check".)

12. After pressure test is completed, disconnect manifold gauge hoses from compressor service ports. Install cap on compressor suction service port. Install cap or fan drive override switch (if equipped) on compressor discharge service port.

13. Check air conditioning system for refrigerant leaks using an electronic leak detector. Follow equipment manufacturer's instructions.

14. Close hood and cab doors.

COMPONENT REMOVAL AND INSTALLATION

IMPORTANT

Certain precautions must be observed when servicing the air conditioning system. (See SAFETY PRECAUTIONS and also "Service Hints" below.)

SERVICE HINTS

Special attention to the following items while performing component removal, installation and service operations will aid in avoiding unnecessary and time consuming problems.

1. Note control cable routings during removal and reroute cables carefully in the same path when installing.

   Where necessary cables should make gradual, sweeping curves. Sharp directional turns tend to increase resistance to bowden wire movement and sometimes cause kinks which render the cable inoperative.

Make sure control cables are properly adjusted. (See control cable adjustment instructions outlined elsewhere in this section.)

2. It is most important that all refrigerant fittings and "O" rings be lubricated with refrigeration oil to allow the connections to seat squarely and to be tightened evenly to the specified torque. It is nearly impossible to attain the correct torque with a dry fitting.

   Do not attempt to disconnect or reconnect refrigerant fittings with only one wrench. Always use a back-up wrench when loosening or tightening fittings to prevent damage to hoses, lines or components.

   When tightening refrigerant connections, use only a torque wrench known to be accurate. It should be noted that torque values specified in the "Torque Chart" are for original components with fittings manufactured from specific materials; i.e. brass, aluminum, etc. These torque values may not be correct for substitute components. Use only genuine IH replacement parts.

3. Be certain that the evaporator core temperature control sensing bulb is properly inserted into the evaporator core.

4. The expansion valve refrigerant temperature sensing tube must be securely attached to the evaporator refrigerant outlet tube. Also, the temperature sensing tube and expansion valve must be tightly wrapped with insulating tape to prevent the ambient tempeature from affecting correct sensing of the temperature of the refrigerant leaving the evaporator.

5. All refrigerant hose and tubing support clamps and strap locks must be reinstalled in their original positions.

6. The freon compressor oil level must be maintained as specified. (See SPECIFICATIONS and "Checking Compressor Oil Level" under SERVICE OPERATIONS.)

7. Last but certainly not least is cleanliness. When removing components of the air conditioning system, all openings should be immediately covered or plugged during removal and remain so until reinstallation to prevent the entry of dirt, moisture or other foreign material.

BLOWER MOTOR AND FAN

Removal:

1. Make sure key and blower fan switches are "OFF ".
2. Remove cover from right side of instrument panel.
3. Remove cover from heater/evaporator unit.
4. Disconnect blower motor wiring connector and ground wire.
5. Disconnect motor cooling air hose from blower housing (where equipped).
6. Remove mounting screws and remove motor/ fan assembly from blower housing (Fig. 38).
7. Remove fan from motor shaft as follows:
   a. Remove fan lock nut.
   b. Remove fan from motor shaft.
   c. Pry metal spacer from motor side of fan.

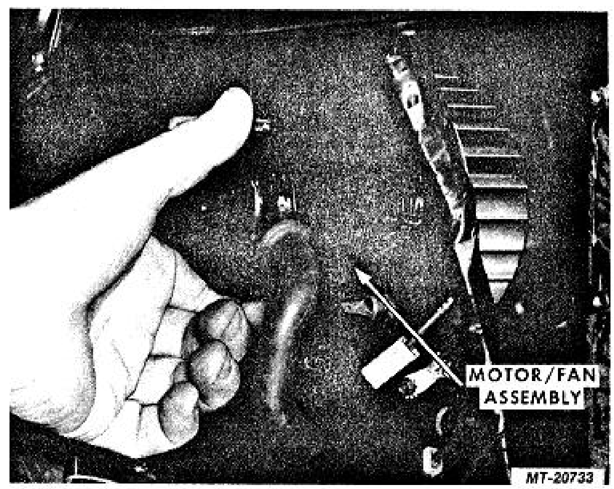

Fig. 38 Blower Motor/Fan Removal

Installation:

1. Install fan on motor shaft as follows:
   a. Position metal spacer in shaft hole (motor side) of fan.
   b. Position fan on motor shaft.
   c. Install fan lock nut and tighten to 1.4 to 1.7 N.m (12-15 in.lbs.).
2. Install motor/fan assembly on blower housing and install mounting screws.
3. Connect motor cooling air hose to outlet on blower housing (where equipped).
4. Connect blower wiring connector and ground wire.

5. Turn key and blower fan switches "ON" and check motor operation. Turn switches "OFF" after operation check.

6. Install covers on heater/evaporator unit and instrument panel.

BLOWER RESISTOR

Removal:

1. On vehicles equipped with air conditioning:

    a. Remove cover from right side of instrument panel.

    b. Remove cover from heater/evaporator unit.

Cover removal is not required on vehicles with heater only.

2. Disconnect wiring harness connector from resistor.

3. Remove resistor mounting screws and remove resistor from blower housing (Fig. 39).

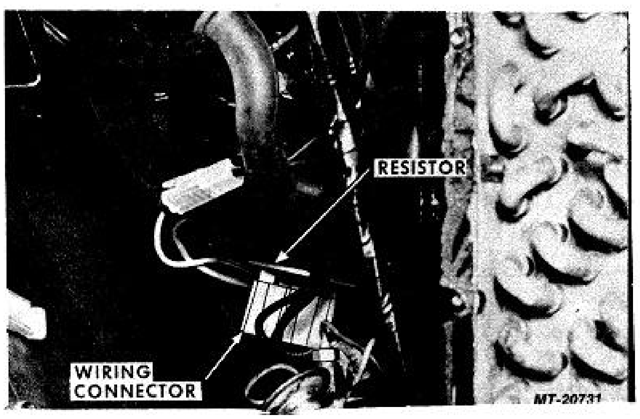

Fig. 39 Blower Resistor Removal

Installation:

1. Position resistor in blower housing. Make sure resistor terminal locations correspond with wiring harness terminals. Install mounting screws.

2. Connect wiring harness connector to resistor.

3. Turn key switch "ON". Operate blower switch and check resistor operation. Turn key switch "OFF" after operation check.

4. Install covers on heater/evaporator unit and instrument panel.

BLOWER SWITCH

Removal:

1. Make sure key switch is "OFF".

2. Pull knob from blower switch lever (Fig. 40).

3. Remove control assembly mounting screws. Remove control assembly trim plate. Pull control assembly outward. (It may be necessary to remove ash tray to allow movement of control assembly.)

4. Disconnect wiring harness connector from blower switch.

5. Remove blower switch mounting screws and remove switch from control assembly.

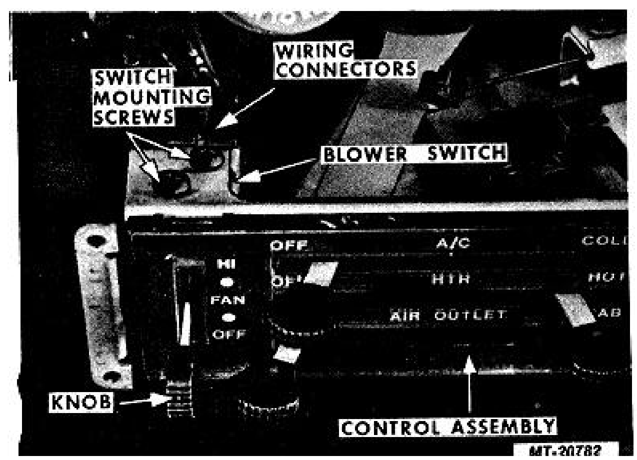

Fig. 40 Blower Switch

Installation:

1. Position blower switch on control assembly and install switch mounting screws.

2. Connect wiring harness connector to blower switch.

3. Position control assembly in instrument panel and install trim plate and mounting screws.

4. Push knob onto blower switch lever.

5. Turn key switch "ON", and check operation of blower switch. Turn key switch "OFF" after operation test.

COMPRESSOR

IMPORTANT

Compressor removal and installation procedures vary between engine and vehicle models. General instructions are outlined below.

Removal:

1. Raise hood and fender assembly.
2. Discharge air conditioning system as outlined under SERVICE OPERATIONS.
3. Remove drive belt(s).
4. Disconnect magnetic clutch feed wire from engine wiring harness.
5. Disconnect inlet and outlet hoses from compressor. Cap or tape compressor and hose openings to prevent entry of foreign material.
6. Remove bolts securing compressor to mounting bracket(s).
7. Remove compressor from mounting bracket.

IMPORTANT

For compressor service instructions, refer to Body and Cabs, Section CTS2577 of the Truck Service Manual.

Installation:

1. Check oil level in compressor as outlined under SERVICE OPERATIONS.
2. Position compressor on mounting bracket(s) and install mounting bolts. (Do not tighten mounting bolts.)
3. Install drive belt(s).
4. Check drive belt alignment and tighten compressor mounting bolts.
5. Adjust drive belt(s) to specified tension (see SPECIFICATIONS).
6. Lubricate fittings with refrigerant oil and connect inlet and outlet hoses to compressor.
7. Connect magnetic clutch feed wire to engine wiring harness.
8. Evacuate and charge air conditioning system as outlined under SERVICE OPERATIONS.
9. Lower hood and fender assembly.

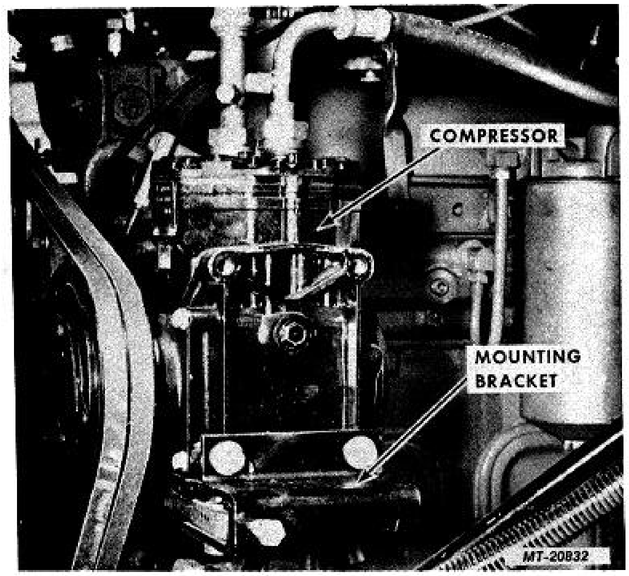

Fig. 41 Compressor Mounting (Typical)

COMPRESSOR MAGNETIC CLUTCH

On most applications the magnetic clutch can be removed for service without discharging the system or removing the compressor from the engine.

Removal:

1. Make sure key switch and A/C lever are "OFF".
2. Disconnect clutch feed wire from engine wiring harness.
3. Loosen compressor drive belt tension and remove belt(s) from clutch pulley.

   Inspect drive belt(s) and replace if worn or damaged.
4. Using spanner wrench (SE-2392-4) to hold clutch hub, remove clutch retainer bolt (Fig. 42).
5. Thread 5/8-11 remover bolt (SE-2392-5) into clutch drive hub. Tighten remover bolt against end of compressor crankshaft to loosen clutch. Remove clutch assembly and drive key from crankshaft.
6. Remove mounting bolts and remove field coil assembly (or stationary brush assembly) from compressor body.

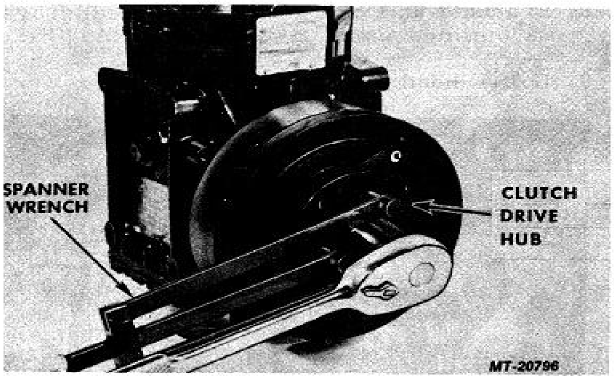

Fig. 42 Removing Magnetic Clutch

IMPORTANT

For clutch service instructions, refer to Body and Cabs, Section CTS-2577 of the Truck Service Manual.

Installation:

1. Install field coil assembly (or stationary brush assembly) on compressor body. Tighten mounting bolts finger tight only.
2. Position drive key in slot of compressor crankshaft. Position clutch assembly on crankshaft and install clutch retainer bolt.
3. Using spanner wrench (SE-2392-4) to hold clutch hub, tighten clutch retainer bolt to specified torque (see Bolt Torque Chart).
4. Rotate pulley by hand and check for interference between pulley and field coil assembly (or stationary brush assembly). Interference is indicated by a rubbing noise heard when pulley rotates. If necessary, adjust position of field coil (or stationary brush assembly) to avoid interference. Tighten mounting bolts.
5. Install compressor drive belt(s).
6. Check pulley alignment and adjust drive belt(s) to specified belt tension (see SPECIFICATIONS).
7. Connect clutch feed wire to engine wiring harness.
8. Operate engine and check magnetic clutch operation.

CONDENSER

Removal:

1. Remove radiator grille.
2. Raise hood and fender assembly.
3. Discharge air conditioning system as outlined under SERVICE OPERATIONS.
4. Disconnect inlet and outlet hoses from condenser. Install caps or tape on hose and condenser openings to prevent entry of foreign material.
5. Remove condenser mounting bolts (Fig. 43) and remove condenser from radiator support.

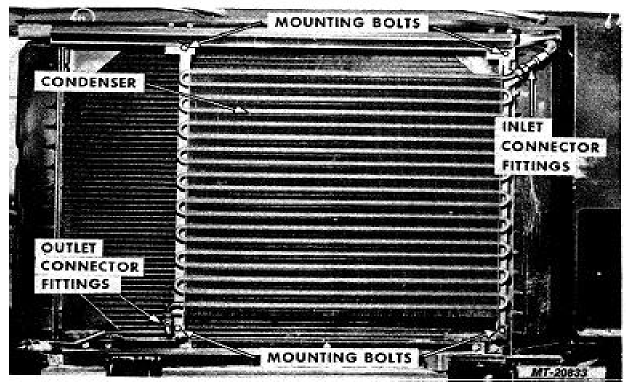

Fig. 43 Condenser Mounting (Typical)

Installation:

1. Position condenser on radiator support and install mounting bolts.
2. Remove caps or tape from condenser and refrigerant hose openings.
3. Lubricate hose fittings with refrigerant oil and connect refrigerant hoses to condenser.
4. Replace filter-dehydrator.
5. Evacuate and charge air conditioning system as outlined under SERVICE OPERATIONS.
6. Lower hood and fender assembly.
7. Reinstall radiator grille.

CONTROL ASSEMBLY

Removal:

1. Make sure key switch is "OFF".

2. Remove control assembly mounting screws. Remove control assembly trim plate. Pull control assembly outward (Fig. 44). It may be necessary to remove ash tray to allow movement of control assembly.

3. Disconnect wiring harness connector from blower switch.

4. Disconnect instrument panel lamp socket from control assembly as follows:

a. Rotate lamp socket clockwise (as viewed from rear of vehicle).

b. Pull lamp socket (with bulb) from control assembly.

5. Remove control cable to control lever retaining clips. Remove control cable mounting screws and disconnect control cables from control levers.

6. Remove control assembly.

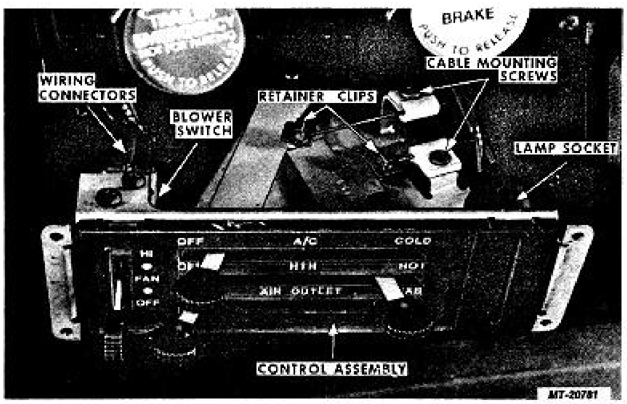

Fig. 44 Removing Control Assembly

Installation:

1. Connect control cables to control assembly levers as follows:

a. Cable with red mounting tab to upper (A/C) lever.

b. Cable with white mounting tab to center (HTR) lever.

c. Cable with black mounting tab to lower (AIR OUTLET) lever.

Install control cable mounting screws and cable retaining clips.

2. Connect instrument panel lamp socket to control assembly.

3. Connect wiring harness connector to blower switch.

4. Position control assembly in instrument panel and install trim plate and mounting screws.

5. Check operation and adjustment of control cables as outlined under "Control Cable Adjustment" .

CONTROL CABLE REPLACEMENT

Removal:

1. Disconnect battery cable from battery.

2. Remove cover from right side of instrument panel.

3. Remove cover from heater/evaporator unit.

4. Remove control assembly mounting screws. Remove control assembly trim plate. Pull control assembly outward. (It may be necessary to remove ash tray to allow movement of control assembly.)

5. Remove control cable-to-control lever retaining clips. Remove control cable mounting screws and disconnect cable(s) from control lever(s)(Fig. 44) cables can be identified by the colored cable mounting tabs:

Air Conditioning (A/C) Cable	Red Tab
Heater (HTR) Cable	White Tab
Air Control Cable	Black Tab

6. Disconnect opposite end of cable(s) as follows:

Air Conditioning (A/C) Cable

a. Remove cable mounting screw from thermostatic control switch bracket (Fig. 45).

b. Remove thermostatic control switch mounting switch from bracket.

c. Remove retainer clip and disconnect cable from switch lever.

Heater (HTR) Cable

a. Remove control cable mounting screw from cable mounting bracket (Fig. 45).

b. Disconnect cable from blend air door.

c. Withdraw end of cable through hole in heater/evaporator unit housing.

Air Control Cable

a. Remove control cable mounting screw from mounting bracket (Fig. 45).

b. Remove retainer clip and disconnect cable from defrost door crank.

7. Note cable routing and withdraw cable(s) from under instrument panel.

Installation:

1. Route cable(s) under instrument panel.

2. Connect cable(s) to control lever(s) of control assembly and install retainer clip(s).

   Install cable(s) with longest end from adjuster toward control assembly.

   Follow cable color code listed above, under Step 5 of Removal Procedure.

3. Install cable mounting screw(s).

4. Position control assembly in instrument panel and install trim plate and mounting screws.

5. Connect opposite end of cable(s) as follows: (Follow color code.)

Air Conditioning (A/C) Cable

a. Connect cable to switch lever and install retainer clip.

b. Position switch on bracket and install mounting screws.

c. Position cable mounting tab on switch bracket and install mounting screw.

Heater (HTR) Cable

a. Insert cable through hole in heater/ evaporator unit housing.

b. Connect cable to blend air door.

c. Position cable mounting tab on cable mounting bracket and install mounting screw.

d. Seal cable hole in heater/evaporator unit housing with body sealer after adjusting cable, Step 6.

Air Control Cable

a. Connect cable to defrost door crank and install retainer clip.

b. Position cable mounting tab on mounting bracket and install mounting screw.

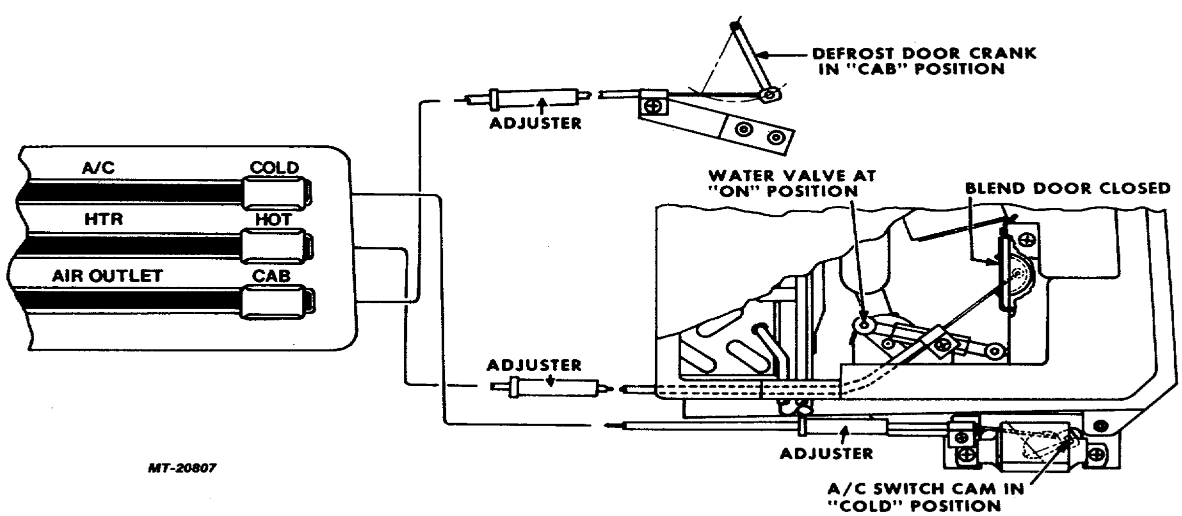

Fig. 45 Control Cable Adjustment Positions

6. Adjust control cable(s) as outlined under "Control Cable Adjustment".

7. Install covers on heater/evaporator unit and instrument panel.

8. Connect battery cable to battery.

CONTROL CABLE ADJUSTMENT (Refer to Figure 45)

1. Remove cover from right side of instrument panel.

2. Remove cover from heater/evaporator unit.

3. Set control panel assembly levers to the extreme right:

a. A/C lever at "COLD".

b. HTR lever at "HOT" and in detent.

c. AIR OUTLET lever at "CAB" and in detent.

IMPORTANT

These lever positions must be maintained during adjustment.

4. Rotate cable adjusters (expand cables) to obtain mid-travel position of:

a. Thermostatic temperature control switch.

b. Blend air door.

c. Defrost door crank.

5. Rotate cable adjusters (shorten cables) as needed to obtain the following settings with cables free from binding:

a. Thermostatic temperature control switch at "COLD" position.

b. Blend air door closed about 20 percent compression of door seal and hot water flow control valve in "ON" position.

c. Defrost door crank at "CAB" position.

6. Operate control panel levers several times and check to assure that proper adjustment is maintained.

If necessary, repeat Steps 3, 4 and 5 to obtain proper adjustment.

7. Install covers on heater/evaporator unit and instrument panel.

EVAPORATOR CORE

Removal:

1. Raise hood and fender assembly.

2. Discharge air conditioning system as outlined under SERVICE OPERATIONS.

3. Remove cover from right side of instrument panel.

4. Remove cover from heater/evaporator unit.

5. Remove dash panel seal retainers and seals surrounding evaporator unit inlet and outlet tubes (Fig. 46).

6. Disconnect inlet and outlet hoses from evaporator unit inlet and outlet tubes (Fig. 46).

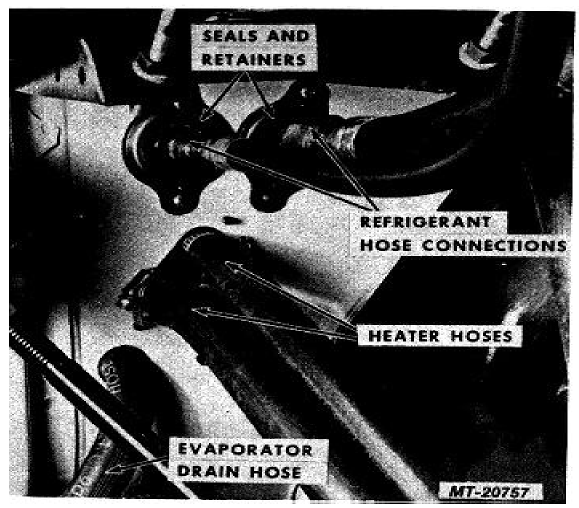

Fig. 46 Evaporator Dash Panel Connections

7. Disconnect low pressure switch wires from wiring harness.

8. Remove bolt and nut from clamp securing expansion valve to bracket on blower housing.

9. Remove air filter seal mounting strip and air filter from blower housing (Fig. 34).

10. Remove heater core mounting screws. (Do not disconnect hoses from heater core.) Pull heater core outward to disengage mounting slot. Move heater core down and to the right.

(This will permit access to front evaporator core mounting screws and permit withdrawal of thermostatic temperature control switch capillary tube 'from evaporator core.)(See Figure 57.)

11. Withdraw thermostatic temperature control switch capillary tube from evaporator core.

12. Remove evaporator core mounting screws (Fig. 47).

13. Remove evaporator core from unit housing (Fig. 48).

14. Remove low pressure switch and expansion valve from evaporator core.

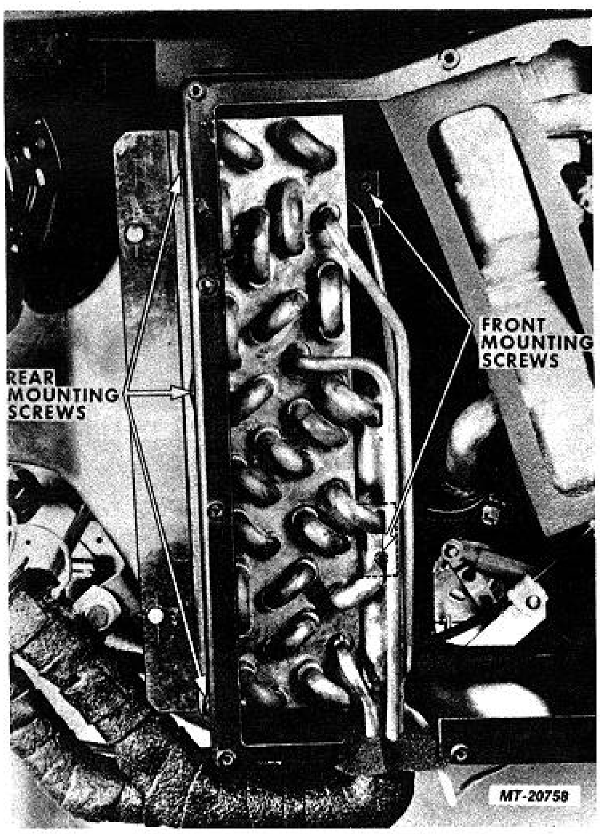

Fig. 47 Evaporator Core Mounting Screws

Installation:

1. Install expansion valve and low pressure switch on evaporator core. (Refer to "Expansion Valve" and "Low Pressure Switch".)

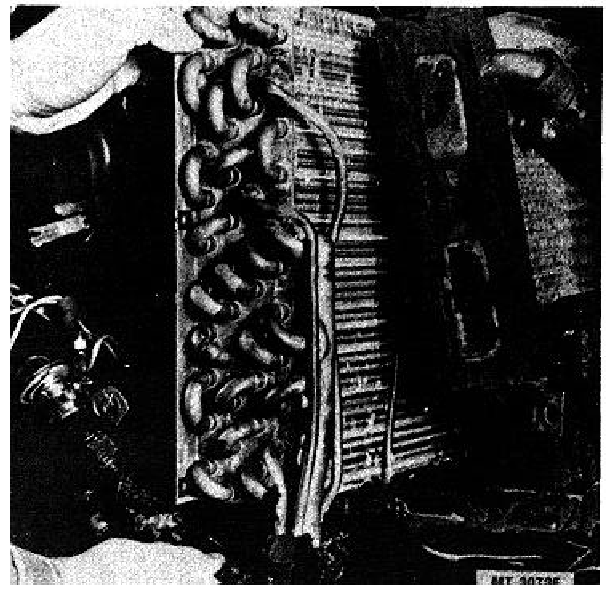

Fig. 48 Removing Evaporator Core

2. Position evaporator core in unit housing.

   Replace seal surrounding evaporator inlet and outlet pipes in bottom of unit housing if damaged.

3. Install evaporator core mounting screws.

4. Position thermostatic temperature control switch capillary tube in evaporator core. (Refer to "Thermostatic Temperature Control Switch".)

5. Install heater core as follows:

a. Make sure gaskets are on ends of heater core.

b. Align slot in heater core fume with rivet at front of housing and push core into position.

c. Install heater core mounting screws.

6. Install air filter and seal mounting strip on blower housing.

7. Install clamp, bolt and nut to secure expansion valve to bracket on blower housing.

8. Connect low pressure switch wires to wiring harness

9. Lubricate threads with refrigerant oil and connect inlet and outlet hoses to evaporator unit inlet and outlet tubes.

10. Install dash panel seals and retainers surrounding evaporator inlet and outlet tubes.

11. Evacuate and charge air conditioning system as outlined under SERVICE OPERATIONS.

12. Install covers on heater/evaporator unit and instrument panel.

13. Lower hood and fender assembly.

EXPANSION VALVE

Removal:

1. Make sure key switch is "OFF".

2. Raise hood and fender assembly.

3. Discharge air conditioning system as outlined under SERVICE OPERATIONS.

4. Remove cover from right side of instrument panel.

5. Remove cover from heater/evaporator unit.

6. Disconnect wiring harness connector from blower resistor located on bottom of blower housing.

7. Remove insulated tape from expansion valve and evaporator inlet and outlet tubes.

8. Disconnect expansion valve equalizer line from fitting on evaporator outlet tube (Fig. 49).

9. Remove screw and clamp securing expansion valve feeler bulb to evaporator outlet tube.

10. Disconnect expansion valve inlet tube from expansion valve.

11. Remove bolt, nut and clamp securing expansion valve to bracket on blower housing.

12. Using two wrenches, disconnect expansion valve from evaporator core inlet tube. Remove expansion valve.

Installation:

1. Lubricate threads with refrigerant oil and connect expansion valve to evaporator core inlet tube. Tighten fitting using two wrenches.

2. Install clamp, bolt and nut' securing expansion valve to bracket on blower housing.

3. Lubricate threads with refrigerant oil and connect expansion valve inlet tube to expansion valve. Tighten nut to 11-14 N.m (15-20 ft.lbs.).

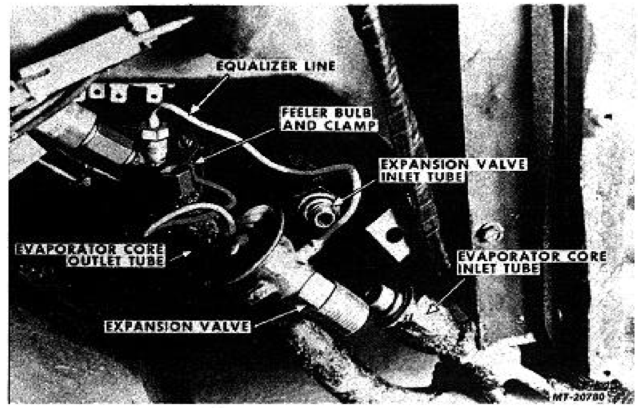

Fig. 49 Removing Expansion Valve

4. Position expansion valve feeler bulb on evaporator core outlet tube and secure with clamp and screw.

5. Lubricate threads with refrigerant oil and connect expansion valve equalizer line to fitting in evaporator outlet tube. Using two wrenches tighten fittings to 7-11 N.m (10-15 ft. lbs.) torque.

6. Wrap expansion valve and evaporator inlet and outlet tubes with insulated tape.

7. Connect wiring harness connector to blower resistor.

8. Evacuate and charge air conditioning system as outlined under SERVICE OPERATIONS.

9. Install covers on heater/evaporator unit and instrument panel.

10. Lower hood and fender assembly.

FAN DRIVE OVERRIDE SWITCH

The fan drive override switch can be replaced without discharging the refrigerant from the air conditioning system. A spring-loaded valve in the compressor discharge service port prevents loss of refrigerant when switch is removed.

Removal:

1. Raise hood and fender assembly.

2. Make sure key switch is '"OFF".

3. Disconnect fan drive override switch wires from engine wiring harness.

4. Using two wrenches, remove fan drive override switch from compressor discharge service port.

CAUTION

A small amount of refrigerant may escape from service port valve while switch is being removed.

Installation:

1. Lubricate threads of fan drive override switch and position switch on compressor discharge service port.
2. Using two wrenches, tighten fan drive override switch.
3. Connect switch wires to engine wiring harness.
4. Lower hood and fender assembly.

FAN DRIVE OR SHUTTER CONTROL SOLENOID VALVE

Removal:

1. Make sure key switch is "OFF".
2. Raise hood and fender assembly.
3. Bleed pressure. from vehicle's air system.
4. Disconnect solenoid feed wire from solenoid valve.
5. Disconnect air hoses from solenoid valve.
6. Remove mounting screws and remove solenoid valve from mounting bracket.
7. Remove air pipe fittings from solenoid valve.

Installation:

1. Install air pipe fittings in solenoid valve.
2. Position solenoid valve on mounting bracket and install mounting screws.
3. Connect air hoses to solenoid valve.
4. Connect feed wire to solenoid valve.
5. Lower hood and fender assembly.

FILTER-DEHYDRATOR

IMPORTANT

Filter-dehydrator should be replaced whenever air conditioning system is opened to service components.

System must be discharged before removing filter-dehydrator.

Removal:

1. Disconnect inlet and outlet hoses from filterdehydrator. Cap or tape hoses openings to prevent entry of foreign material.
2. Loosen U-bolt and remove filter-dehydrator from mounting bracket (Fig. 50).

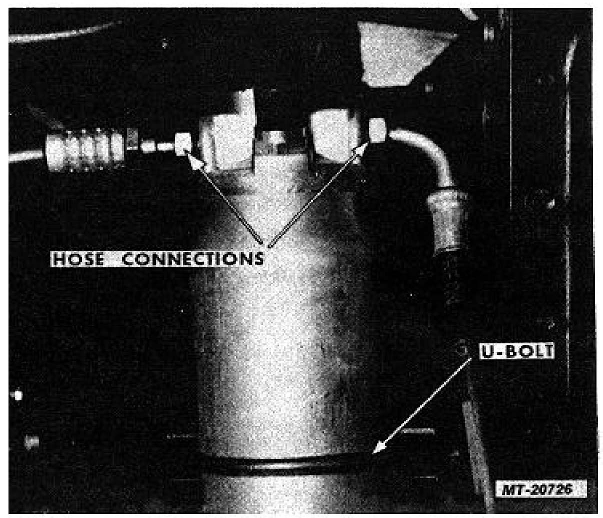

Fig. 50 Filter-Dehydrator Mounting

Installation:

1. Position filter-dehydrator in mounting bracket. Make sure inlet and outlet openings index and align with their corresponding hoses.
2. Tighten mounting U-bolt to 15-18 N.m (11-14 ft.lbs.).
3. Remove plug from inlet opening of filterdehydrator. Remove cap or tape from inlet hose. Lubricate threads with refrigerant oil and connect inlet hose to filter-dehydrator.

4. Remove plug from outlet opening of filter dehydrator. Remove cap or tape from outlet hose. Lubricate threads with refrigerant oil and connect outlet hose to filter-dehydrator.

IMPORTANT

To avoid contamination, do not uncover filter-dehydrator openings longer than necessary to make connections.

5. Evacuate and charge air conditioning system as outlined under SERVICE OPERATIONS.

HEATER CORE

Removal:

1. Raise hood and fender assembly.
2. Drain engine cooling system.
3. Remove cover from right side of instrument panel.
4. Remove cover from heater/evaporator unit.
5. Loosen hose clamps at heater core.
6. Open blend air door.
7. Remove heater core mounting screws (Fig. 51).
8. Disconnect hoses from heater core and pull core outward (toward rear of vehicle) to remove.
9. Remove gaskets from ends of heater core.
10. Inspect hoses and gaskets and replace if damaged or deteriorated.

Installation:

1. Position gaskets on ends of heater core.
2. Open blend air door.
3. Position heater core into housing. Align slot in heater core frame with rivet at front of housing and push heater core into position
4. Install heater core mounting screws.
5. Connect hoses to heater core and tighten hose clamps.
6. Refill engine cooling system.

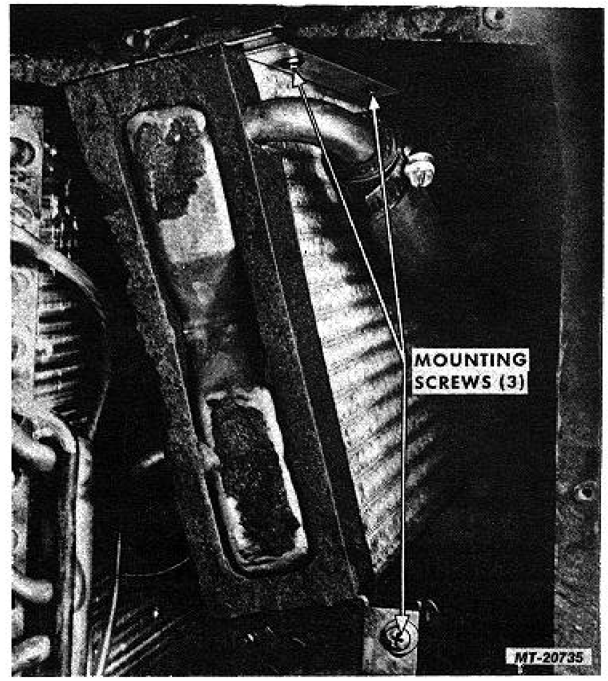

Fig. 51 Heater Core Mounting Screws

7. Set heater (HTR) control lever at "HOT". Operate engine. Check for coolant leaks and coolant flow through heater core.
8. Install covers on heater/evaporator unit and instrument panel.
9. Lower hood and fender assembly.

HIGH SPEED AND LOW PRESSURE SWITCH RELAYS

Relays are mounted on defroster duct and are located in front of instrument panel and above blower motor.

Removal:

1. Disconnect battery cable.
2. Remove cover from right side of instrument panel.
3. If relays are accessible, proceed to Step 4.

   If relays cannot be reached, remove radio/ ash tray panel, as follows, to gain access to relays.

a. Remove radio/ash tray panel mounting screws and pull panel outward.

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b. Disconnect radio power feed wire, speaker leads and antenna lead from radio.

c. If necessary, disconnect hourmeter, front wheel drive warning light, engine oil temperature gauge and transmission oil temperature gauge wiring.

d. Disconnect ash tray light from ash tray frame.

e. Remove radio/ash tray panel.

4. Using offset screwdriver or screwdriver socket, remove relay mounting screws and remove relay(s) from air duct (Fig. 52).

5. Disconnect wiring harness connectors from relay(s).

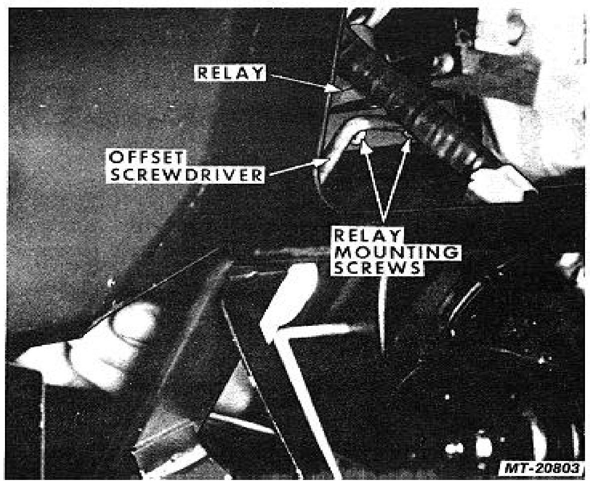


Fig. 52 Removing Relay

Installation:

1. Connect wiring harness connectors to relay(s).

2. Position relay(s) on air duct and install mounting screws. Use offset screwdriver or screwdriver socket to tighten screws.

3. Reinstall radio/ash tray panel and related parts (if removed).

4. Reconnect battery cables.

5. Turn key switch "ON" and check operation of relay(s). Turn key switch "OFF" after operation check.

6. Install instrument panel cover.

HOT WATER FLOW CONTROL VALVE

Removal:

1. Raise hood and fender assembly.

2. Drain engine cooling system.

3. Remove cover from right side of instrument panel.

4. Remove cover from heater/evaporator unit.

5. Remove heater core as follows:

   a. Loosen hose clamps at heater core.

   b. Open blend air door.

   c. Remove heater core mounting screws.

   d. Disconnect hoses from heater core and pull core outward to remove.

6. Remove control cable mounting screw from mounting bracket (Fig. 53). Disconnect control cable from blend air door.

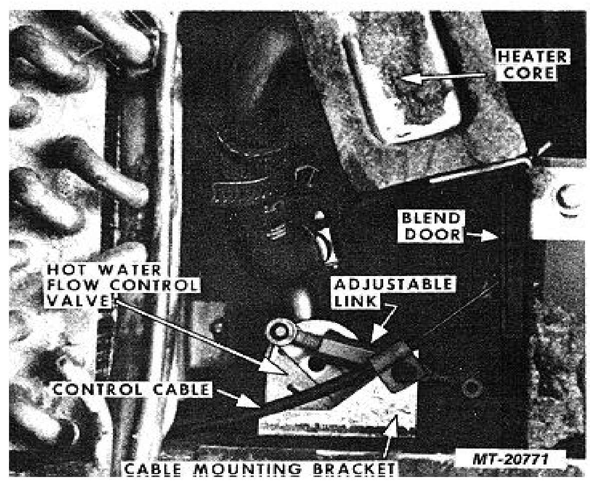


Fig. 53 Hot Water Flow Control Valve Connection Details

7. Loosen hose clamp and disconnect inlet hose (located beneath heater/evaporator unit housing) from neck of flow control valve.

8. Remove flow control valve mounting screws. (Screw heads are located on bottom of heater/ evaporator unit housing.)

9. Remove control cable mounting bracket.

10. Disconnect -adjustable link from blend air door.

11. Rotate control valve assembly as necessary to withdraw lower neck of valve through grommet in bottom of heater/evaporator unit housing. Remove valve (Fig. 54).

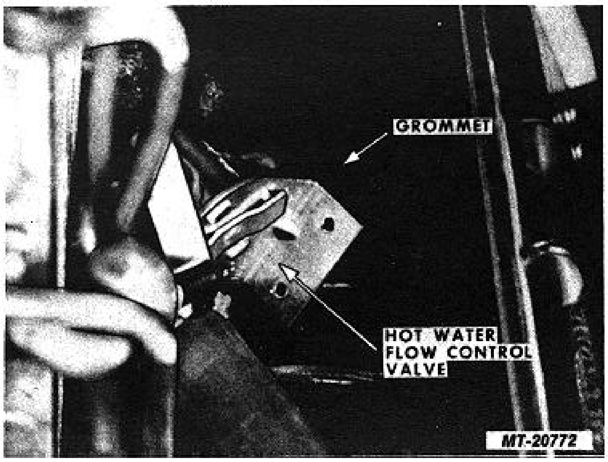


Fig. 54 Removing Hot Water Flow Control Valve from Unit Housing

12. Disconnect hose clamp and remove valve-to-heater core hose from valve.

13. Inspect all hoses and control valve inlet neck grommet in bottom of unit housing. Replace if damaged or deteriorated.

Installation:

1. Position control valve-to-heater cover hose on valve and tighten hose clamp.

2. Insert lower neck of flow control valve through grommet in bottom of heater/evaporator unit housing and rotate valve assembly into position.

3. Connect adjustable link to blend air door.

4. Position flange of control cable mounting bracket under mounting flange of control valve.

5. Install and tighten valve mounting screws.

6. Connect inlet hose to lower neck of flow control valve and tighten hose clamp.

7. Install heater core as follows:

   a. Make sure gaskets are in position on ends of heater core.

   b. Open blend air door.

   c. Position heater core into housing. Align slot in heater core frame with rivet at front of housing and push core into position.

   d. Install heater core mounting screws.

   e. Connect hoses to heater core and tighten hose clamps.

8. Connect control cable to blend air door and install cable mounting screw.

9. Adjust control cable as outlined under "Control Cable Adjustment".

10. Refill engine cooling system.

11. Set heater (HTR) control at "HOT". Operate engine and check for coolant leaks and for proper operation of flow control valve.

12. Install covers on heater/evaporator unit and instrument panel.

13. Lower hood and fender assembly.

LOW PRESSURE SWITCH

The low pressure switch can be replaced without discharging the refrigerant from the air conditioning system. A spring-loaded valve in the switch mounting adapter on the evaporator outlet pipe prevents loss of refrigerant when switch is removed.

Removal:

1. Make sure key switch is "OFF".

2. Remove cover from right side of instrument panel.

3. Remove cover from heater/evaporator unit.

4. Disconnect low pressure switch wires from wiring harness.

5. Using two wrenches, remove low pressure switch from adapter on evaporator outlet pipe (Fig. 55).

CAUTION

A small amount of refrigerant may escape from adapter while low pressure switch is being removed.

Installation:

1. Lubricate threads of low pressure switch with refrigerant oil and position switch on adapter.
2. Using two wrenches, tighten low pressure switch.
3. Connect low pressure switch wires to wiring harness.
4. Install covers on heater/evaporator unit and instrument panel.

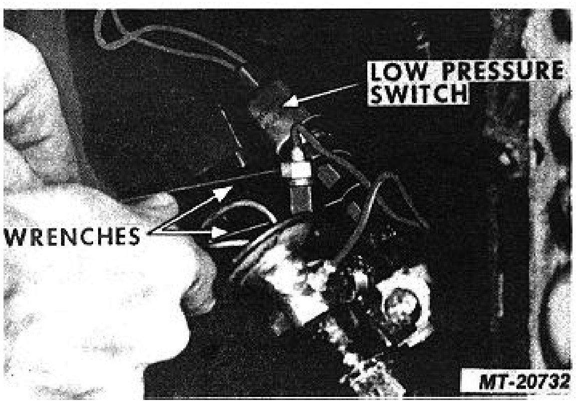


Fig. 55 Removing Low Pressure Switch

THERMOSTATIC TEMPERATURE CONTROL SWITCH

Removal:

1. Make sure key switch and A/C lever are "OFF" .
2. Remove cover from right side of instrument panel.
3. Remove cover from heater/evaporator unit.
4. Disconnect wiring connectors (3) from thermostatic control switch.

IMPORTANT

Before disconnecting wires, note circuit number locations to assure correct reassembly.

5. Remove control cable mounting screw (Fig. 56).
6. Remove thermostatic control switch mounting screws and remove switch from bracket (Fig. 56).

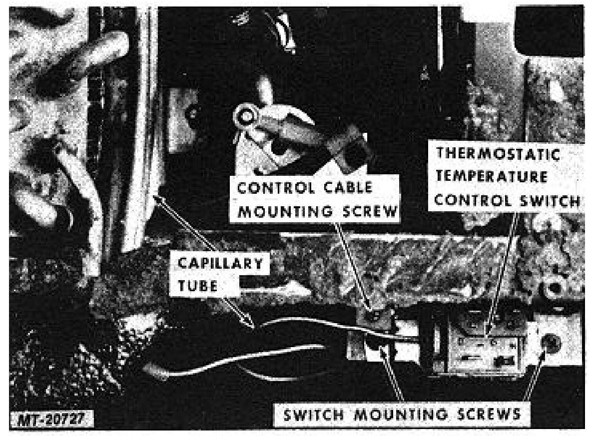


Fig. 56 Thermostatic Control Switch Mounting Details

7. Remove retainer clip and disconnect control cable from switch lever.
8. Remove heater core mounting screws. (<u>Do not</u> disconnect hoses from heater core.) Pull heater core outward to disengage mounting slot. Move heater core down and to the right. (This will permit withdrawal of thermostatic control switch capillary tube from evaporator core.
9. Withdraw thermostatic control switch capillary tube from evaporator core (Fig. 57).

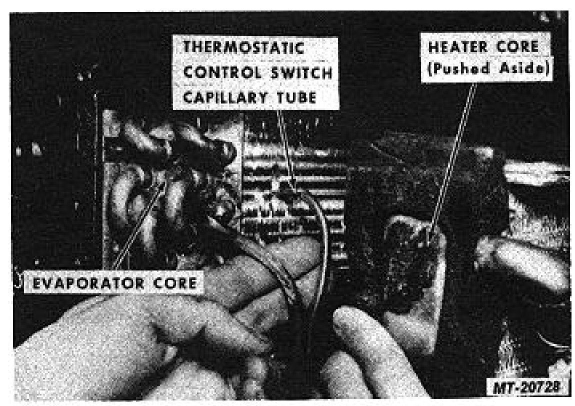


Fig. 57 Withdrawing Thermostatic Control Switch Capillary Tube from Evaporator Core

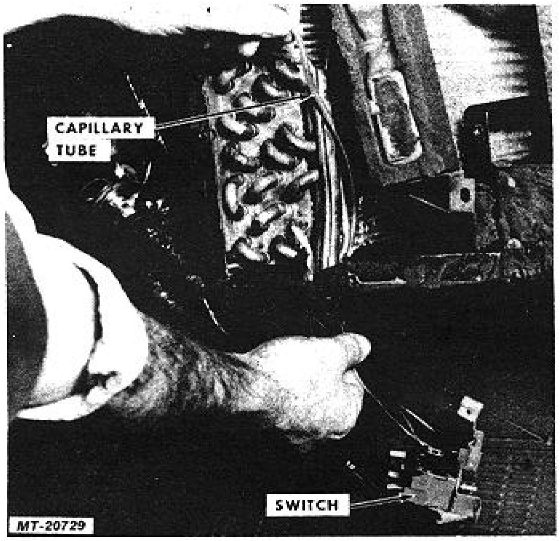


Fig. 58 Withdrawing Thermostatic Control Switch Capillary Tube from Housing

Installation:

1. Insert thermostatic temperature control switch capillary tube through hole in seal at bottom of heater/evaporator unit housing.

2. Insert end of capillary tube into evaporator core at location shown in Figure 59. (Remove air filter seal strip and air filter to check position of end of capillary tube.)

3. Connect control cable to switch lever and install retainer clip.

4. Position switch on bracket and install switch mounting screws.

5. Position cable mounting ta on switch bracket and install mounting screw.

6. Check control cable adjustment as outlined under "Control Cable Adjustment".

7. Install heater core as follows:

   a. Make sure gaskets are in place on ends of heater core.

   b. Align slot in heater core frame with rivet at front of housing and push core into position.

   c. Install heater core mounting screws.

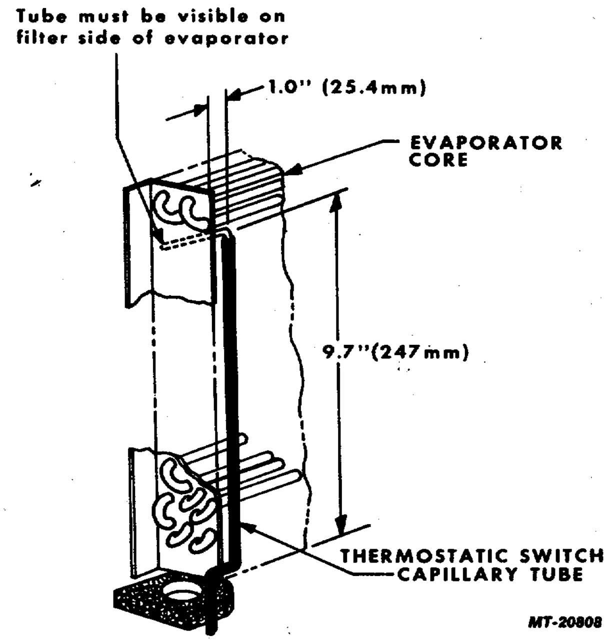


Fig. 59 Capillary Tube Location in Evaporator

8. Connect wiring connectors to thermostatic control switch. Make sure connectors are located properly (Fig. 60).

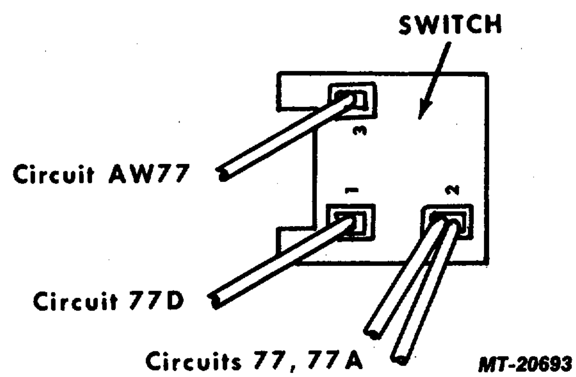


Fig. 60 Thermostatic Control Switch Wiring Connector Locations

9. Check operation of thermostatic control switch.

10. Install covers on heater/evaporator unit and instrument panel.

COMPONENT PROBLEM ANALYSIS

COMPRESSOR

Some possible failings of the compressor include:

1. Leaking Front Seal This allows refrigerant and lubricating oil to escape from system in loss of cooling and damage to compressor.

2. Bearing Failure Usually the result of material wear but can result from excessive drive belt tension or pulley misalignment.

3. Burned-Up Compressor Caused by lack of lubricating oil. This emphasizes the need for checking the oil level in the compressor at the time of system service.

   In the event that compressor failure is severe enough to form metal particles, purge compressor discharge-to-filter-dehydrator lines with 4.5 kg (1 lb.) of refrigerant and replace the filter-dehydrator.

   For compressor service procedures, refer to Bodies and Cabs, Section CTS-2577 of the Truck Service Manual

MAGNETIC CLUTCH

The two most common clutch failures are:

1. Burned-Out Facings.

2. Broken Torque Springs.

Both of these failings are usually symptomatic of troubles somewhere else in the system. (Example: A restriction in the condenser will cause excessive head pressures, which in turn will overwork the compressor and clutch, eventually causing failure of one or both.)

For clutch service procedures, refer to Bodies and Cabs, Section CTS-2577 of the Truck Service Manual.

THERMOSTATIC TEMPERATURE CONTROL SWITCH

The thermostatic temperature control switch is relatively trouble free; however, should it fail, it must be replaced. If the clutch remains engaged continually, check the sensing tube of the control switch to see that it has not been pulled out of the evaporator core. The sensing tube should be located in the evaporator core as shown in Figure 59.

Also, make sure air conditioning (A/C) control cable is properly adjusted.

CONDENSER

Possible problems with the condenser include:

1. A leak in the condenser.

2. A stoppage or restriction of refrigerant flow through the condenser. This could result from some foreign material inside the core or by a sharp bend or dent in the condenser tubing or in the hoses leading into or out of the condenser.

   (Make a visual check to make sure this has not occurred.)

3. A restriction of air flow through the condenser. This is the most common problem and results from dirt, leaves, etc. collecting on the front area.

   A stoppage or restriction of refrigerant flow or air flow through the condenser will be indicated by a high discharge pressure reading on the test gauge.

   Restriction of refrigerant flow will show a lower than normal suction pressure on the test gauge. Restricted air flow will build high discharge and suction pressures.

   In some instances tubing may be replaced or leaks may be repaired by silver soldering if the spot is accessible, however, a stopped-up or internally restricted core must be replaced.

CAUTION

Never weld, solder, steam clean or use any excessive amount of heat on any of the refrigerant lines or components of the refrigeration system while the system is charged. Heat applied to any part would cause-the pressure of the refrigerant within the closed system to become excessive.

EXPANSION VALVE

Possible problems at the expansion valve include:

1. Stoppage - Stoppage in the system tends to occur at the valve or at the filter-dehydrator tank.

2. Valve Sticking - The valve tends to stick closed cutting off the refrigerant supply to the evaporator and stopping all cooling from the air conditioner.

3. Ruptured Sensing Bulb If the sensing tube ruptures, the valve will remain closed.

4. Sensing Bulb Loose If the sensing bulb works loose from its proper location on the evaporator output line, the valve will remain open and flood the evaporator with refrigerant.

If it is determined that the valve is faulty, it must be replaced with another valve of exactly the same capacity and type. It requires no adjustment.

EVAPORATOR CORE

This unit is very similar to the condenser, both in type of construction and in its trouble-free operating characteristics. When checking this component, make sure that:

The air flow through the core is in no way obstructed by dirt, etc. clogging the fins of the core.

The sensing tube of the thermostatic control switch is in its proper place inside the evaporator core.

TROUBLE SHOOTING GUIDE

Outlined below are possible causes of problems most frequently experienced with the heating/air conditioning system.

When analyzing air conditioning operational problems, it is required that the manifold gauge set be connected to the compressor service ports and that the system be operated for a sufficient period to normalize (e g. to have removed the initial heat from the cab and settled to an average flow rate and pressure). See Performance Checks under SERVICE OPERATIONS.

Problem	Possible Cause
No Heat.	1. Kinked or obstructed heater hoses. 2. Faulty blower motor, resistor assembly or switch. 3. Plugged or defective heater core. 4. Faulty water flow control valve. 5. Faulty control assembly or cables.
Insufficient Heat.	1. Kinked or obstructed heater hoses. 2. Faulty blower motor, resistor assembly or switch. 3. Faulty water flow control valve. 4. Obstructed heater core. 5. Faulty control assembly or cables. 6. Poor sealing around vent door, blend door or other cab areas.
Too Much Heat (Heater won't regulate).	1. Blend door cable disengaged or misadjusted. 2. Faulty water control valve.
All Air Flow Coming from Defroster Outlets.	1. Faulty control assembly. 2. Control cable defective or disengaged from defrost door.
No Cooling.	1. Loss of Refrigerant. 2. Broken or slipping compressor drive belt. 3. Inoperative Compressor Clutch. 4. Frozen or faulty expansion valve. 5. Faulty thermostat control. 6. Faulty compressor. 7. Broken refrigerant line.
Insufficient Cooling.	1. Low refrigerant charge. 2. Clogged air filter. 3. Obstructed air passages. 4. Slipping compressor drive belt. 5. Inoperative or faulty blower or switch. 6. Faulty thermostatic control switch. 7. Faulty expansion valve. 8. Faulty compressor.

TROUBLE SHOOTING GUIDE (Continued)

Problem	Possible Cause
Compressor Noise and Vibration.	1. Worn, loose or misaligned compressor drive belt. 2. Loose compressor clutch. 3. Foreign material or damaged parts in compressor. 4. Damaged clutch. 5. Loose or broken mounting bracket. 6. Excessive refrigerant charge. 7. Compressor oil level below minimum.
Engine Overheating.	1. Low radiator coolant level. 2. Clogged engine cooling system. 3. Debris-laden condenser and radiator. 4. Inadequate engine cooling system. 5. Excessive refrigerant charge. 6. Broken or slipping fan belt. 7. Faulty engine thermostat. 8. Radiator shutters stuck shut. 9. Faulty water pump. 10. Collapsing or obstructed radiator hoses. 11. Faulty, fan drive system.
Excessive Compressor Drive Belt Wear.	1. Incorrect belt tension. 2. Incorrect belt alignment. 3. Slippage due to excessive refrigerant charge. 4. Cord fracture due to forcing belt into place. 5. Broken or nicked pulley. 6. Excessive oil on belt.
Compressor Clutch Inoperative.	1. Blown fuse. 2. Loose connection or broken wire. 3. Faulty field coil. 4. Faulty thermostatic control switch. 5. Broken drive belt.
Clutch Slippage.	1. Excessive head pressure. 2. Loose pulley. 3. Oily drive belt. 4. Worn drive belt.
Unit Blower Motor Inoperative or Operate Slow.	1. Blown fuse. 2. Loose connection. 3. Broken wire. 4. Defective switch. 5. Faulty resistor. 6. Motor shaft bound.

TROUBLE SHOOTING GUIDE (Continued)

Problem	Possible Cause
High Head Pressures. (Discharge Side)	1. Excessive refrigerant charge. 2. Air in system. 3. Engine overheated. 4. Condenser air flow restricted. 5. Flooded evaporator (indicated by heavy frosting of suction line). 6. Kinked lines. 7. Defective fan drive or fan drive switch.
Low Head Pressure (Discharge Side)	1. Insufficient refrigerant charge. 2. Defective compressor valves.
High Suction Pressure (Suction Side)	1. Expansion valve sensing tube not tightly secured to evaporator discharge line (compressor suction line). 2. Leaking or broken compressor valves. 3. Compressor drive belt slipping. 4. Magnetic clutch slipping. 5. Expansion valve not closing. 6. Faulty expansion valve.
Low Suction Pressure (Suction Side)	1. Insufficient refrigerant. 2. Restriction at filter-dehydrator or in lines. 3. Expansion valve feeler bulb charge low. 4. Expansion valve capillary tube broken or charge lost. 5. Expansion valve blocked. 6. Moisture freezing in expansion valve. 7. Expansion valve sticking. 8. Moisture-saturated filter-dehydrator unit.
Automatic System Shutdown.	1. Defective low pressure switch. 2. Low refrigerant charge. 3. Excessive discharge pressure. 4. Ambient temperature too low. 5. Blown fuse.

SPECIFICATIONS

Refrigerant Type	R-12
Refrigerant Quantity (Full Charge)	2 kg. (4.5 lbs.)
Compressor Oil Type	Texaco "Capella E, Dual Inhibited" or Equivalent
Compressor Oil Level (Vertical Mounting)	25.4 mm Min. to 34.9 mm Max. (1" Min. to 1 3/8" Max.)
Compressor Oil-Quantity (After Rebuild)	340 g (12 oz.)
Compressor Drive Belt Tension:	
Initial Tension (New Belt)	445 N (100 lbs.)
Normal Tension (Used Belt)	311 N (70 lbs.)
Low Pressure Switch:	
Opens at	14-69 kPa (2-10 psi)
Closes at	179-234 kPa (26-34 psi)
Fan Drive Override Switch:	
Opens at	1379-1517 kPa (200-220 psi)
Closes at	1999-2137 kPa (290-310 psi)

ENGINE SPEED CHART

(For Air Conditioning System Pressure Test)

Engine Model	RPM	
	Direct Drive	Fan Drive

VS	2300	----
DT-466	1750	----
V-800	1800	1750
6-71	1850	----
8V-71, 6V92TT	2000	----
NTC	2100	----
3208	2100	----
3406	2000	1750

SPECIFICATIONS (Continued)

OPERATING PRESSURE TEST CHART

A properly charged and functioning air conditioning system should indicate the readings shown below with the engine operating at the speed shown in ENGINE SPEED CHART, blower on "HIGH" speed, control lever on "COLD" and both cab doors open.

RELATIVE HUMIDITY BELOW 30%

Ambient Temperature C	(F)	Average Compressor Refrigerant Pressures HEAD	SUCTION	Passenger Inboard Outlet Air Temperature C	(F)
20	(68)*	880-1080 kPa (125-155 psi)	61-89 kPa (9-13 psi)	5-6	(41-43)
25	(77)*	1130-1330 kPa (160-190 psi)	67-95 kPa (10-14 psi)	5-6	(41-43)
30	(86)	1380-1580 kPa (200-230 psi)	76-104 kPa (11-15 psi)	5-6	(41-43)
35	(95)	1630-1830 kPa (235-265 psi)	104-132 kPa (15-19 psi)	7-9	(45-48)
40	(104)	1790-1890 kPa (260-290 psi)	134-162 kPa (19-23 psi)	10-13	(50-55)

RELATIVE HUMIDITY ABOVE 30%

Ambient Temperature C	(F)	Average Compressor Refrigerant Pressures HEAD	SUCTION	Passenger Inboard Outlet Air Temperature C	(F)
20	(68)*	1115-1315 kPa (160-190 psi)	84-112 kPa (12-16 psi)	5-6	(41-43)
25	(77)*	1360-1560 kPa (195-225 psi)	108-136 kPa (16-20 psi)	7-9	(45-48)
30	(86)	1600-1800 kPa (230-260 psi)	132-160 kPa (19-23 psi)	11-13	(52-55)
35	(95)	1850-2050 kPa (270-300 psi)	178-206 kPa (26-30 psi)	14-17	(57-63)
40	(104)	2090-2290 kPa (300-330 psi)	236-264 kPa (34-38 psi)	18-21	(64-70

* System may cycle at these ambient temperatures. Test readings listed are those that will occur just prior to compressor cycling off.

TORQUE CHART

IMPORTANT

All refrigerant fittings must be lubricated with refrigerant oil prior to tightening. Do not exceed specified torque. Use two wrenches where applicable.

LOCATION	THREAD SIZE	TORQUE	
Condenser Inlet	3/4-16	30-35 N.m	22-26 ft.lbs.
Condenser Outlet	5/8-18	20-26 N.m	15-19 ft.lbs.
Filter-Dehydrator Inlet	11/16-16	15-20 N.m	11-15 ft.lbs.
Filter-Dehydrator Outlet	5/8-18	15-20 N.m	11-15 ft.lbs.
Compressor Suction Line	1-14	54-60 N.m	40-44 ft.lbs.
Compressor Discharge Line	1-14	54-60 N.m	40-44 ft.lbs.
Fan Drive Override Switch	7/16-20	9-15 N.m	7-11 ft.lbs.
Refrigerant Supply Line to Heater-A/C (Evaporator) Unit	5/8-18	20-26 N.m	15-19 ft.lbs.
Refrigerant Return Line from Heater-A/C (Evaporator) Unit	1 1/16-14	89-95 N.m	66-70 ft.lbs.
Expansion Valve Inlet	5/8-18	20-27 N.m	15-20 ft.lbs.
Expansion Valve Outlet	3/4-16	20-27 N.m	15-20 ft.lbs.
Expansion Valve Equalizer Line	7/16-24	14-20 N.m	10-15 ft.lbs.
Low Pressure Switch	7/16-20	9.5-20 N.m	7-15 ft.lbs.
Heater-Evaporator-Blower Unit Mounting Nuts	1/4-20	8-11 N.m	6-8 ft.lbs.
Condenser Mounting Bolts	5/16-18	15-19 N.m	11-14 ft.lbs.
Filter-Dehydrator Mounting Clamp	5/16-18	15-19 N.m	11-14 ft.lbs.
Clutch Retainer Bolt	5/16-24	20-27 N.m	15-20 ft.lbs.
Compressor Oil Level Plug	---------	5-15 N.m	4-11 ft.lbs.
Compressor-to-Mounting Bracket Bolts:			
w/CAT 3208 Engine	3/8-16	24-27 N.m	18-20 ft.lbs.
All Other Engines	3/8-16	26-31 N.m	19-23 ft.lbs.
Compressor Mounting Bracket-to-Engine Bolts	3/8-16	41-51 N.m	30-38 ft.lbs.
	3/8-24	41-51 N.m	30-38 ft.lbs.
	7/16-14	68-81 N.m	50-60 ft.lbs.
	1/2-13	95-115 N.m	70-85 ft.lbs.

BODIES AND CABS

S-SERIES CONVENTIONAL CAB

INDEX

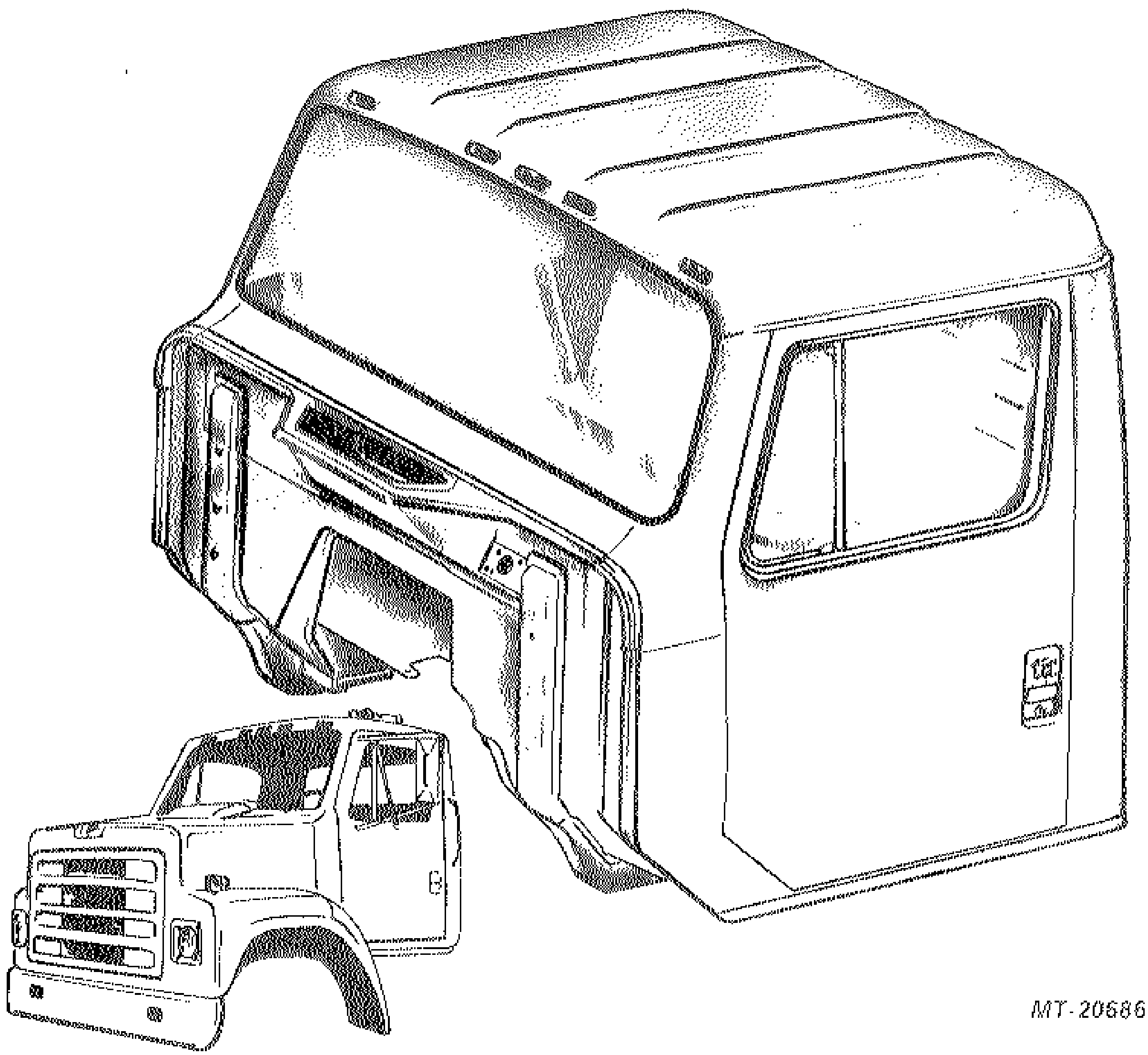


Fig. 1. S-Series Conventional Cab

GENERAL

The S-Series mid-range conventional cab shown here in Figure 1 and covered in this manual is available in either 200 or 230 cm width (80 or 90 inch) and for three different bumper to back of cab (B.B.C.) dimensions.

This manual has been prepared to help servicemen maintain cab in its original condition or restore cabs which may have sustained damage.

CONTROLS INSTRUMENT PANEL

While there is a wide range of optional equipment available on the S-Series models for which this cab is used, all instruments, gauges and driver controls are located for driver convenience. Fig. 2 shows the cab interior and a typical instrument panel installation. Removable panels provide for easy access to speedometer, cables, gauges, bulbs, wiring, plumbing, switches, valves, etc.

CAUTION

Always disconnect battery ground before servicing or removing instrument panel.

For further information on S-Series instrument panel see INSTRUMENTS CTS-2735.

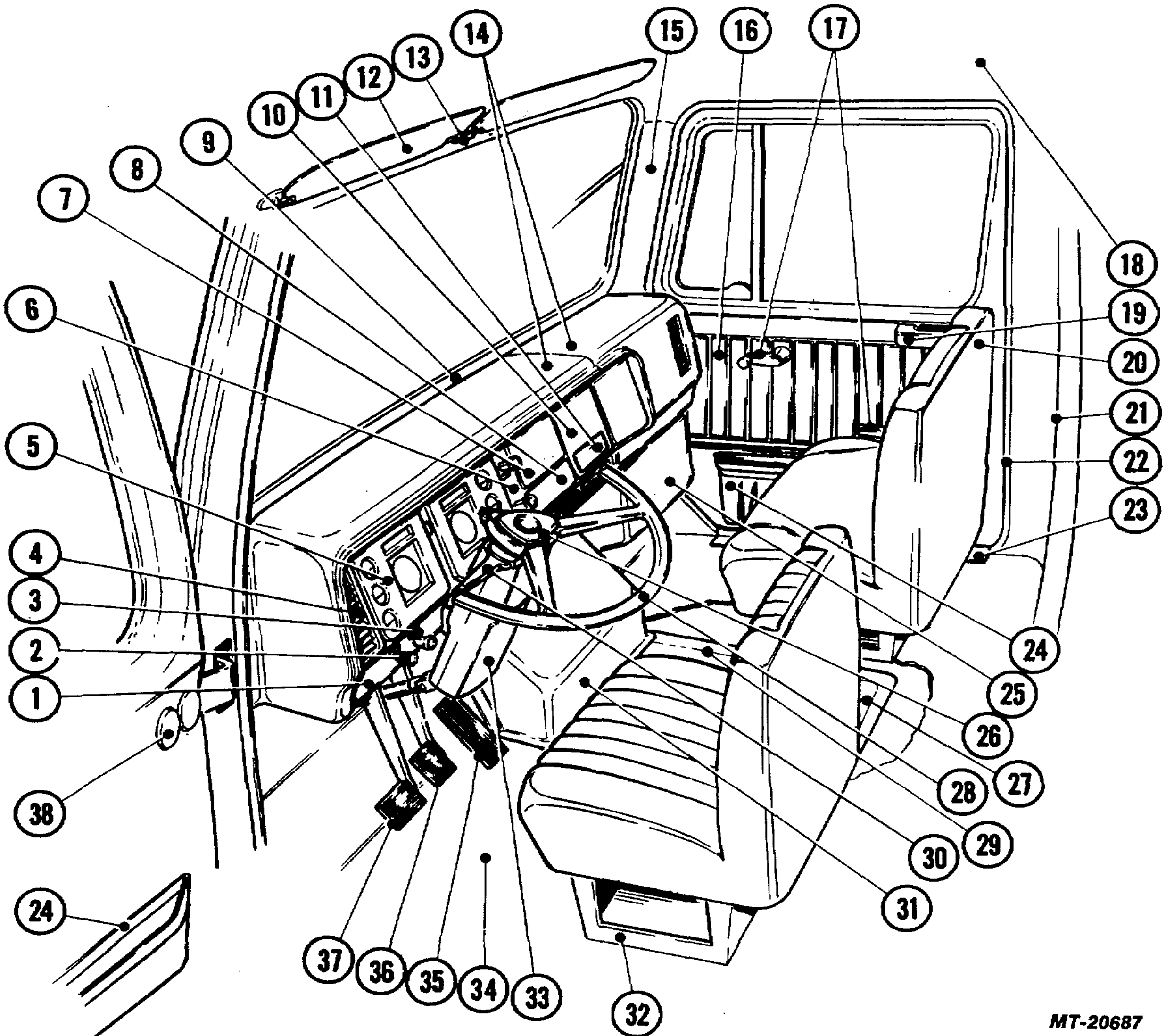


Fig. 2 S-Series Cab Interior View (Typical)

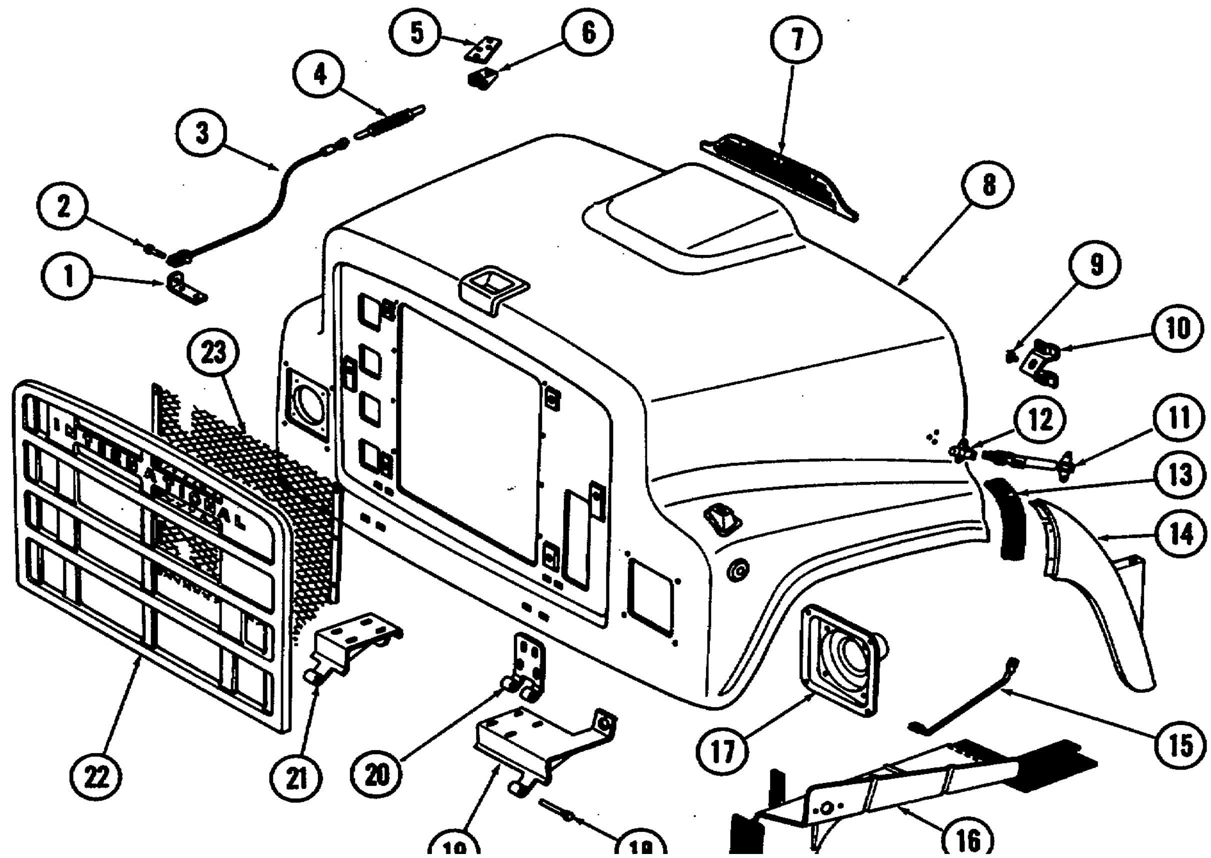
Key	Description	Key	Description	Key	Description
1	Lower Instrument Panel	14	Instrument Panel Cover	27	Transmission Cover
2	Control Knobs	15	Hinge Pillar Access Cover	28	Steering Wheel
3	Name Plate	16	Door Trim Panel (Custom)	29	Shift Lever
4	Air Conditioning Louver	17	Door Hardware	30	Turn Signal Lever
5	Instrument Cluster	18	Headliner	31	Engine Cover
6	Instrument Panel	19	Arm Rest	32	Seat Riser
7	Air Control Cluster	20	Seat	33	Steering Column
8	Heater/Air Conditioner Control	21	Back Inner Trim Panel	34	Floor Mat
9	Defroster Panel	22	Door Trim Strip	35	Accelerator Pedal
10	Radio Panel	23	Scuff Plate	36	Brake Pedal
11	Ash Tray	24	Manifest Pocket, Vinyl or Metal	37	Clutch Pedal
12	Sun Visor	25	Heater	38	Button Plug, Hinge Cover
13	Sun Visor Clip	26	Horn Button		

SERIAL NUMBER LOCATIONS

Serial numbers are necessary if the need for replacement parts should occur. For this reason you will want to know the location for these important numbers. S-Series chassis serial numbers are located on face of cab lock pillar. S-Series cab serial numbers are located at top right of cow-ront panel.

MAINTENANCE

Most service requirements, disassembly procedures or adjustments, on this cab and hood can be performed with ordinary mechanic's hand tools. Illustrations and suggested procedures for helping the mechanic are covered in paragraphs which follow.



MT-20773

Fig. 3 Hood and Hinge Mounting for S-2200 Cab (230 Cm - 90 Inch Wide)

Legend for Figure 3

Key	Description	Key	Description	Key	Description
1	Bracket, Hood Stop	9	Guide, Hood Locator	17	Shield, Headlight
2	Pin, Cable End	10	Bracket, Locator Guide	18	Pin, Hood Hinge
3	Cable, Assembly, Hood	11	Latch, Hood	19	Hinge, Lower Half Left
4	Spring, Hood Stop	12	Socket, Hood Latch	20	Hinge, Hood Half
5	Reinforcement	13	Seal	21	Hinge, Lower Half Right
6	Bracket, Hood Stop Anchor	14	Fender	22	Grille, Radiator
7	Grille, Fresh Air Intake	15	Brace, Splash Panel	23	Screen, Radiator
8	Hood, Assembly	16	Panel, Fender Splash		

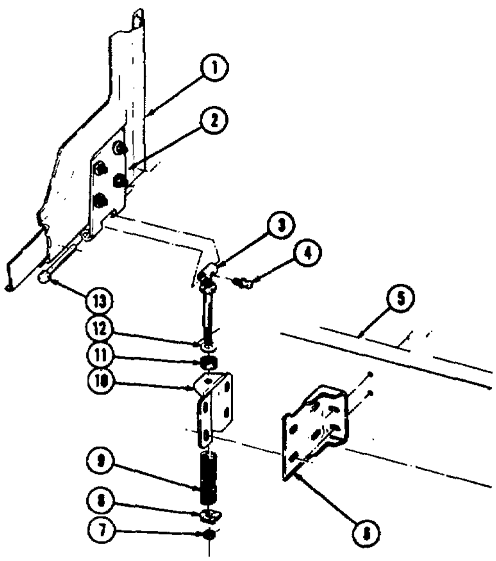
HOOD AND HINGE MOUNTINGS

Tilt type hoods (Figs. 3 & 4) used with S-Series cabs are one-piece molded fiberglass units. While they may vary slightly in size, appearance and hinge mounting, they are similar in servicing as follows:

Hood Opening (Tilting)

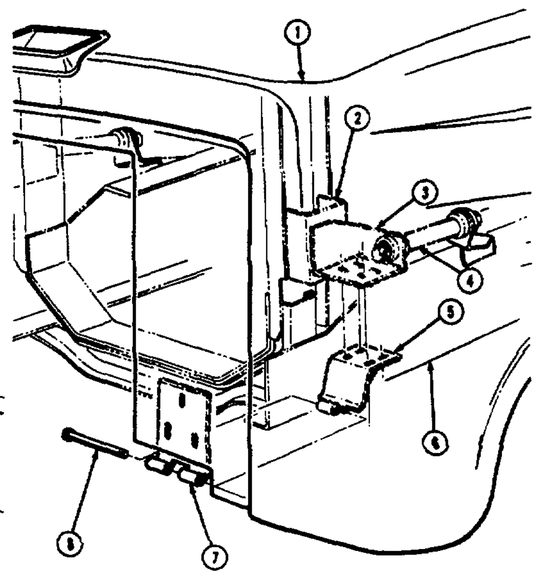
The hood assembly is hinged near bumper and can be tilted by releasing hood latches on cowl panels. Place foot on bumper step, grasp handle recess and pull complete hood, fenders and grille assembly to front. There are two hood stop cables to prevent over-travel of hood.

To lower hood, push the hood towards cab and at the same time hold back at handle recess to ease the hood into travelling position. Secure both hood latches at cowl panels. Do not allow hood to drop into place or damage can result



FOR S-2500 AND
S-2600 CABS

Key	Description
1	Hood, Assembly
2	Hinge, Hood Half
3	Hinge, Frame Half
4	Lubricator
5	Sidemember, Frame
6	Bracket, Hinge-to-Frame
7	Nut, Slotted
8	Spacer
9	Spring, Tension
10	Bracket, Hinge
11	Insulator
12	Washer
13	Pin, Hood Hinge



FOR S-2100 CAB
(S-1600-1900 SIMILAR)

Key	Description
1	Hood, Assembly
2	Support, Radiator
3	Bracket, Stay Rod Mounting
4	Rod, Stay
5	Hinge, Frame Half
6	Sidemember, Frame
7	Hinge, Hood Half
8	Pin, Hood Hinge

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Remove

1. Release hood latches, on each side of cowl and tilt hood assembly forward.

2. Support tilted hood on floor stands or saw horse to relieve tension on hood stop cables. Protect paint from scratches.

3. Remove spring type pins and cable end pins (one for each cable) and detach stop cables from hood stop brackets at top of radiator.

4. Disconnect headlight wiring harness from connector on underside of hood.

5. Remove spring type pin and hinge pin from the two hood hinge assemblies and detach hood from chassis.

6. Hood-to-frame hinge mounting details for the various size hoods are shown in Figs. 3 and 4.

Fiberglass Repair

Refer to BODIES AND CABS CTS-2408 for fiberglass repair instructions.

Install

Hood installation is the reverse of the foregoing removal procedure. Before final tightening of hood mounting bolts, check hood adjustment.

Adjust

When making any adjustment to tilt hood, inspect hood alignment and clearance between hood and cowl. Elongated mounting holes in frame half of hood to frame hinges provide for hood adjustment. If adjustment is required, loosen hinge to frame mounting bolts and adjust hood to cowl clearance as necessary. Tighten mounting bolts to specified torque (see Torque Chart).

CAB DOORS (Fig. 5)

Doors used on the S-Series cab are of all steel-welded construction with access panel and button plug openings for making hinge adjustments or removal as required. The door is mounted on concealed leaf type hinges and door adjustment is provided by elongated holes in hinge leaves. Door stop is integral with upper hinge. Door striker pin is also adjustable on lock pillar. Service on the door and its components is covered in paragraphs which follow. Fig. 5 Custom Trimmed Door

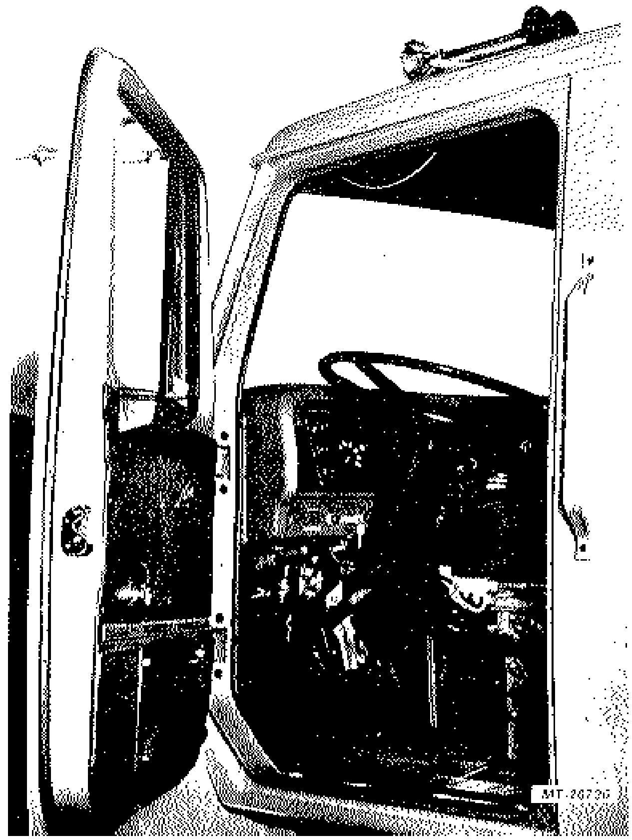

Fig. 5 Custom Trimmed Door

DOOR HARDWARE AND TRIM (Fig. 6)

Components of door assembly can be removed while door is either on cab or removed. They can also be removed individually without having to remove other components for access. Servicemen should have little difficulty in making a complete door disassembly or a removal of any of its component parts. (Most components do require the prior removal of door hardware and trim.)

Remove

1. Remove window regulator handle and door remote control handle by removing socket head screws from handles.

2. Remove two screws and detach arm rest.

3. Remove door trim screws and detach door trim panel (custom trim model only).

Install

Door hardware and trim installation is the same as reverse of removal procedures.

IMPORTANT

Be careful when reinstalling arm rests so as to avoid stripping out mounting screws. Torque for mounting screws is 2.3 N.m (20 in. Lbs).

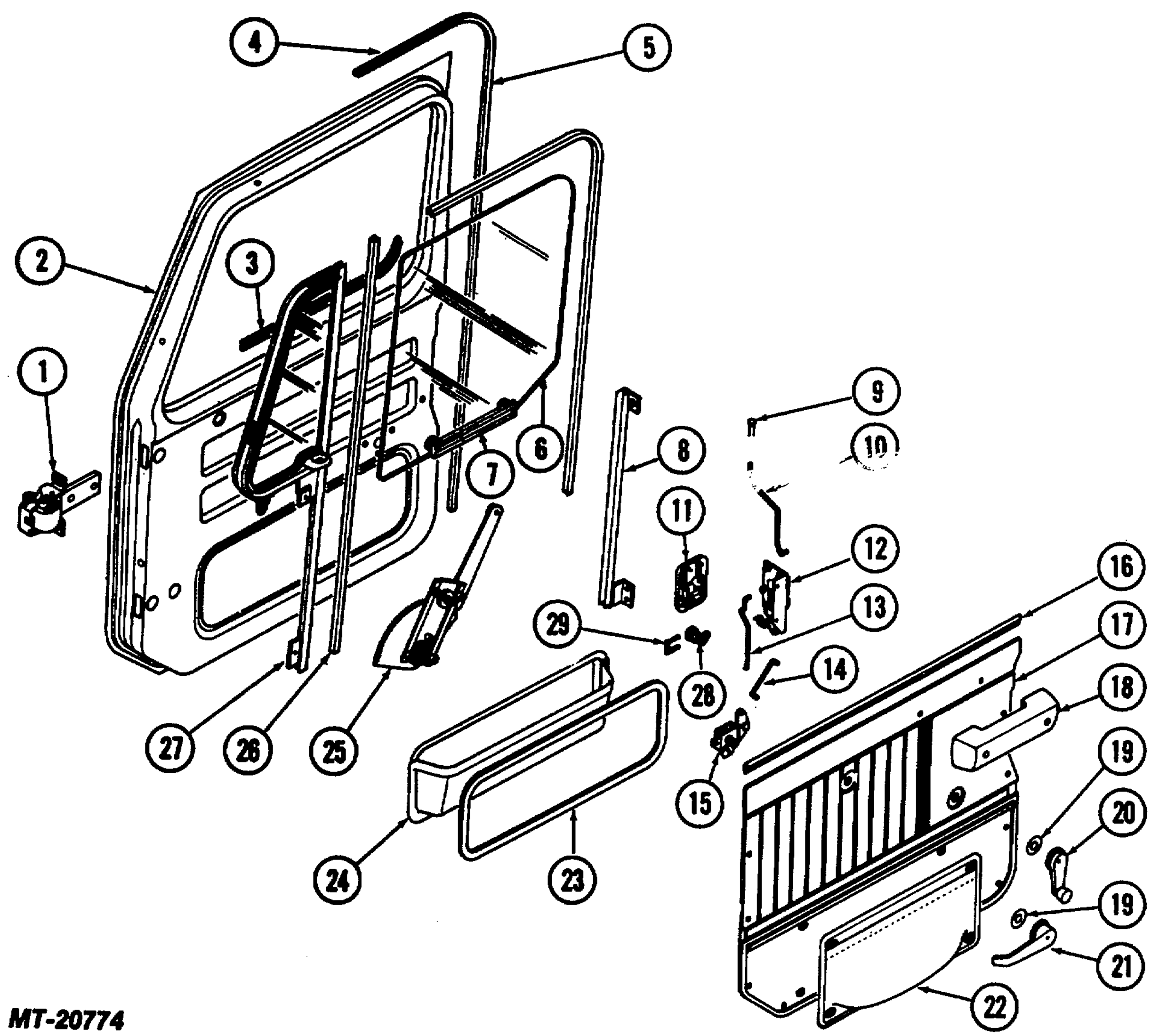

Fig. 6 Door Hardware, Trim and Internal Components-Exploded View

Legend for Figure 6

Key	Description
1	Hinge, Cab Door
2	Door, Assembly, Cab
3	Seal, Door Glass
4	Seal, Door
5	Seal, Door Glass Rear Channel
6	Glass, Door Window
7	Guide, Door Window
8	Channel, Rear Run
9	Knob, Door Lock
10	Rod, Lock Knob to Latch
11	Handle, Assembly Door Outer
12	Latch, Assembly, Door
13	Rod, Remote Control to Latch
14	Rod, Lock Cylinder to Latch
15	Control Assembly, Remote
16	Retainer, Door Trim
17	Panel, Door (Custom Trim)
18	Arm Rest
19	Washer, Door Trim
20	Handle, Window Regulator
21	Handle, Door Remote
22	Pocket, Manifest (Custom Trim)
23	Retainer, Access Door
24	Pocket, Manifest (Standard Trim)
25	Regulator, Assembly, Window
26	Seal Door Glass Front Channel
27	Vent, Assembly Window Glass

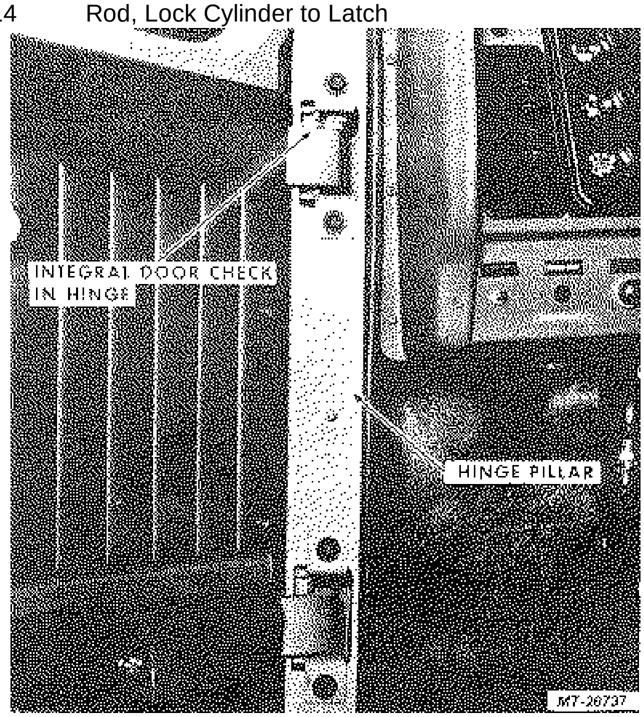

Fig. 7 Door and Hinge Details

DOOR HINGES

An integral door check (Fig. 7) is included in the upper hinge used with this door. If door is removed, upper and lower hinges should not be interchanged. There is no disassembly of hinges since they are serviced as a complete unit. It should also be noted that hinge mounting holes are elongated to provide adjustment for positioning cab door in door opening.

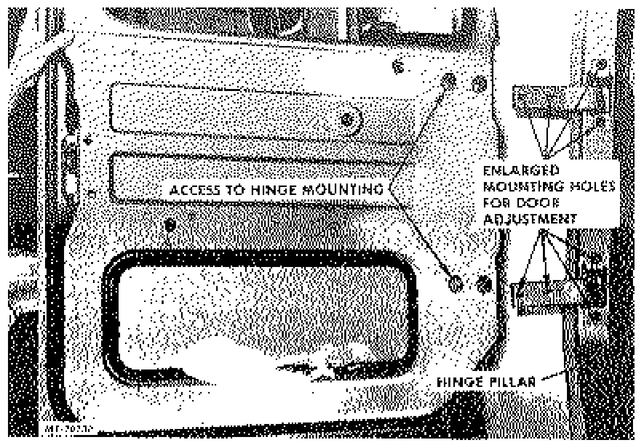

Fig. 8. Removing Door From Cab

Remove

1. Remove door hardware and trim as covered previously.

2. Using a rope sling (or padded chain) through window opening, attach sling to overhead lift and support door.

3. Remove four button plugs for access to hinge bolts.

4. Remove the four flange head hinge bolts and lift door assembly from hinges (Fig. 8).

5. Place door on saw horses or similar support. Protect paint from scratches.

6. To simplify door adjustment on reassembly, mark hinge position on hinge pillar with scratch awl before loosening hinges. Remove the three flange head bolts and detach door hinge from hinge pillar (Fig. 9).

IMPORTANT

Flange head bolt inside pillar can best be removed with a flex socket. Also be careful when extracting bolt so as to avoid its loss inside pillar.

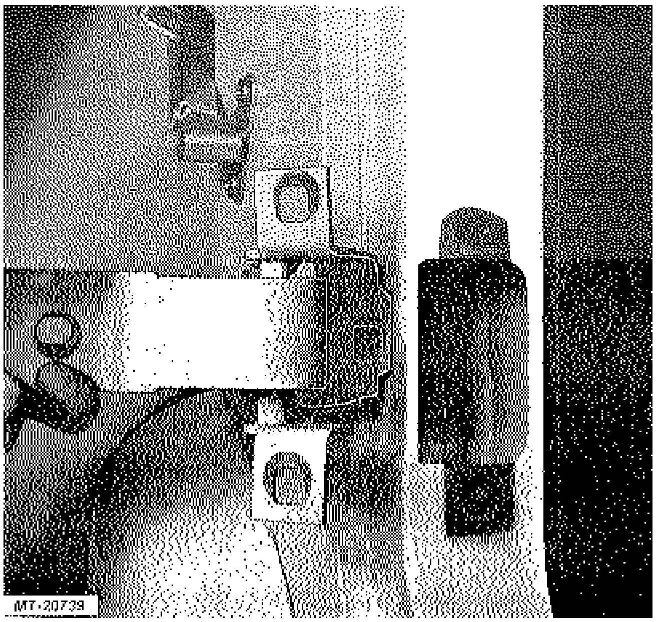

Fig. 9 Removing Cab Door Hinge From Hinge Pillar

<u>Install</u>

Cab hinge and door installation is accomplished by reversing the foregoing removal procedures. Before final tightening hinge mounting bolts, check the door adjustment. See CAB DOOR ADJUSTMENT for complete details.

DOOR GLASS

<u>Remove</u>

1. Remove door trim as covered previously.

2. Remove rubber insert from around door access cover. Use blunt nose screwdriver or seal tool as shown (Fig. 10). Lift out cover and remove seal from access opening.

3. Lower window glass to bottom of its channel.

4. Working thru access opening remove two glass fastener screws from window guide and detach guide from glass and window regulator lever (Fig. 11).

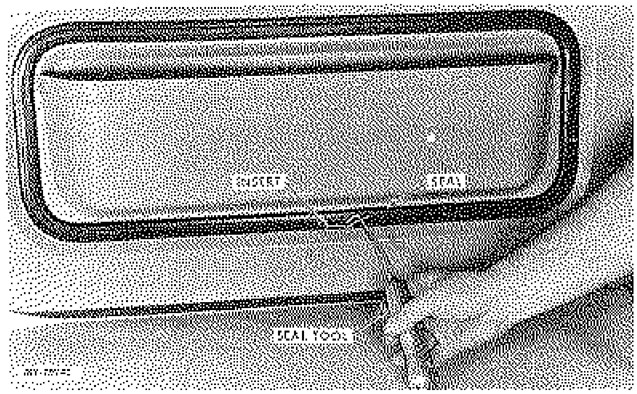

Fig. 10 Removing Access Panel From Door

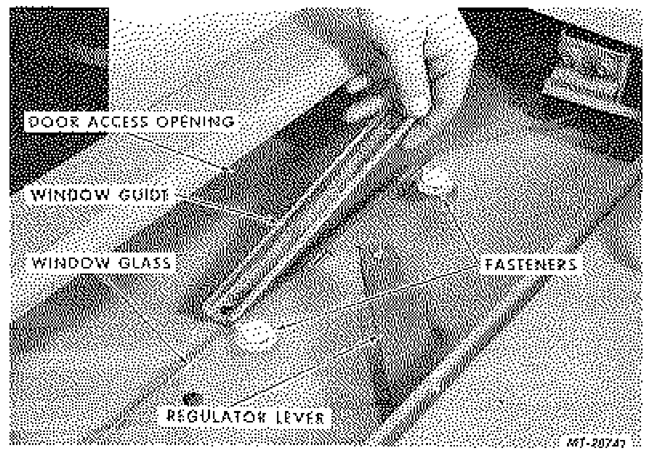

Fig. 11 Removing Window Guide From Window Glass

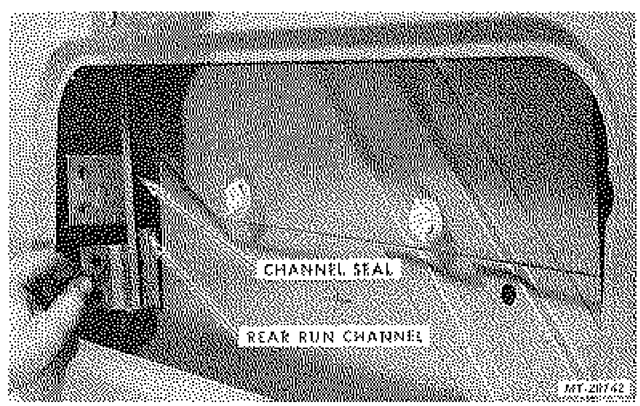

Fig. 12. Removing Rear Run Channel

5. Remove button plug from side of door for access to rear glass run channel upper retaining bolt. Remove bolt.

6. Remove two retaining bolts from lower end of glass rear run channel. Remove channel and channel seal (Fig. 12) from glass and lay aside in door.

7. Remove glass from front run channel.

8. Pull glass out bottom of access opening (Fig. 13).

Fig. 13 Removing Or Installing Window glass

Install

1. Insert window glass through access opening (Fig. 13).

2. Enter glass into front run channel.

3. Slide rear run channel and channel seal onto rear edge of glass.

4. Secure rear run channel retainer to upper and lower mounting brackets with bolts and washers.

5. When assured that glass will slide easily from top to bottom in window channels, move window to lowered position.

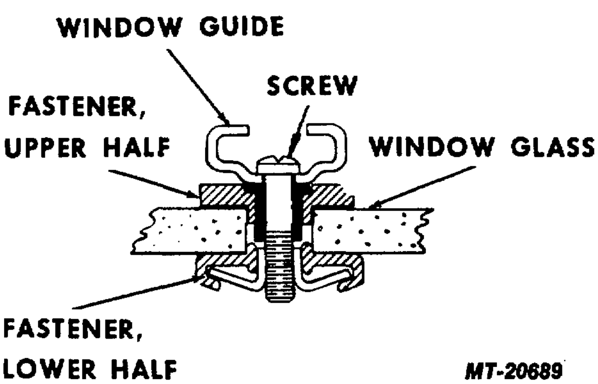

Fig. 14 Window Glass Fastener Cross Section

6. Temporarily install regulator handle and turn regulator lever to engage with bottom edge of window.

7. Install window guide and regulator lever stud to window glass using the two fastener assemblies (Fig. 14) through holes provided in glass.

8. Operate regulator handle to make sure all components have been assembled correctly.

9. Reinstall access door.

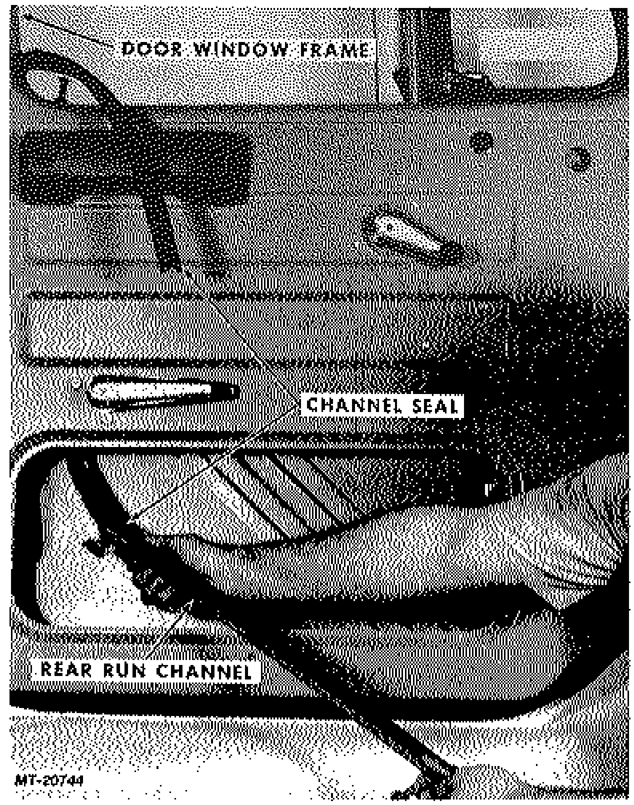

Fig. 15 Removing Rear Run Channel and Seal

DOOR GLASS REAR RUN CHANNEL AND CHANNEL SEAL

The door glass rear channel seal (weather stripping) is moulded for a compression fit in window frame as well as in glass rear run channel. No clips are required to retain it. Channel and seal are removed together.

Remove

1. Remove cab door glass as outlined under "DOOR GLASS". Glass may be left in bottom of door or removed through access opening as desired.

2. Pry out channel seal from door window frame (Fig. 15).

3. Since rear run channel is already loosened as outlined under "DOOR GLASS", remove channel and seal through door access opening (Fig. 15).

Install

1. Obtain replacement channel seal and insert lower end in rear run channel.

2. Place channel and seal assembly inside door and press upper end of seal into window frame.

3. Procedure for mounting rear run channel to door is same as covered under "DOOR GLASS".

DOOR GLASS INNER AND OUTER SEALS

Door glass inner and outer seals are retained in bottom of window frame by clips (Fig. 16).

Remove

1. Remove cab door glass as outlined under "DOOR GLASS". Glass may be left in bottom of door or removed through access opening as desired.

2. Carefully pry out inner and outer seals from window frame (Fig. 16). Apply pressure at clips to avoid damage. If clips are broken during removal, a replacement seal will be necessary.

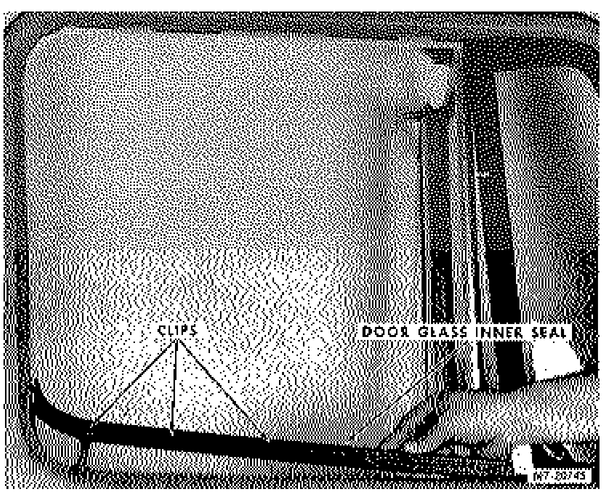

Fig. 16 Door Glass Inner Seal

Install

To install door glass inner and outer seals, simply align seals in place and press clips into openings provided. Avoid damage to seal by applying pressure at clip locations only.

DOOR VENT GLASS AND FRONT RUN CHANNEL

The door vent glass and front run channel (Fig. 17) is serviced as one assembly. It is held in place in door by two pan head screws and two hex head bolts.

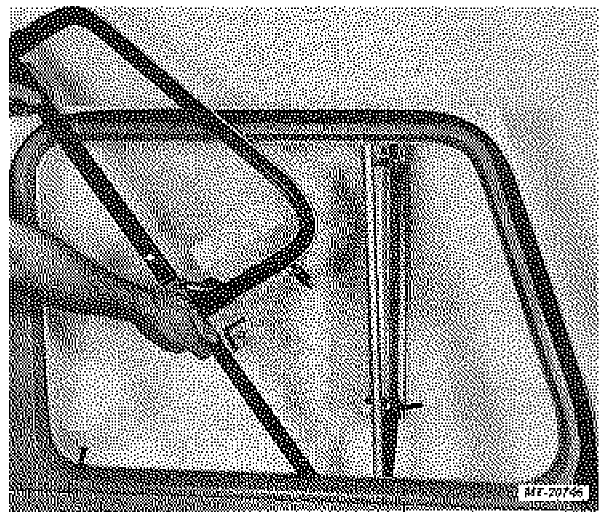

Fig. 17 Removing or Installing Door Vent Glass and Front Run Channel

Remove

1. Remove door glass and door glass window seals as outlined previously.

2. At the outside of door remove two pan head mounting screws, one from top and one from front edge.

3. From inside of door remove two hex head bolts and detach vent glass and front run channel from door.

4. Lift out vent glass and front run channel as an assembly through window frame (Fig. 17).

Install

Door vent glass and front run channel installation is accomplished by reversing the foregoing removal procedure.

DOOR GLASS REGULATOR

The cab door glass regulator is serviced as a complete unit with the door glass either in place or removed. If it is not desired or necessary to replace door glass, simply lower glass sufficiently to detach regulator lever from glass and then push glass back up into window frame. Secure glass temporarily to top of door with tape.

Remove

1. Remove door hardware, trim and access door (same as for removing door glass).
2. Lower glass to bottom of door and remove the two glass fastener screws and regulator lever from window guide.
3. Remove window guide by sliding it from regulator lever.
4. Push door glass up in window frame and secure glass to top of door with tape.
5. Remove the four retaining screws which hold regulator assembly in door.
6. Push regulator shaft through hole in door inner panel and remove regulator assembly through access opening (Fig. 18).

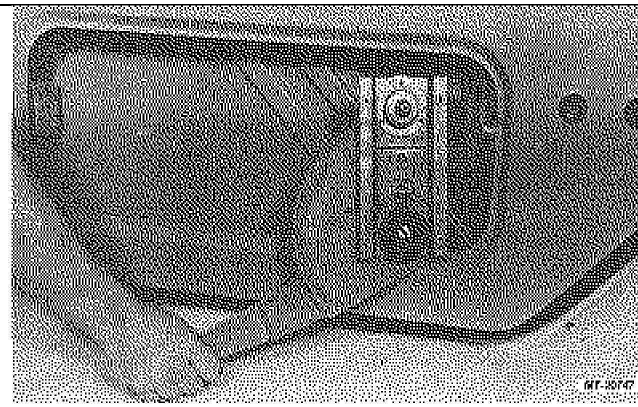

Fig. 18 Removing or Installing Door Glass Regulator

Install

Cab door glass regulator installation is accomplished by reversing the foregoing removal procedure. See Fig. 19 for door internal component details.

Lubricate

Lubricate cab door glass regulator gear teeth, arm pin and slide at installation. See Lubrication.

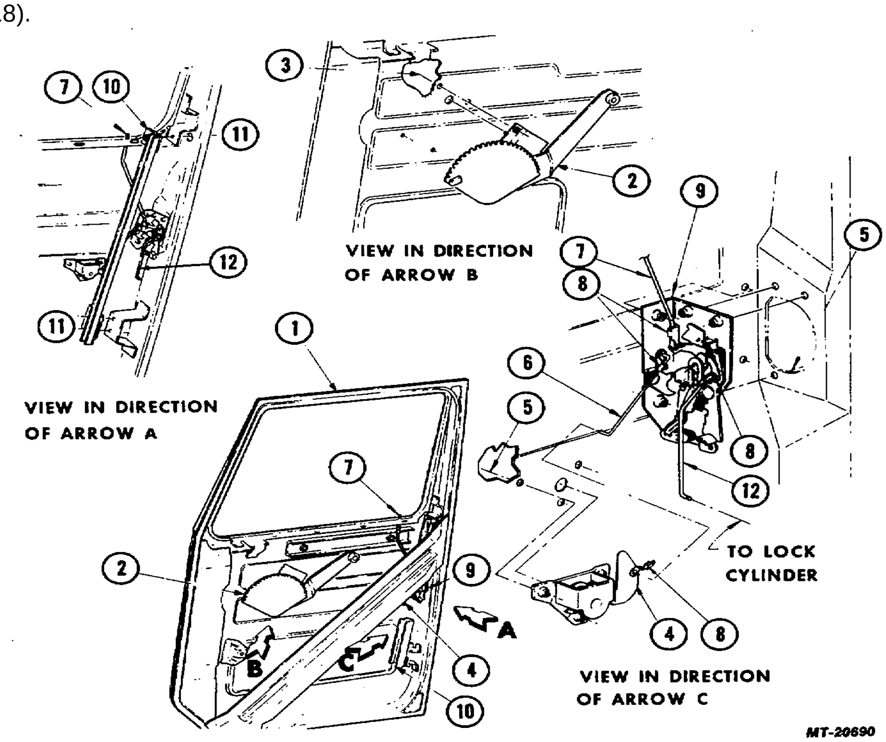

Fig. 19 Door Glass Regulator and Latch Details

Legend for Figure 19

Key	Description	Key	Description
1	Door, Assembly, Cab	7	Rod, Lock Knob to Latch
2	Regulator, Assembly, Window	8	Clip, Rod End
3	Screw, Mounting, Pan Head	9	Latch, Assembly, Door
4	Control Assembly, Remote	10	Retainer, Rear Run Channel
5	Screw, Mounting	11	Bolt, Mounting, Hex Head
6	Rod, Remote Control to Latch	12	Rod, Lock Cylinder to Latch

IMPORTANT

Be careful when reinstalling door glass, door glass regulator and related parts to avoid glass breakage. Door glass inner and outer seals, channel seals and glass mounting fasteners have been designed to protect glass through rugged operating conditions. Make sure the reassembly of these parts will maintain this same glass protection.

DOOR LATCH ASSEMBLY AND REMOTE CONTROL

The cab door latch assembly (Figs. 19 and 20) used with this door features positive norattle latch jaws which engage with striker pin on cab lock pillar. Latch assembly mounts to a small opening in edge of door and connects to remote control, lock cylinder and lock knob by relay control rods.

Remove

1. Remove door hardware, trim and access door (same as for removing door glass).
2. Remove lock knob from relay control rod through window frame.
3. Unfasten rod end clips and remove relay control rods from remote control assembly and from lock cylinder assembly. Opposite ends of the three relay control rods can remain attached to latch assembly.
4. Remove three socket head screws and detach remote control from inside of door (Fig. 21).
5. Remove five socket head screws and detach door latch assembly from inside of door frame (Fig. 22). Latch jaws should be closed.

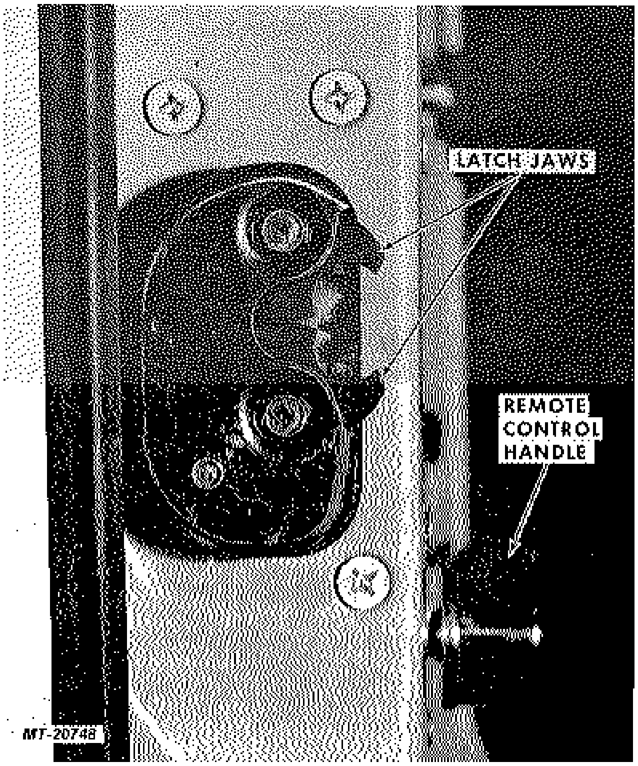

Fig. 20 Door Latch Assembly

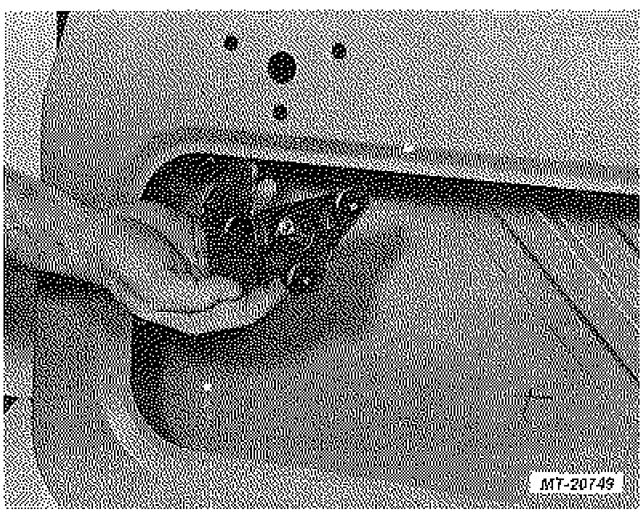

Fig. 21 Removing Remote Control Assembly

Install (Refer to Fig. 19 for Component Details)

1. Position latch assembly to inside of door. Latch jaws must be closed and the three relay control rods should be preassembled to latch.

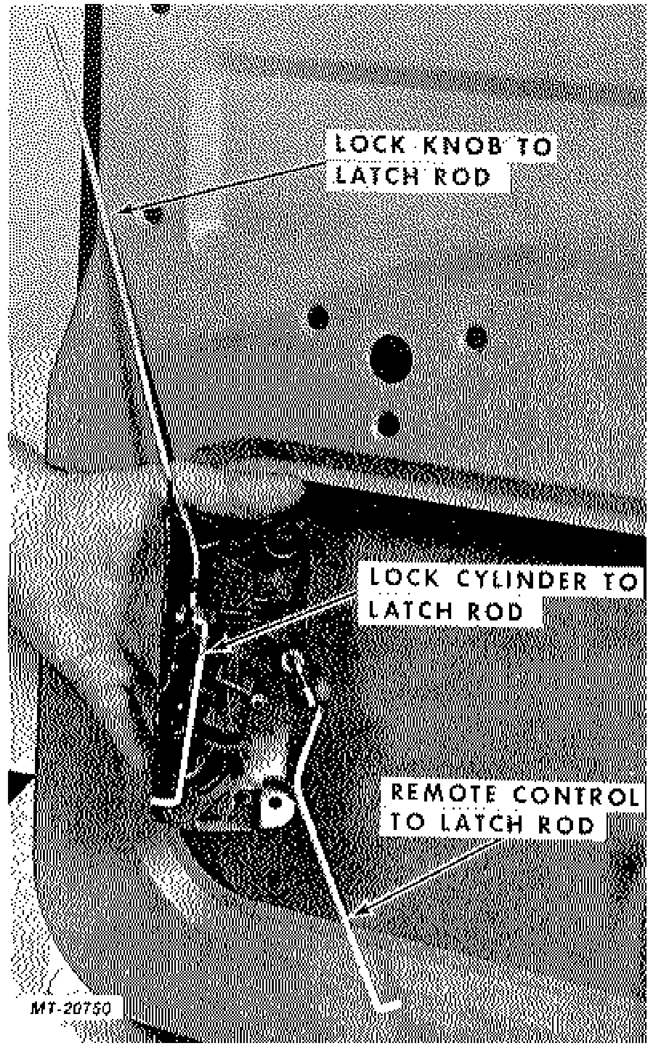

Fig. 22 Removing Latch Assembly

2. Pilot threaded end of upper lock knob rod through lock knob hole in window frame while positioning latch. Install lock knob.

3. Secure latch assembly in door with five socket head screws.

4. Position remote control assembly in door and secure with three socket head screws.

5. Connect the two remaining relay control rods to remote control assembly and to lock cylinder lever. Secure rods with rod end clips.

6. Operate latch assembly to assure correct assembly.

DOOR OUTER HANDLE

The door outer handle (Fig. 23) is a combination handle and lever operating assembly that connects with the latch assembly mechanism inside door to actuate the latch jaws. Outer handle can be removed without removing latch assembly.

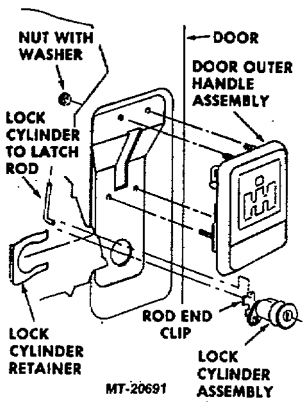

Fig. 23 Door Outer Handle and Lock Cylinder

<u>Remove</u>

1. Remove door hardware, trim and access door (same as for removing door glass).
2. Remove three hex nuts from studs through door from rear of handle.
3. Remove door outer handle from door (Fig. 24).

<u>Install</u>

To install outside door handle, reverse foregoing removal procedure.

DOOR LOCK CYLINDER ASSEMBLY

The door lock cylinder (Fig. 23) is key coded to key switch on instrument panel so that one key operates both. If keys are lost or a replacement of lock cylinder is desired, see special instructions under "KEY SWITCH AND DOOR LOCK CYLINDER REPLACEMENT".

<u>Remove</u>

1. Remove door hardware, trim and access door (same as for removing door glass).
2. Disconnect rod end clip and detach control rod from door lock cylinder assembly.

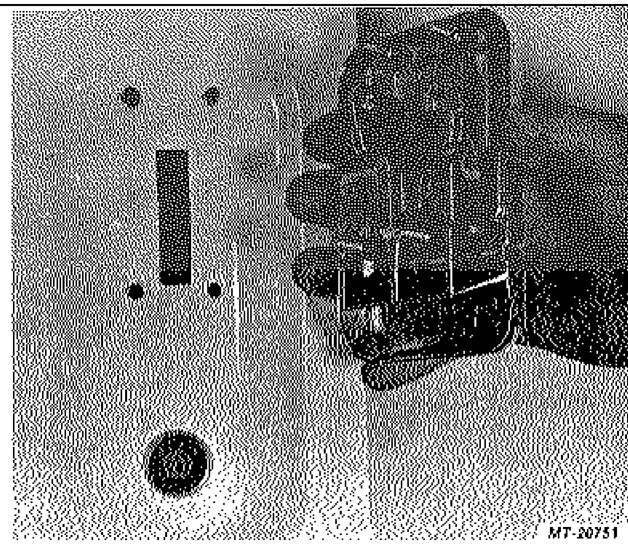

Fig. 24 Removing Door Outer Handle

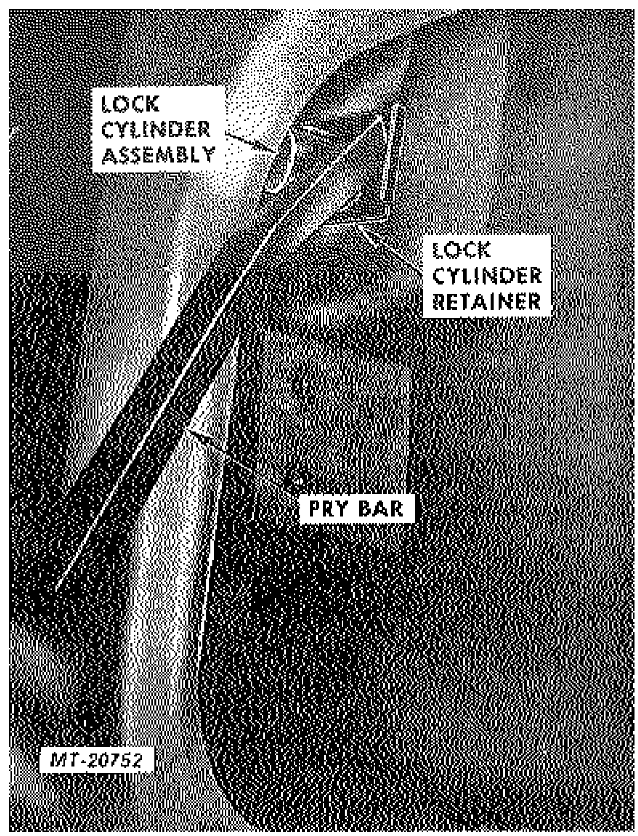

Fig. 25 Removing Lock Cylinder Retainer

IMPORTANT

Lock cylinder retainer can be removed without removing glass rear run channel. Channel removed in Fig. 25 for clarity.

3. Working through door access opening pry lock retainer from lock cylinder assembly (Fig. 25) with a small pry bar or screwdriver.

4. Rotate locks cylinder assembly slightly and remove from door.

Install

To install door lock cylinder assembly, reverse foregoing removal procedure.

KEY SWITCH AND DOOR LOCK CYLINDER REPLACEMENT

The instrument panel mounted key switch and the lock cylinder in the door are coded so that one key operates both. Code number is stamped on key switch body just back of cap nut. Door lock cylinder assembly does not have a code number stamped on body since this cylinder is coded to the key switch.

To locate code number on key switch, remove key switch mounting cap nut and detach key switch from instrument panel.

The key switch cylinder can be replaced providing the regular key is used.

Remove

To remove key switch cylinder from switch body, place key in switch cylinder and insert a piece of stiff wire or rod 1.5 mm (1/16") dia. in the small hole behind cap nut in switch body. Turn key to left (accessory position) and press the cylinder retainer down with the wire. The switch cylinder can then be pulled out of switch body.

Install

To install a new switch cylinder, simply push cylinder into switch body and turn to right ("ON" position) until the cylinder retainer snaps into place.

Door lock cylinder replacement is by the complete assembly. Lock cylinder itself (tumbler unit) is not removable. If door lock replacement is required, lock cylinder assemblies should be replaced in pairs.

If a replacement of key switch cylinder is necessary and the operator wants to use the original key, the tumblers on the new switch cylinder can be coded accordingly.

This is accomplished by inserting original key in new cylinder (cylinder removed from body) and filing off the tumblers that protrude from cylinder. When making this change, be sure no burrs are left on tumblers and all filings are blown out with air. Apply a small quantity of powdered graphite to tumblers and reinsert cylinder in key switch body.

IMPORTANT

If keys are lost, switch cylinder must be drilled out using a 7.9 mm (5/16") drill, 12.7-19 mm (1/2-3/4") deep. This will permit tumblers to drop out and free lock.

DOOR WEATHER SEAL

A one piece rubber weatherseal is secured to cab door flange with plastic fasteners and provides a weather-tight seal around door when door is closed.

Remove

Pry up old weather seal at fastener locations and remove complete seal from cab door flange.

Install

1. Obtain new seal.

2. Be sure all old fasteners have been removed and door flange is free of dirt.

3. Place new weather seal into place on door flange and align fasteners over mounting holes.

4. Apply pressure to each fastenerto secure weatherseal.

DOOR STRIKER PIN

Door striker pin (Fig. 26) mounted on lock pillar provides for positive engagement with the door latch assembly (Fig. 20). Striker pin removal and installation requires a special driver tool. Enlarged mounting hole in lock pillar permits adjustment.

For complete details on striker pin adjustment, see "CAB DOOR ADJUSTMENT".

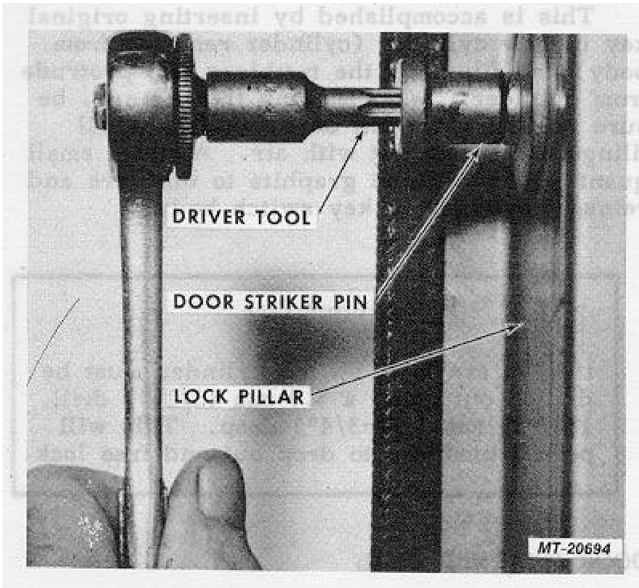

Fig. 26. Removing or Installing Door Striker Pin

CAB DOOR ADJUSTMENT

Getting a good cab door to door opening fit requires a knowledge of where the various adjustments are located and what effect each adjustment has on door fit. These adjustments apply whether door has been removed or door adjustment is simply being changed or improved.

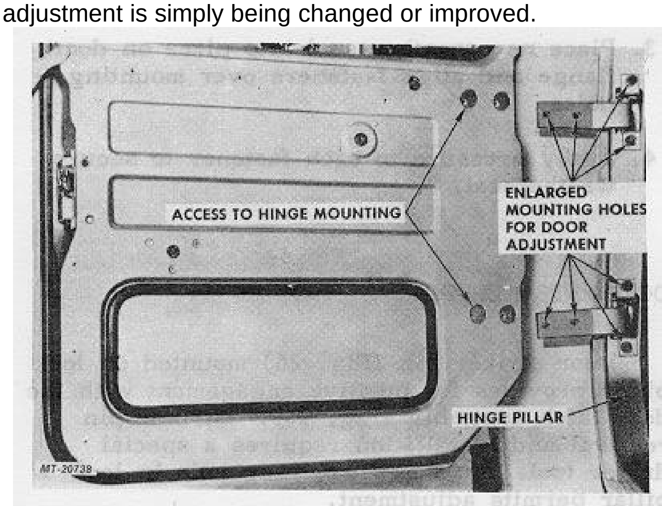

Fig. 27. Location for Door Adjustments at Hinge Pillar

1. Adjustment at Hinge Pillar (Fig. 27)

   a. Fore and aft door adjustment is made at enlarged holes in door half of hinge.

   b. Up and down or in and out door adjustment is made at enlarged holes in pillar half of hinge.

   c. With mounting bolts slightly loosened, one hinge at a time, adjust door to fit evenly in door opening and snug against door seal. Tighten mounting bolts to specified torque (see Torque Chart).

2. Adjustment at Lock Pillar (Fig. 26)

   a. Door striker pin or stud is mounted in an enlarged hole in lock pillar. Loosen pin to move pin up or down and in or out as required.

   b. Fore and aft adjustment is by spacer shim between striker pin and pillar.

   c. Make final adjustment of striker pin and tighten to specifications (See Torque Chart).

When adjusted (1) door weatherseal should contact door frame all around with slight pressure but without damage to seal (2) door should latch, lock and release without undue effort, and (3) door should be rattle free when vehicle is in motion.

DRIVER AND PASSENGER SEATS

Seat types available with S-Series cabs are determined by cab width and by the kind of equipment (engine, transmission, auxiliary, etc.) furnished with the truck. Full width bench seat and individual driver and passenger seats are available in the 200 cm (80 inch) wide cab. Individual driver and passenger seats only are available in the 230 cm (90 inch) wide cab. Mechanical and air suspension seats are also available optionally.

FULL WIDTH BENCH SEAT (Fig. 28)

Full width bench seats have fore and aft seat adjustment standard. Adjustable seat backs however, are available only on models having custom trim.

The fore and aft seat adjuster assembly consists of two integral sliding rail assemblies, the upper halves of which are bolted to seat bottom and lower halves to seat risers. Risers are firmly bolted to cab floor.

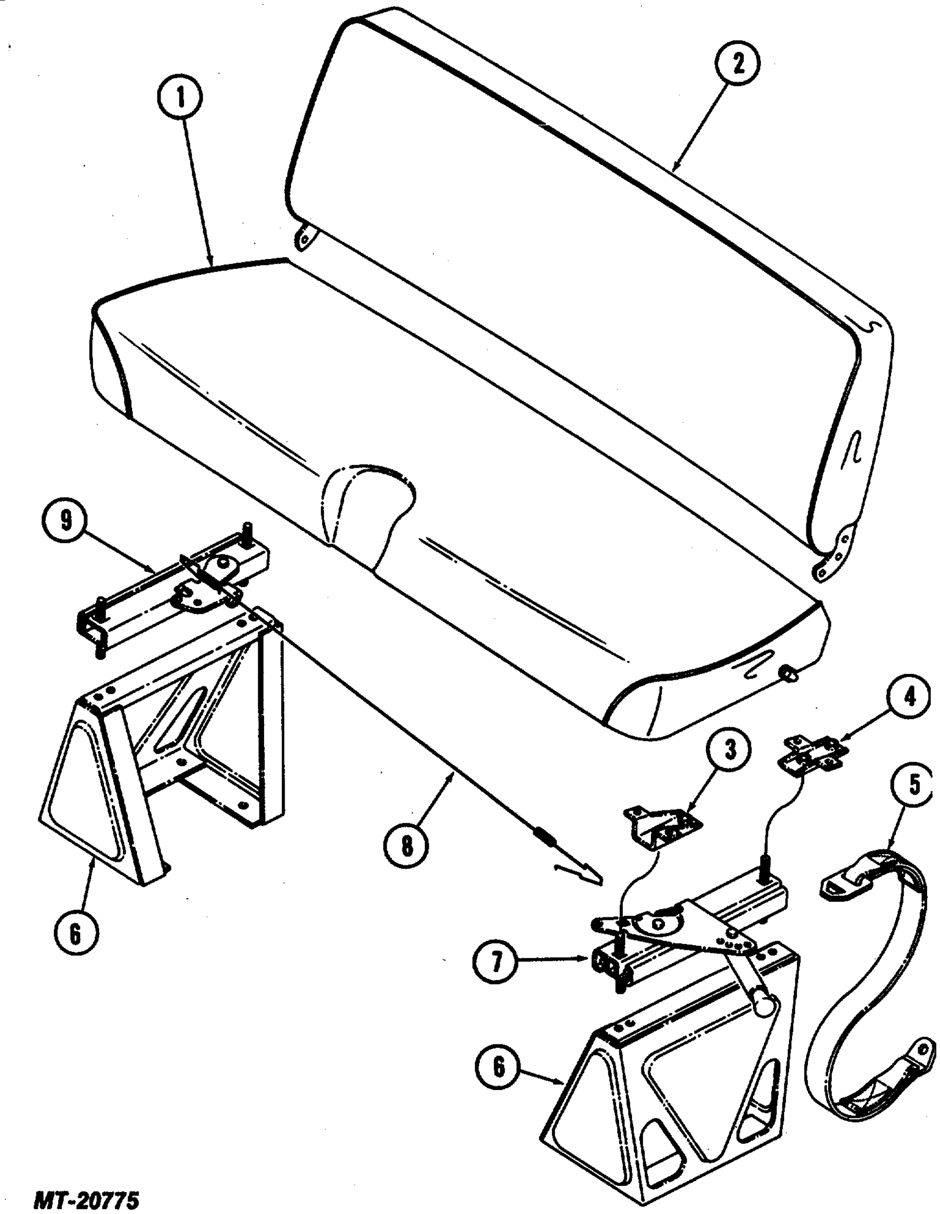

Fig. 28. Full Width Bench Seat - Standard Trim - Exploded View

Legend for Figure 28

Key	Description	Key	Description
1	Cushion, Seat Assembly	2	Cushion, Back with Support
3	Bracket, Seat Adjuster, Front	4	Bracket, Seat Adjuster, Rear
5	Belt, Seat	6	Riser, Seat
7	Adjuster, with Handle, Seat Left	8	Wire, Seat Adjuster
9	Adjuster, Seat, Right		

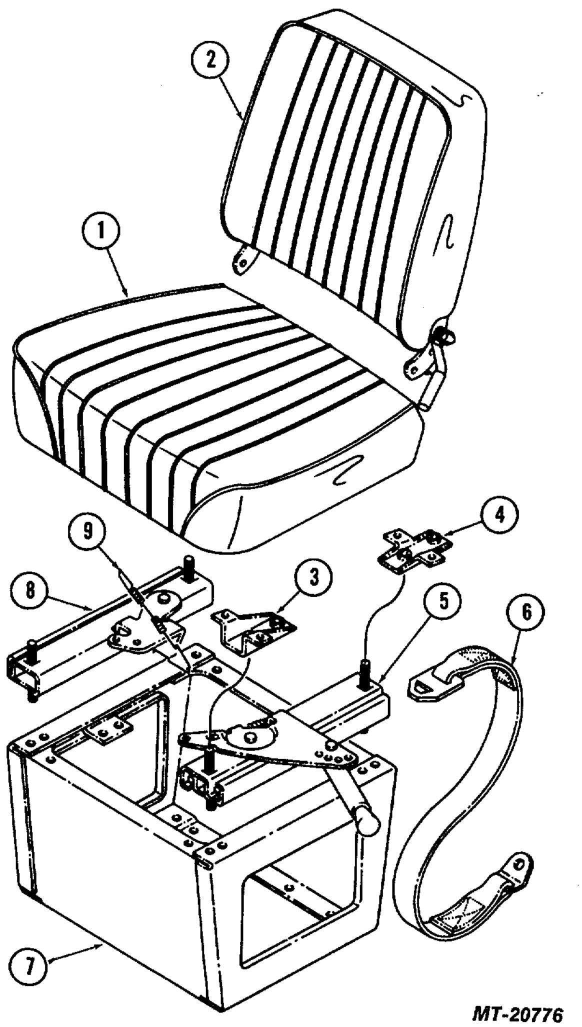

Fig. 29. Individual Drivers Seat Custom Trim Exploded View

Legend for Figure 29

Key	Description
1	Cushion, Seat Assembly
2	Cushion, Back with Support
3	Bracket, Seat Adjuster Front
4	Bracket, Seat Adjuster Rear
5	Adjuster with Handle, Seat Left
6	Belt, Seat
7	Riser, Seat
8	Adjuster, Seat, Right
9	Wire, Seat Adjuster

INDIVIDUAL DRIVERS SEAT (Fig. 29)

Individual drivers seats are similar in construction to the bench seat and have the same adjustment features and mechanisms. Individual passenger seats however are fixed in one floor position.

Removal and installation procedures which follow apply to both the full width bench seat and the individual drivers seat.

Remove

1. Remove the four bolts which secure the upper adjuster rails to seat bottom on right and left side and detach seat and back assembly. Slide seat fore and aft as necessary for access to mounting bolts.

2. Unlock seat adjuster wire between the two rails.

3. Remove two bolts which secure lower half of each seat adjuster to seat riser and remove right and left seat adjusters.

4. Clean seat adjusters as required. Apply a light coat of multi-purpose lube (IH 251 HEP) to rails to assure a smooth operation on reassembly. Wipe away excess lube.

Install

Seat installation procedure is the reverse of removal. See Torque Chart for specified mounting torques.

WINDSHIELD

The windshield used with the S-Series cab is either one or two piece flat glass type depending on whether cab is the 200 or 230 cm (80 or 90 inch) width model. A molded weatherseal (weatherstrip) with either an integral or detached insert fits perimeter of glass to retain glass in windshield opening. Seam between halves of two piece windshield is closed with inner and outer division bars and seals. When replacing windshield always use a new weatherseal since a used weatherseal is likely to be stretched or deteriorated and susceptible to leaks.

Remove

If either windshield or weatherseal must be replaced, procedure is as follows:

1. Remove washer hose from fittings on top of cowl.

2. Remove cap nut and detach windshield wiper arms (Fig. 30).

For further information on S-Series windshield wipers and washers see BODIES AND CABS CTS-2732.

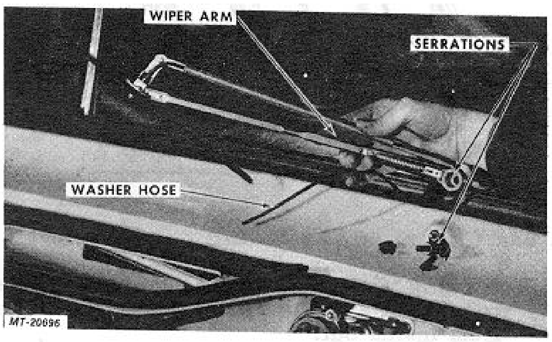

Fig. 30. Removing Windshield Wiper Arms

3. Pry integral or detached insert from weatherseal with a thin blade screwdriver or sealtool (SE-2442) (Fig. 31) around entire glass. See Fig. 32 for details of weatherseal.

4. If windshield is two piece type remove inner and outer division bars and seals (Fig. 33).

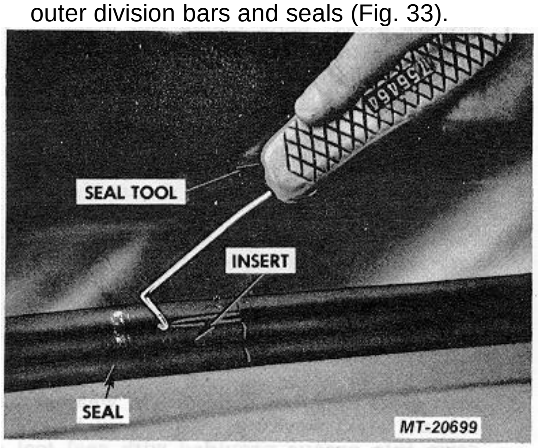

Fig. 31. Removing Windshield Weatherseal Insert

5. Working with one man outside cab and an assistant inside apply light pressure on windshield from inside of cab to push glass from seal. Be careful during this operation since heavy pressure at any one point can lead to glass breakage.

6. Lift glass from opening and peel weatherseal from fence (weld flange).

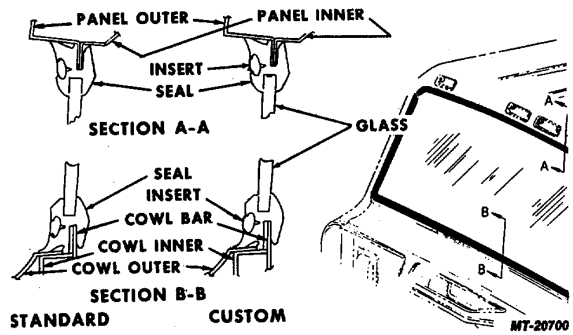

Fig. 32. Windshield Weatherseal (Retainer)

Install

IMPORTANT

Before installing new weatherseal or windshield, clean body flange and glass free of dirt, old sealing compound, wax, etc.

1. Coat weatherseal with a soapy solution or rubber lubricant for ease of assembly.

2. Install weatherseal carefully around edge of windshield opening flange. Position splice joint of seal ends at centerline of cab and on lower flange.

3. Working from outside the cab, place windshield in channel of weatherseal, starting at lower edge of opening.

4. For two piece type windshield install inner and outer division bars and seals. Check seal details (Fig. 33).

5. Work weatherseal insert (Fig. 31) down into groove provided around entire weatherseal. Use seal tool or a dull screwdriver to seat insert in groove. A second coat of rubber lubricant in groove will simplify installation.

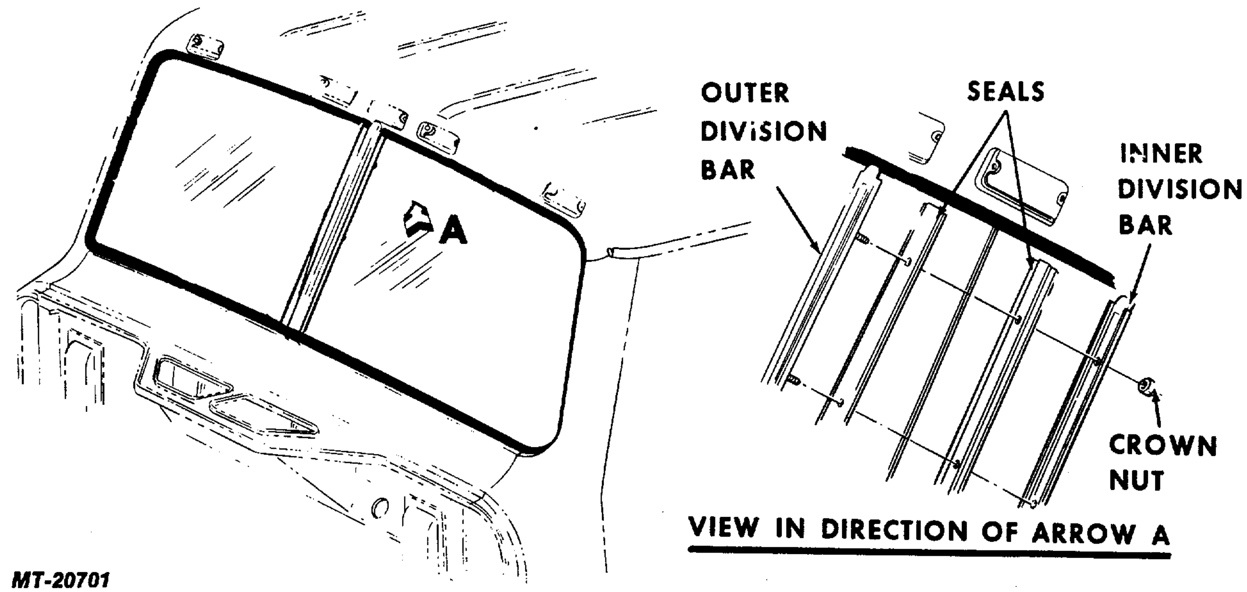

Fig. 33. Details of Windshield Division Bar (230 cm or 90 Inch Cab Only)

Cab rear window glass (Fig. 34) is secured in cab rear window opening with a molded one piece weatherseal with integral insert similar to that used for windshield. The weatherseal fits around edge of glass and is so formed, that it retains the glass in window opening by fitting over the window opening flange. Old or deteriorated weatherseals should not be reused whenever window glass is replaced.

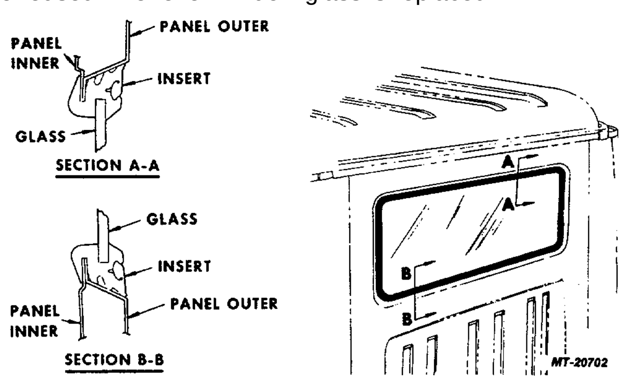

Fig. 34. Cab Rear Window Glass and Weatherseal

Remove

1. Pry out integral insert of weatherseal with seal tool or a thin blade screwdriver around entire perimeter of glass.

2. Working with an assistant, one man inside cab and one man outside, gently push glass from inside out.

3. Lift glass from opening.

Install

IMPORTANT

Before installing new weatherseal or window glass, body flange and glass must be cleaned free of dirt, old sealing compound, wax, etc.

1. Coat weatherseal with a soapy solution or rubber lubricant for ease of assembly.

2. Position weatherseal carefully around edge of rear window glass opening flange.

3. Working from outside the cab place rear window glass in channel of weatherseal starting at lower edge of opening.

4. With glass completely seated in weatherseal channel start working weatherseal insert down into groove provided with seal tool or dull screwdriver. A second coat of rubber lubricant will expedite this step.

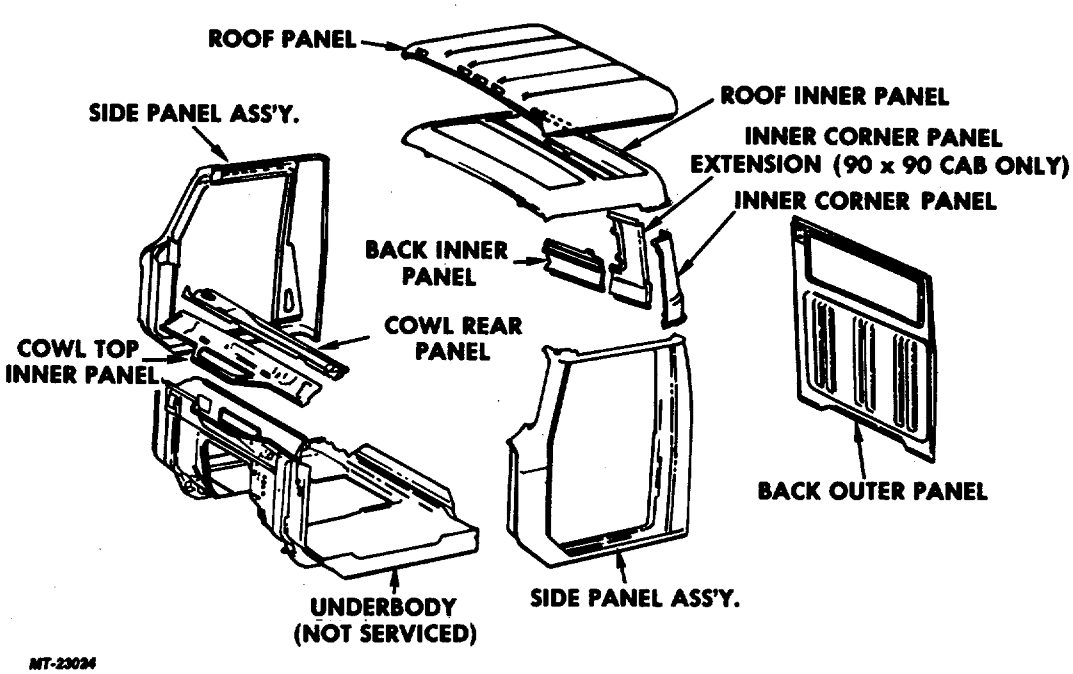

Fig. 35. S-Series Cab Panels

SHEET METAL REPAIRS

A special feature of the S-Series Cab is the availability of complete body panels for repairing the cab. The types of panels available are shown in Fig. 35. These panels enable a service man to restore a damaged cab to new condition without the usual problems associated with cab rebuilding. Extensive metal refinishing is not required and most restoration welds are in areas of low stress.

SHEET METAL TOOLS

To perform the necessary cab sheet metal disassembly and rebuild work, the special tools listed here should be on hand. Most of these are common to any cab or body rebuilding shop.

1. Electric or pneumatic drill.
2. Sheet metal drill bits.
3. Pneumatic chisel (SE-2664 or SE-2129).
4. An assortment of C-clamps.
5. MIG welder (SE-2640).
6. Weld wire Spec. No. E70S-3.

PREPARING CAB FOR PANEL REMOVAL

Before sheet metal repairs to cab can be started some mechanical work must be performed. This will depend on cab damage and which panel is being replaced. Since the side panel (Fig. 36) or door frame is a commonly replaced panel, let us use the left side panel replacement as an example for what mechanical work is required. The following items must be removed:

1. Left door, seat and interior trim.
2. Dash pad and instrument panel left side mounting.
3. Roof and back panel liners.
4. Left scuff plate and floor mat.
5. Windshield and rear window glass.
6. Junction boxes, relays, dimmer switch, wiring harness and brake piping.
7. Marker light harness and air horn supply line.
8. Fuse block, junction block and starter solenoid.
9. Fuel or air tanks.
10. Cowl top outer panel.

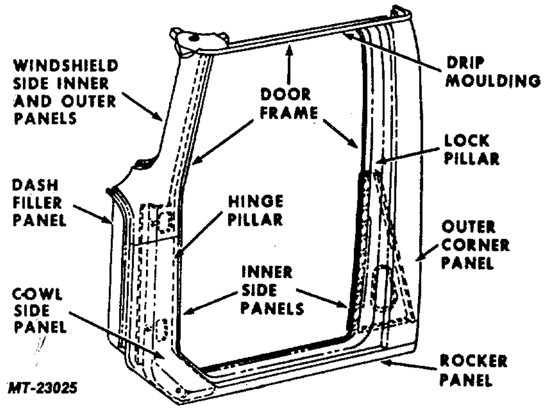

Fig. 36. Components of Side Panel Assembly

REMOVING SPOT WELDS

The actual side panel removal requires the drilling out of spot welds which attach the side panel to other panels of the cab. Sheet metal drill bits should be used. These are drill bits, the ends of which have been ground for this special purpose. An example of a sheet metal drill bit as compared to a regular drill bit is shown in Fig. 37. When spot welds have been removed, a pneumatic chisel is then used to open seams which have been clinched together.

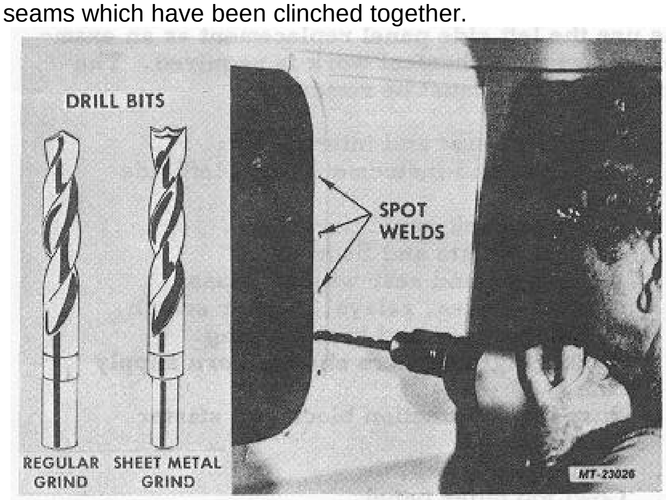

Fig. 37. Removing Cab Inner Corner Panel

SIDE PANEL REMOVAL

1. For access to back panel joint, remove cab inner corner panel. Remove trim strip between corner panel and inner roof panel and drill out spot welds (Fig. 37) around panel. Separate corner panel from back panel, inner roof panel and side panel assembly.

2. Separate inside panel of side panel assembly from sill side inner panel. Free inside panel of side panel assembly by cutting through MIG weld (Fig. 38) at bottom of panel. (On 80" wide cabs remove spot weld used at cowl side inner panel).

3. Drill out spot welds along drip moulding from front to rear and around corner to end of side panel. Separate side panel from outer roof panel (Fig. 39).

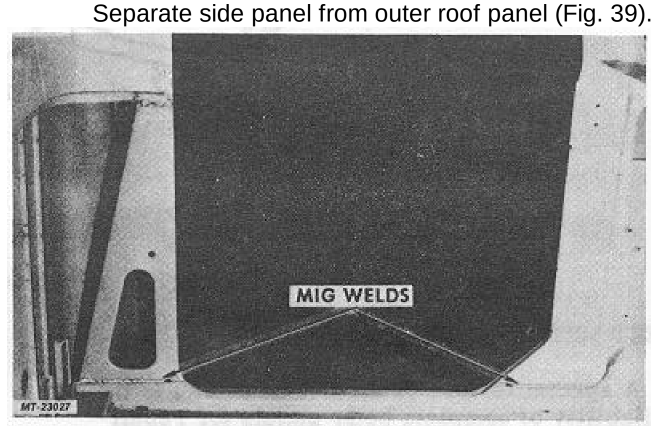

Fig. 38. Location of MIG Weld Seams

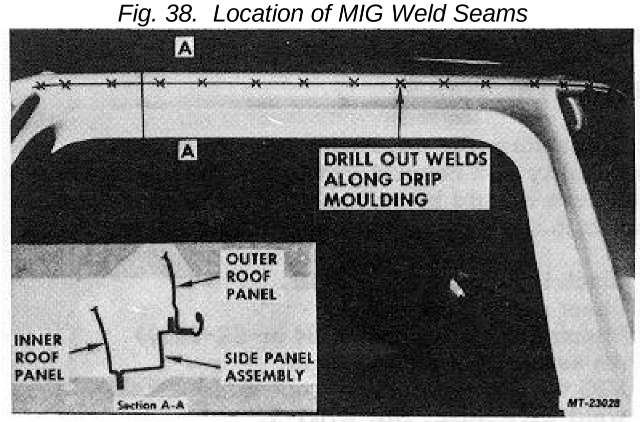

Fig. 39. Side Panel to Outer Roof Panel Spot Welds

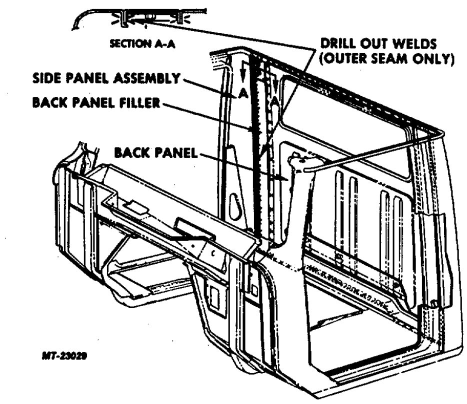

Fig. 40. Side Panel to Back Panel Spot Welds (Right Corner 90" Wide Cab Shown)

4. Drill out spot welds along seam between back panel and side panel and separate rear of side panel from back panel (Fig. 40). Drill at outer seam if for 90" wide cab.

5. Drill out spot welds along seam at bottom of cab and separate rocker panel from sill side inner panel (Fig. 41).

6. Drill out spot welds at seam between dash filler panel and dash panel. Separate filler panel from dash panel (Fig. 42).

7. Drill out five spot welds and separate windshield side outer panel from cowl top inner panel (Fig. 43).

8. Drill out six spot welds and separate windshield side outer panel from cowl rear panel and bracket (Fig. 44).

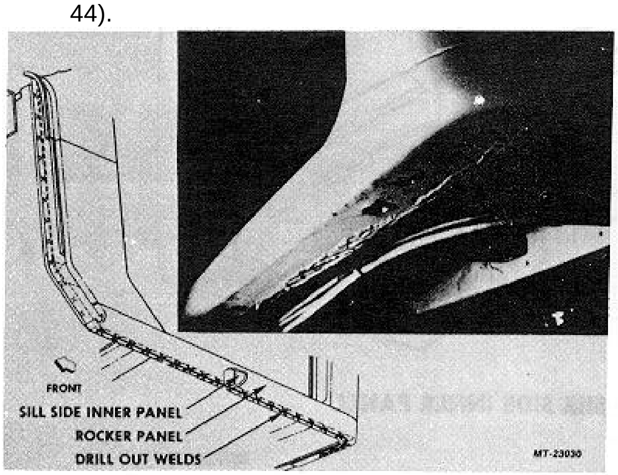

Fig. 41. Rocker Panel to Sill-Side Inner Panel Spot Welds

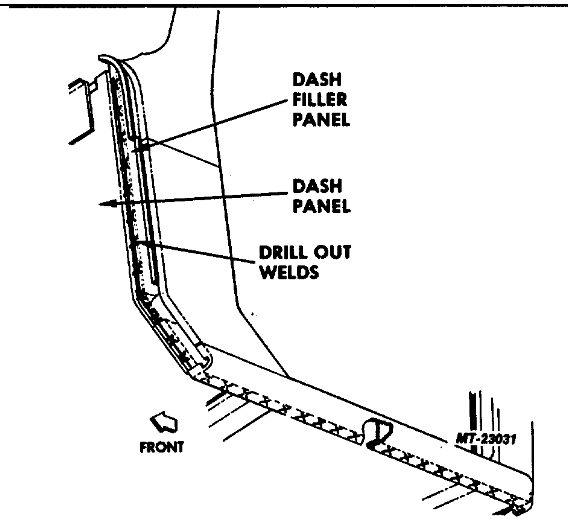

Fig. 42. Filler Panel to Dash Panel Spot Welds

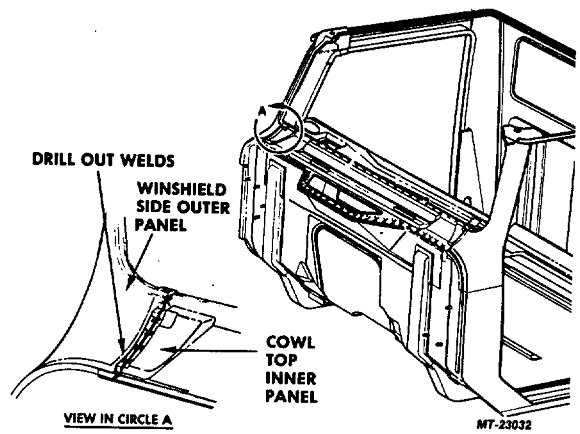

Fig. 43. Windshield Outer Panel to Cowl Inner Panel Spot Welds (Rt. Side Shown)

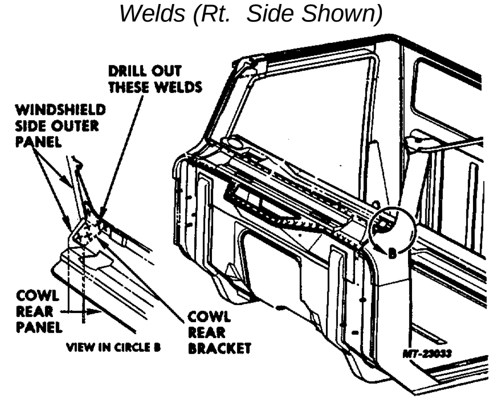

Fig. 44. Windshield Side Outer Panel to Cowl Rear Panel and Bracket Spot Welds

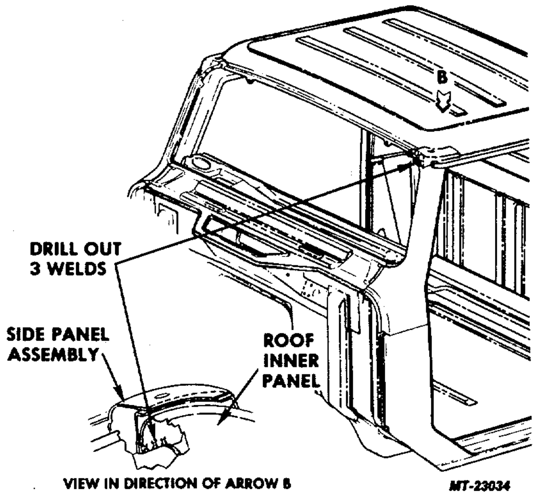

Fig. 45. Side Panel to Roof Outer and Inner Panel Spot Welds (Outer Roof Panel Not Shown)

9. Drill out three spot welds and separate side panel from roof outer and inner panels (Fig. 45).
10. Drill out fourteen spot welds along top of door opening and separate side panel from roof inner panel (Fig. 46).

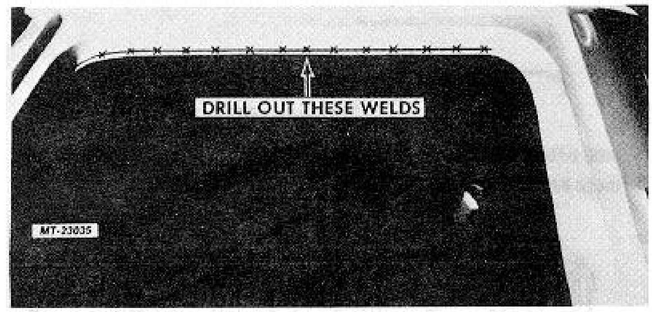

Fig. 46. Side Panel to Roof Inner Panel Spot Welds

11. Drill out fifteen spot welds along bottom of door opening and separate side panel from sill side inner panel (Fig. 47). Note that on 80" wide cabs there are additional spot welds to be removed at lower front corner of door opening.

12. Drill out three or four additional welds along top edge of windshield opening as required to separate roof panels and raise roof panel sufficiently to permit removal of side panel from cab.

IMPORTANT

Be careful while removing side panel so as to avoid damage to roof panel.

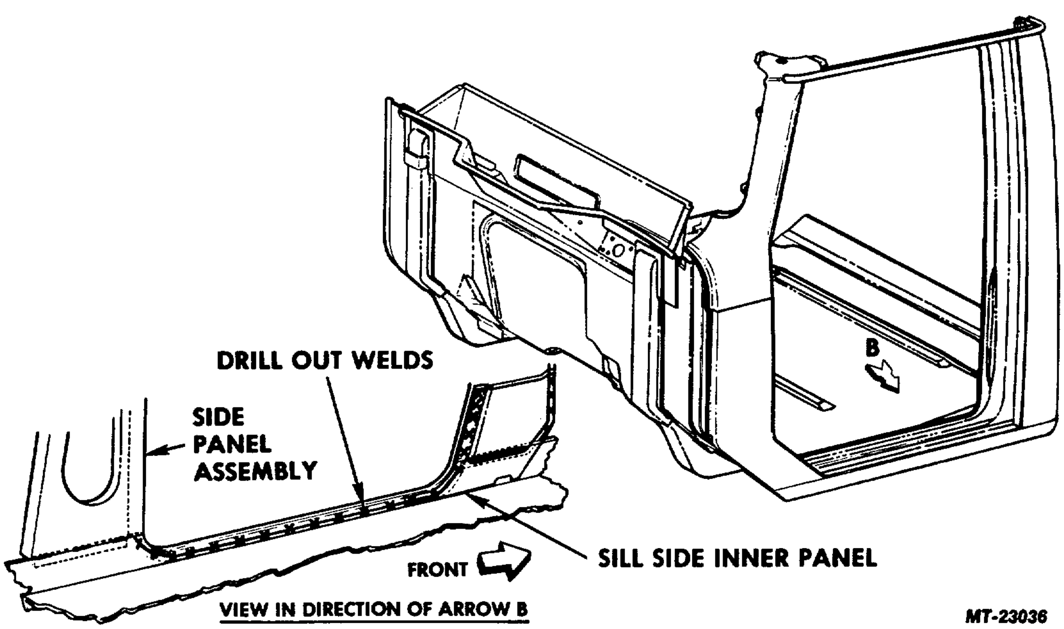

Fig. 47. Side Panel To Sill Side Inner Panel Spot Welds

INSPECT CAB STRUCTURE FOR DAMAGE

With side panel removed, inspect remainder of cab for damage. Look especially for and repair:

1. Damage to cab sill welds.

2. Loosening of floor panels.

3. Underbody bent out of alignment. (This step can vary with each job. Keep in mind you are trying to return cab to its original condition.)

Reweld any cracked or missing welds. The sill side inner panel on the cab underbody must be straight and flat.

ALIGN NEW SIDE PANEL TO CAB

1. Position and clamp new side panel assembly to side of cab.

2. Raise roof outer panel sufficiently to insert windshield pillar top corner between inner and outer roof panels.

3. Apply heat expanding type sealer (Plastisol or equivalent) to this seam.

4. Align panels to establish windshield opening and install "C" clamps to secure.

5. Align remaining joints at dash panel, cowl, roof panel and back panel using "C" clamps to hold new side panel in place.

WELDING SIDE PANEL TO CAB

1. Using MIG welder inside cab (Fig. 48), plug weld around door opening through holes drilled out of original cab panels during side panel removal.

CAUTION

Adjust welder so as not to damage or burn sheet metal when performing these welds.

2. Where drilled holes are not accessible such as at bottom of rocker panel, use 2.5 cm (1 inch) seam welds spaced 7.5 cm (3 inches) apart to secure rocker panel to sill side inner panel.

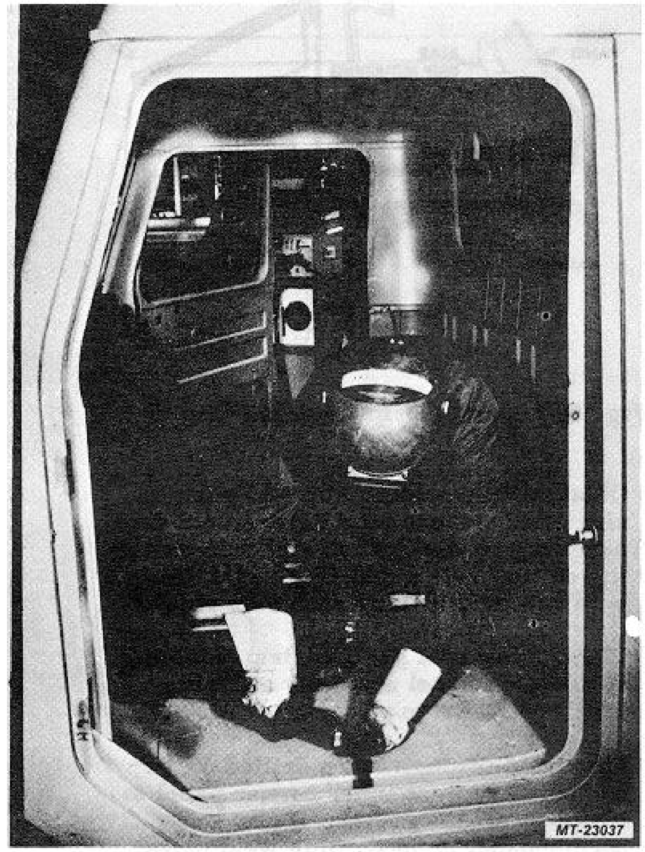

Fig. 48. Using MIG Welder For Plug Welds

3. At inside of cab weld base of inner side panels to sill side inner panel (Fig. 49). Note: 80" wide cabs do not use a seam weld at cowl seam joint but have a panel extension on sill side inner panel to be plug welded to inside of side panel.

Fig. 49. Seam Weld At Inside Of Side Panel

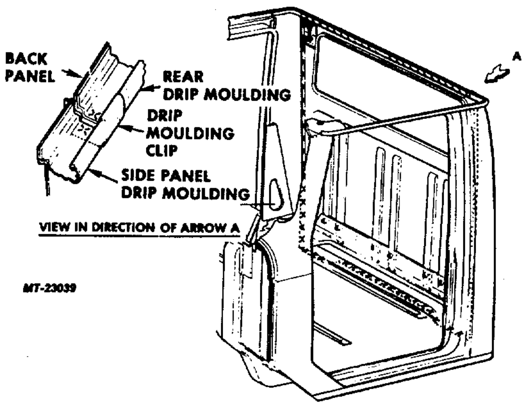

Fig. 50. Securing Drip Moulding Clip

4. Obtain drip moulding clip and position clip so as to close joint between old drip moulding on back of cab and drip moulding on new side panel (Fig. 50). Secure with one plug weld at each side of joint.

5. Clamp outer roof panel to drip moulding of new side panel assembly and plug weld roof panel to moulding (Fig. 51).

6. Plug weld through holes drilled for removing to replace inner corner panel to inside of cab (Fig. 52). If new inner corner panel is used, plug weld holes must be drilled into new panel before welding.

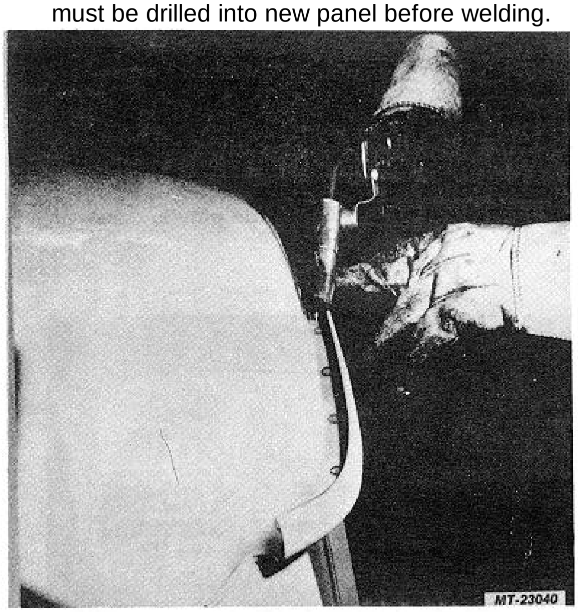

Fig. 51. Fastening Roof Panel To New Side Panel

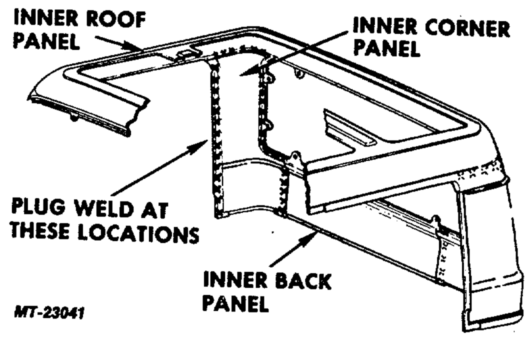

Fig. 52. Installing Inner Corner Panel (Right Side - 80" Wide Cab Shown)

7. Grind, sand or wire brush away any excess weld or weld ash from all newly welded areas.

8. Obtain body sealant (Plastisol Type 1 or equivalent) and apply to the following locations:

   a. Roof panel to drip moulding seam.
   b. Side panel to back panel joint at rear of cab.
   c. Dash filler panel to dash panel joint at front of cowl.

   d. Drilled out holes on upper side of sill side inner panel to rocker panel seam (under cab).

9. Apply primer paint to affected areas to assure good protection from rust. Finish paint as required.

OTHER PANEL REPAIRS

Since each cab panel component contributes to the overall strength of the cab, proper welding, sealing and rust-proofing practices must be observed for any other panel replacement. Under-cab components especially should be rust-proofed whenever cab repair operations are performed.

When rust-proofing cab components, use a good quality air-dry zinc rich primer. Combination type primer-surfacer paints are not recommended. Finish paint as required.

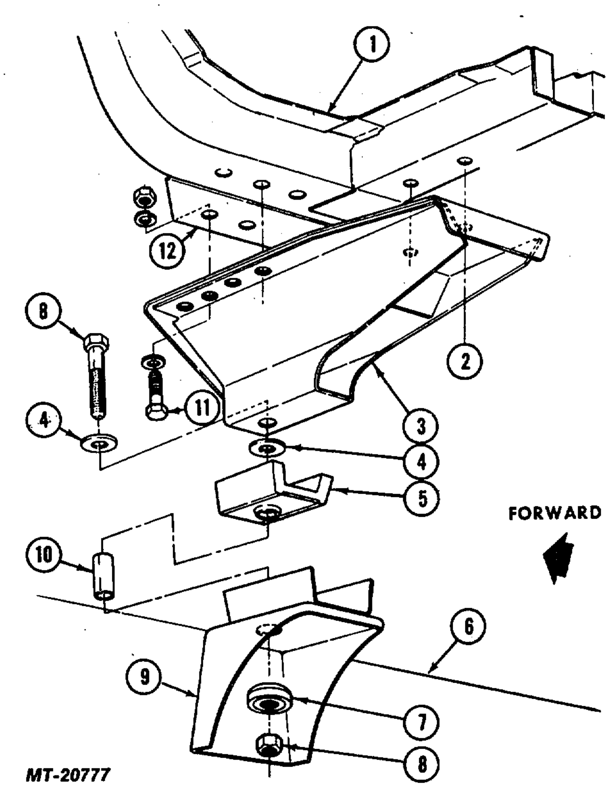

Fig. 53. Cab Front Mounting Bracket (Left Front View)

Legend for Figure 53

Key	Description
1	Sill, Cab Underbody
2	Bolt, Intermediate Bracket
3	Bracket, Intermediate
4	Washer, Flat
5	Insulator, Water Type
6	Sidemember, Frame
7	Insulator, Donut Type
8	Bolt and Nut (Cab Mounting)
9	Bracket, Cab Front Mounting
10	Bushing
11	Bolt, Nut and Washer
12	Reinforcement

CAB MOUNTING

A four point rubber cushioned mounting is used for securing cab to frame. This mounting has been designed to give a firm foundation to cab and at the same time provide enough flexibility in mounting to prevent severe road shock from being transferred from frame to cab. The hard rubber insulators used are maintenance free.

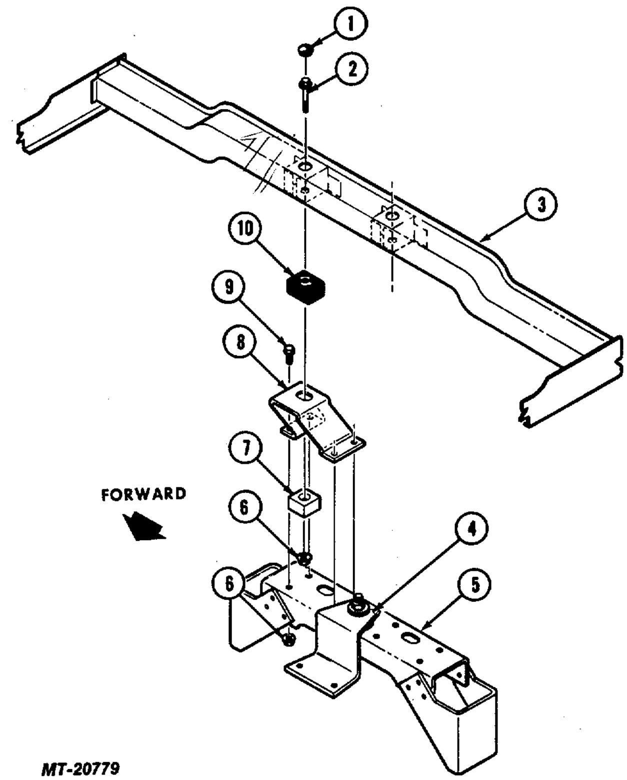

Fig. 54. Cab Rear Mounting (200 cm 80 Inch Wide Cab)

Legend for Figure 54

Key	Description
1	Plug, Button
2	Bolt, Cab Mounting
3	Sill, Cab Underbody
4	Bracket, Transmission Mounting
5	Crossmember, Cab Rear Mounting
6	Nut, Flange Type
7	Insulator, Lower
8	Bracket, Cab Rear Mounting
9	Bolt, Flange Head
10	Insulator, Upper

Cab Front Mounting

Both 200 and 230 cm (80 and 90 Inch) wide cabs use a cab front mounting that is similar to that shown in Fig. 53. Cab width mounting differences are accommodated by using different mounting holes in the intermediate mounting bracket.

Cab Rear Mounting

The different cab rear mountings used for the 200 and 230 cm (80 and 90 inch) wide cabs are shown in Figs. 54 and 55.

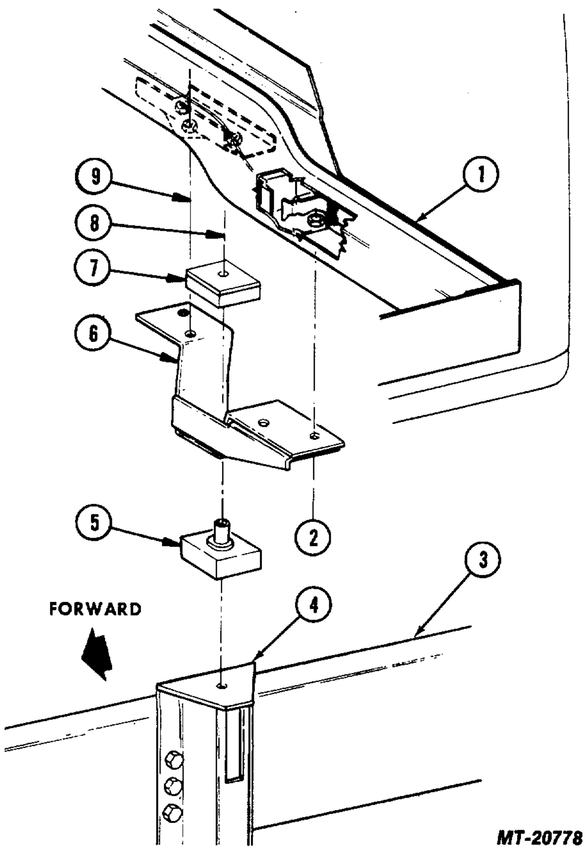

Fig. 55. Cab Rear Mounting (230 cm 90 inch Wide Cab)

Legend for Figure 55

Key	Description
1	Sill, Cab Underbody
2	Bolt
3	Sidemember, Frame
4	Bracket, Frame
5	Insulator, Lower
6	Bracket, Intermediate
7	Insulator, Upper
8	Bolt, Flange Head, Cab Mounting
9	Bolt, Hex Head

Cab Stay Rods

Cab stay rods which add stability and provide more comfortable ride characteristics are also used with S-Series cabs. Stay rods for the different cab models are shown in Figs. 56 and 57.

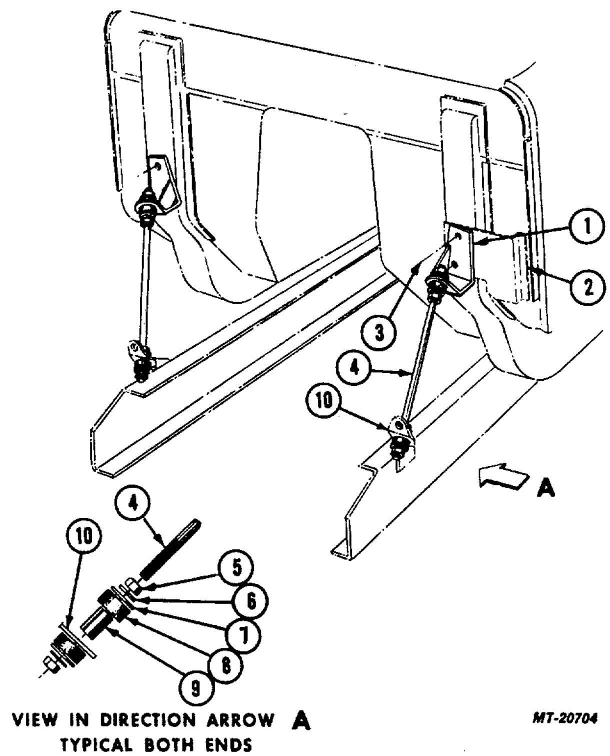

Fig. 56. Stay Rod Details for 200 x 280 cm (80 x 112 inch) Cab

Legend for Figure 56

Key	Description
1	Bracket, Cab Stay Rod, Upper
2	Bracket, Washer Bottle Mounting
3	Bolt, Bracket Mounting
4	Rod, Cab Stay
5	Nut, Hex 5/8-11
6	Washer, Lock
7	Washer, Flat
8	Insulator, Stay Rod
9	Spacer, Stay Rod
10	Bracket, Cab and Radiator Stay Rod

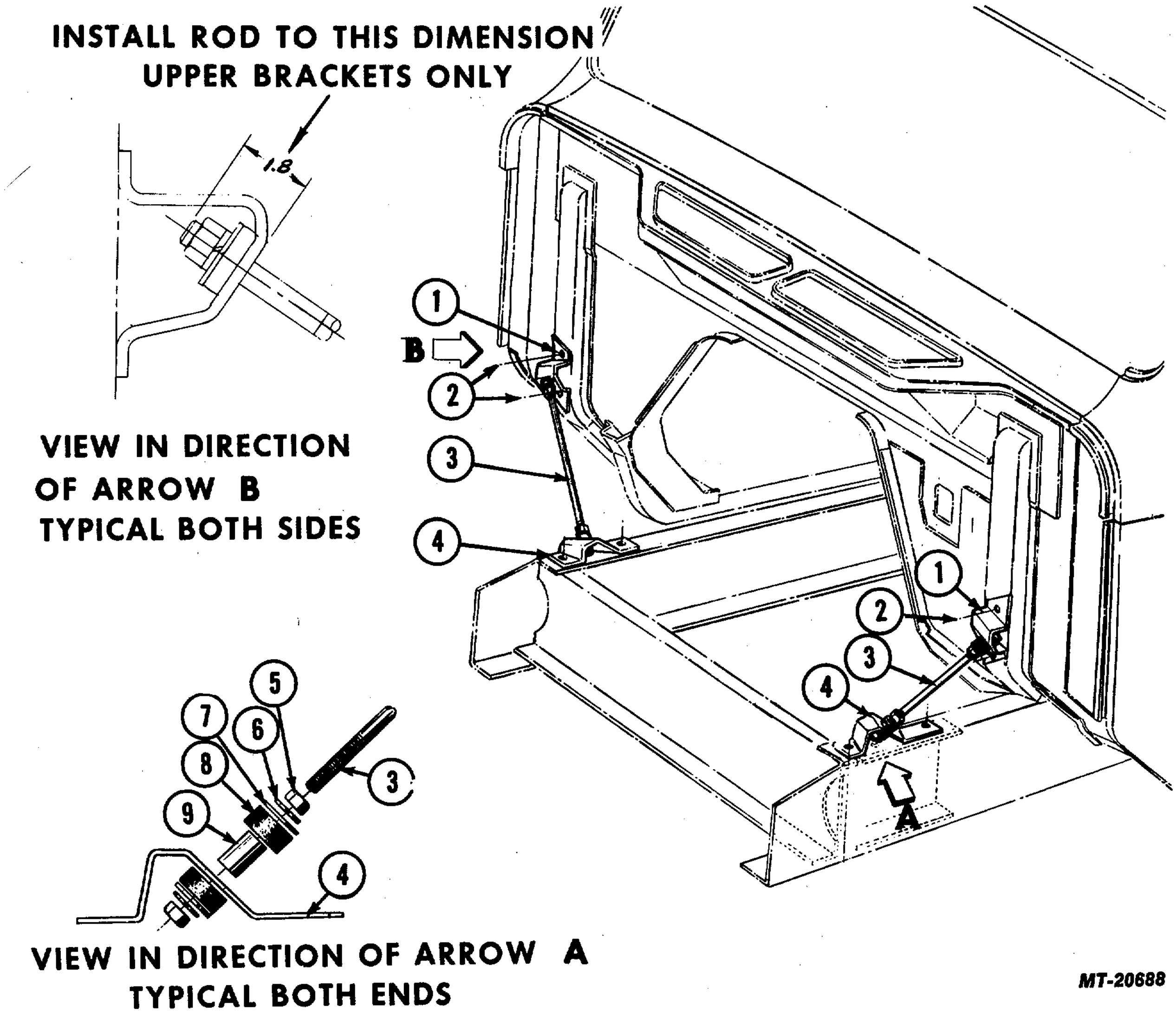

Fig. 57. Stay Rod Details for 230 x 230 cm (90 x 90 inch) Cab

Legend for Figure 57

Key	Description	Key	Description
1	Bracket, Cab Stay Rod, Upper	6	Washer, Lock
2	Bolt, Bracket Mounting	7	Washer, Flat
3	Rod, Cab Stay	8	Insulator, Stay Rod
4	Bracket, Cab Stay Rod, Lower	9	Spacer, Stay Rod
5	Nut, Hex 5/8-11		

CAB REMOVAL

The removal of the S-Series cab from chassis can be performed providing an overhead crane and cab lifting fixture are available. Removal procedures may vary for various models depending on type of equipment and accessories.

The following steps may be used as a guide.

1. Block wheels of truck and release parking brake.
2. Tilt or remove hood.
3. Disconnect battery ground cable.
4. Drain radiator and disconnect heater hose.
5. Disconnect steering shaft at gear.
6. Disconnect accelerator linkage.
7. Disconnect electrical connections and ground wire.
8. Disconnect clutch linkage.
9. Disconnect brake system (air or hydraulic).
10. Disconnect speedometer and tachometer drive cables.
11. Disconnect air conditioning lines (if so equipped).
12. Remove shift lever from transmission.
13. Detach exhaust system from cab if system is vertical type.
14. Install cab lifting fixture. Make sure fixture is padded to prevent damage to cab.
15. Remove cab to frame stay rods.
16. Partially lift cab so cab weight will be supported on lifting fixture.
17. Remove cab to frame mounting bolts and nuts at front and rear locations.

CAUTION

Inspect all cab to frame attaching points to be sure they are disconnected or damage can result.

18. Carefully lift cab from chassis.

CAB INSTALLATION

Cab installation is the reverse of the foregoing removal procedure. No special adjustment is required for cab to frame mounting bolts and nuts other than the application of specified torques. Connect all wiring harnesses, plumbing and controls. Start engine and check all systems and controls before returning truck to service.

LUBRICATION

Cab hardware and other mechanisms require a periodic application of lubricant to increase service life and prevent objectionable squeaking. New cabs are lubricated at factory and before they are delivered to customer. After the cab is placed in service, regular lubricating intervals based on type of service should be established. Thorough lubrication at definite intervals adds greatly to cab service life and reduces overall expense.

For specified lubrication intervals refer to Operator's Manual. For those special items requiring attention and a particular type of lubricant, refer to LUBRICATION section, CTS-2412 in the Service Manual.

Wipe off all lubricant points before applying new lube to prevent lube contamination. Apply lube sparingly and wipe away excess.

TORQUE CHART

Application	Size	N.m	Ft. Lbs.
Door Hinge Mounting Bolts	5/16-18	27-30	20-22
Hood Hinge Mounting Bolts	5/16-18	27-30	20-22
Door Striker Pin	1/2-13	60-80	45-60
Cab to Frame Mounting Bolts (Front)	1/2-13	95-115	70-85
Cab to Frame Mounting Bolts (Rear)	1/2-13	95-115	70-85
Seat Riser to Floor Mounting Bolts	5/16-18	27-30	20-22
Seat Adjuster to Seat Mounting Bolts	5/16-18	27-30	20-22
Seat Belt to Cab Sill Mounting Bolts	1/2-13	95-115	70-85
Arm Rest to Door Mounting Screws	1/4-20	2-2.5	1.5-2
Stay Rod Bracket to Dash Mounting Bolt	3/8-16	26-37	19-27
Splash Shield Bracket To Cab Mounting Bolt	5/16-18	18-21	12-16

BODIES AND CABS

FIBERGLASS REPAIR INSTRUCTIONS

INDEX

GENERAL

The information contained in this manual section has been prepared to provide service personnel with a ready reference to step-by-step procedures for the repair or replacement of fiberglass components.

Instructions for making fiberglass repairs to sheet metal are also covered in this section.

A fiberglass reinforced plastic repair kit (Fig. 1) has been made available which contains the material needed to repair either fiberglass or sheet metal components. This kit may be obtained through regular Service Part channels.

The mixing directions for the resin mixture and plastic putty are found on the cans.

CAUTION

Do not put mixed material back into cans.

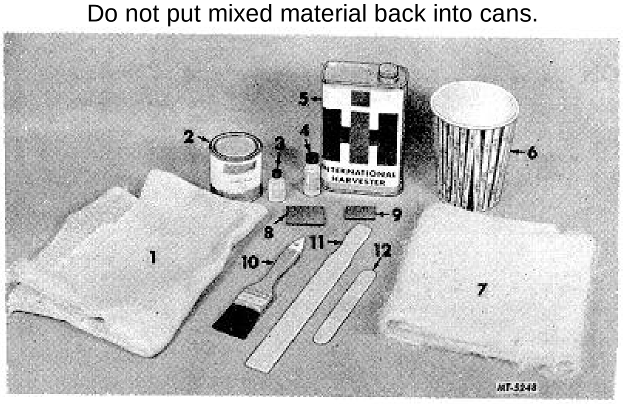

Fig. 1. Fiberglass Repair Kit.

Legend for Fig. 1

Key	Description
1	CLOTH
2	PLASTIC FILLER
3	PLASTIC ACTIVATOR
4	RESIN ACTIVATOR
5	RESIN
6	MIXING CUP (3)
7	MAT
8	SQUEEGEE (1-1/2" x 2")
9	SQUEEGEE (1-1/2" x 1")
10	PAINT BRUSH
11	STIRRING STICK
12	STIRRING STICK

DESCRIPTION

Fiberglass is manufactured from filaments of pure glass spun into yarn then either woven into a fabric (cloth) or a loosely bound mat. The cloth or mat is then saturated with a resin. When the resin cures (hardens) it acts as a binder to hold the fiberglass together, thus forming a solid panel.

Fiberglass components, such as the hood with fenders assembly, are formed from laminated sheets of fiberglass mats held together with a synthetic resin. When the liquid resin mix cures (hardens) it binds the filaments of glass in the fiberglass mat creates a solid panel. The glass fiber provides the strength in the panel while the resin bonds the glass fibers together and supplies only a limited additional amount of strength. Therefore when repairing a section, be sure to cover more than just the hole where the damaged material has been removed. Always overlap the undamaged portion with fiberglass patches, so that a more continuous sheet of reinforced fiberglass results.

Since the material hardens by a chemical action, a hard surface indicates a hard interior, ready for finishing. The mixture becomes hot before reaching setting temperature and then it begins to harden. It reaches full hardness after 48 hours. It can however be sanded and finished before then.

To hasten the curing action or if the working temperature is below 60° F, hold a heat lamp approximately 18" from work.

NOTE

250° F to 275° F is the high limit for the material and to go higher might distort the fiberglass form you are patching. Therefore, keep a close control over the external heat supply. Cooler temperature increases the working time and hardening time.

The paint refinishing method is the same as that recommended for metal parts with the exception that the temperature must be kept below 250° F, which means the air dry process is the most practical method. Either enamels or lacquers may be used to paint the fiberglass.

TOOLS AND EQUIPMENT NEEDED

Tools and equipment necessary to make repairs on fiberglass are as follows:

- IH Repair Kit (Fig. 1)
- Putty Knife
- Electrical Drill and Bits
- Electrical Grinder or Sander
- Respirator
- "C" Clamps
- Hacksaw Blades and Holder
- Files
- Acetone or Lacquer Thinner

Scissors

Polyethylene (Plastic Container Bag Material) or Cellophane Sheets Assorted Bolts, Nuts and Rivets.

SAFETY PRECAUTIONS

Observe The Following When Making Repairs With Fiberglass

1. Avoid spilling the resin or hardener on skin or clothing. If this occurs, remove with paint thinner or denatured alcohol. Then wash with soap and water. If the mixture contacts the eyes, flush thoroughly with water immediately. Continue flushing for at least 15 minutes and contact physician as soon as possible.

2. In some cases, some individuals may have skin sensitivity to the use of these materials. Because of this, protective creams can be applied to the hands to guard against irritation.

3. When protective creams are not available, rubber gloves may be used to protect the hands. The gloves can be removed quickly leaving the hands clean for other work.

4. When working with fiberglass always work in a well ventilated area. DO NOT SMOKE OR EXPOSE FLAME WHERE KITS ARE BEING USED OR STORED. If possible, obtain a kit of material large enough to accommodate only one or two jobs to avoid storing any quantity of this material. Resin liquid must be kept in a metal container or cabinet when not being used.

5. Repairs must be ground or sanded to match surrounding contours. When grinding or sanding, it is advisable to use an approved type respirator during the operation. Suitable respirators are available under equipment number SE-1798 and SE-1799. The ground dust or particles of resin or fiberglass must not be inhaled, otherwise irritation may occur.

REPAIRING FIBERGLASS

Small Holes (Under 3" Diameter):

1. Remove damaged material such as loose fiberglass and bevel the edges (approximately 200). See Fig. 2.

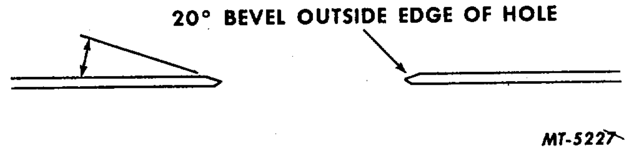

Fig. 2

2. Remove paint from outside surface with sandpaper. Clean inner surface (if accessible).

3. Cut a piece of cloth and a piece of mat so that the patches will extend past the edges of the hole about 2".

4. Coat both inner and outer surfaces with resin mixture and saturate both the mat and cloth.

5. When tacky, apply the mat on the inner surface and the cloth to the outer surface. Press the two patches together using polyethylene. A saucer-like depression should be made. See Fig. 3.

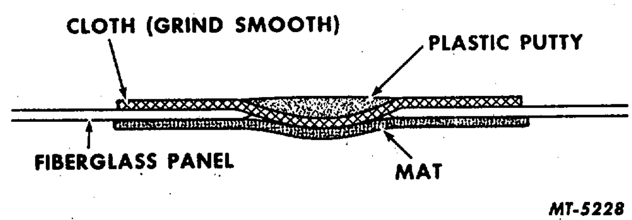

Fig. 3

6. Allow the material to cure. This is a chemical action and not a drying action. A hard surface indicates a hard interior. To hasten curing action heat lamps may be used about 18" from work. Then smooth the outside surface. Additional coats of resin mixture may be added if necessary.

7. Apply plastic putty to fill the low spots, allow time for the putty to cure, then smooth the outside surface.

Large Holes (Over 3" Diameter):

1. Remove damaged material such as loose fiberglass and bevel the edges (approximately 200). See Fig. 2.

2. Remove paint from the outside surface with sandpaper. Clean the inner surface also if it is accessible.

3. On a piece of polyethylene place a piece of cloth cut larger than hole being repaired. Saturate with resin mixture. Obtain a layer of mat cut larger than the hole being repaired and position it on the cloth. Saturate mat also with the resin mixture.

4. Coat the inner surface of area being repaired with the resin mixture. When tacky, apply the patch prepared in item 3. Using the polyethylene sheet press out air pockets and allow patch to cure.

5. On a piece of polyethylene, place another piece of cloth larger than hole being repaired. Saturate with resin mixture. Apply two layers of mat (Fig. 4), saturating both with the resin mixture. Coat the outer surface of area being repaired with the resin mixture. When tacky, position the entire patch on the prepared surface and press into position. Allow the patch to cure.

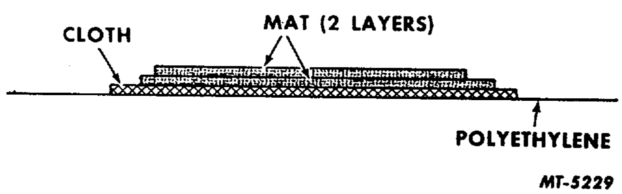

Fig. 4

6. After the inner and outer patches have cured, peel off the polyethylene and smooth the outer surface. Any of the polyethylene material left on patch will be removed when sanded.

7. In the resulting low spots, apply plastic putty. Then over the putty place another sheet of polyethylene and squeeze well to remove all air. When putty has cured, remove polyethylene and sand down to a feather edge.

<u>Crack or Split:</u>

1. Remove loose material and grind to a broad "V" (Fig. 5). Clean inner panel also.

2. Align parts. A nut and bolt with large flat washers may be used to draw parts together. See Fig. 6.

3. Cut one or two pieces of mat and apply to inner surface with resin mixture. (On cracks where excessive stresses may occur, apply two pieces of mat). Apply a piece of cloth with the resin mixture to the inner surface also. Extend patches beyond break about 2". Press the patches firmly into place and allow to cure. NOTE: It is a recommended procedure to leave the washer and nut (if used) in the patch if the mat and cloth were applied over them.

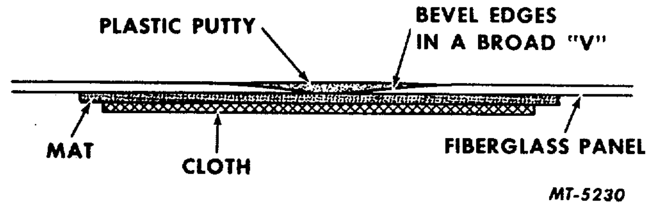

Fig. 5

4. Mix a fresh supply of plastic putty and apply over the outside surface filling the large "V" like valley (Fig. 5). Before the plastic putty cures, remove the bolt and washer (if used) from the outside and fill the hole with putty and allow to cure.

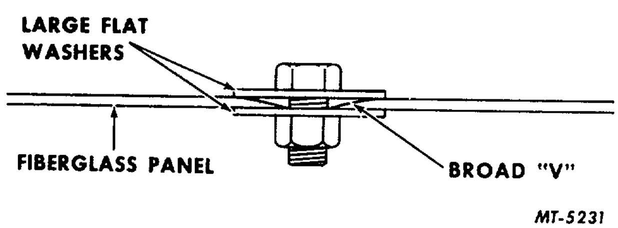

Fig. 6

5. After the putty has cured, sand down to the exposed surface.

<u>Small Scratches or Chipped Area:</u>
(No damage to basic fiberglass structure)

Remove paint from area being repaired and fill damaged area with a plastic putty mixture. After area has cured sand smooth.

FIBERGLASS SERVICE FENDER INSTALLATION (D-400 Series Illustrated)

1. Remove and place hood assembly on level surface or support frame. See Fig. 7. Hood should be blocked so it is horizontal as nearly as possible. See Fig. 8.

2. Using service fender for template, scribe line on hood and remove remaining damaged portion of hood assembly as shown in Fig. 7. Maintain a straight cut on all edges. Before making cutout, measure down one inch below scribe line to allow for service fender flange overlap over hood for firm attachment base. See Fig. 8.

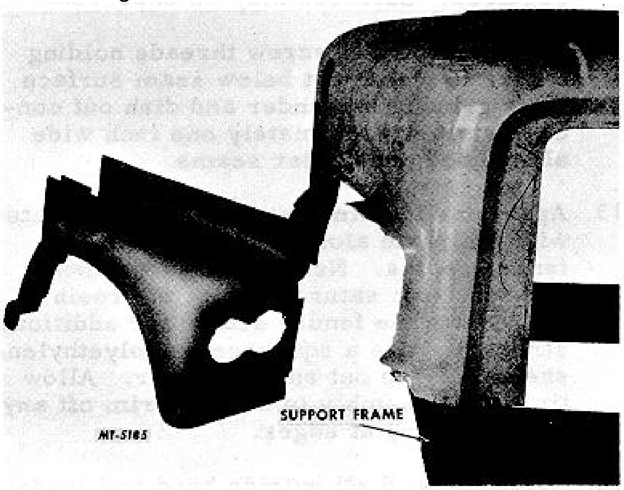

Fig. 7 Service Fender and Damaged Hood Assembly.

3. Cut out any remaining portion of hood and fender in damaged area. Maintain 90° angles at corners. See Fig. 8. Recommended cutting tools are disc (carboflex with masonry blade) or sabre saw with steel blade.
NOTE: Use of face mask and safety goggles are required as protective equipment.

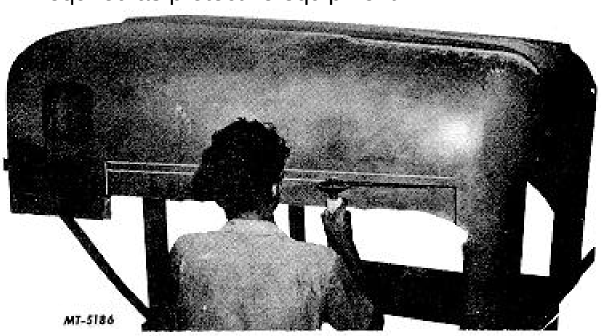

Fig. 8 Service Fender Cutout.

4. Recheck service fender alignment with cutout. Special precautions should be taken to remove all road film or undercoating with acetone. Stiffener surfaces must be ground down to service fender thickness to insure proper bonding. Grind all surfaces and edges to be bonded down to mat surface. Use coarse sandpaper (A.L.O. 26, 36 or 50 grit).

5. Secure finder to hood with "C" clamps. Locate fender flanges to inside of hood. See Fig. 9.

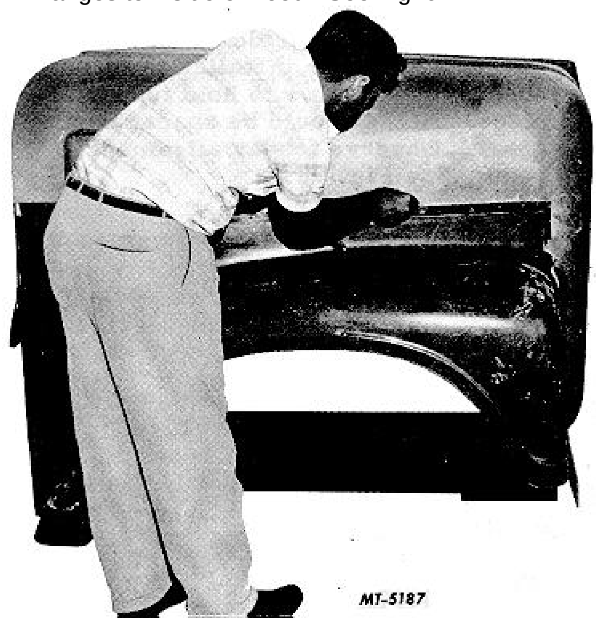

Fig. 9 Service Fender Positioning.

Fig. 10 Reinforcement Service Fender Rear.

6. After clamping fender to hood on D-400 series check position of lower corner of inside rear reinforcement channel. In some cases, the rear reinforcement channel corner will not line up with inside hood channel. See Fig. 10. This is due to slight variations of hoods. To position correctly, cut off reinforcement for reinstallation after fender has been attached.

7. Drill holes from inside of hood through fender flanges for installation of No. 10 sheet metal screws to hold fender in place. Holes should be spaced 3 to 4" apart. Observe fender alignment to hood. See Fig. 11.

Fig. 11 Service Fender Mounting.

8. Grind or buff all joining edges and radius to normal thickness on cowl contours. Blow off all surfaces and corners. Clean with acetone on a soft cloth.

9. Cut several four inch strips of mat material (2" each side of seam). Then on a piece of polyethylene position two layers of mat saturated with the resin mixture. Apply resin mixture to the inside of hood where material is being repaired. When tacky, position the strips (2 layers) over seam. Use the polyethylene to press out air bubbles. Allow to cure.. Additional coats of the resin mixture may be applied to the area if desired. NOTE: If holes are left where the new fender may not cover the damaged area, repair these places as outlined in instruction for repairing holes.

10. Refer to item 6. If required, remount inside rear channel reinforcement corner. Grind edges and mounting surfaces for proper bonding. Apply saturated sections of mat to all edges and seam to hood channel. If corner positions correctly as applied on fender, apply mat required to joining seam only. Brush out air bubbles with a squeegee.

11. Before proceeding on outside repairs, allow inside sections to harden. To speed drying or curing time, apply heat with lamps. No further inside refinishing is required. Surfaces may be undersealed.

12. Grind off outside screw threads holding fender in place just below seam surface. Take grinder or sander and dish out concave strip approximately one inch wide along hood and fender seams.

13. Apply one four inch strip of mat saturated with the resin along concave hood and fender seams. Next apply a four inch strip of cloth saturated with the resin mixture to the fender seams for additional strength. Use a squeegee or polyethylene sheet to force out entrapped air. Allow time for assembly to cure. Trim off any mat overhang at edges.

14. Grind or sand all outside hood and fender joined laminated seams. See Fig. 12

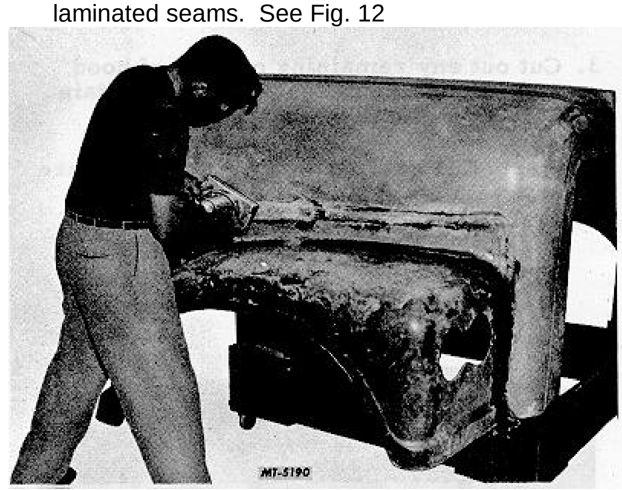

Fig. 12 Service Fender and Hood Refinishing.

15. With plastic putty fill any existing low spots or surface cracks with plastic putty. 16. Sand the entire exterior smooth, using a #400 grit paper. See Fig. 12. Clean surface with acetone or lacquer thinner. Apply prime coat and follow with standard automotive refinishing procedures. See Fig. 13.

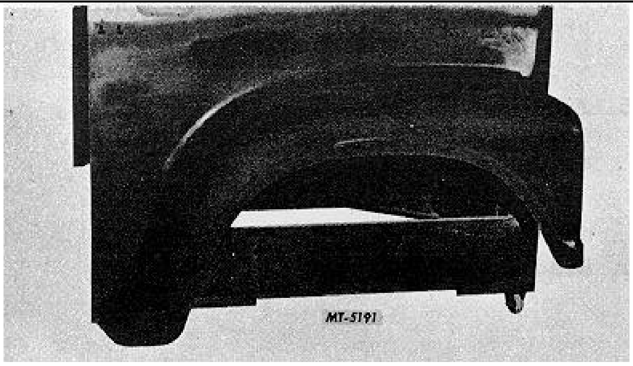

Fig. 13 Repaired Hood and Fender Assembly.

REPAIRING SHEET METAL WITH FIBERGLASS

Small Holes (Under 3" Diameter):

Repair on sheet metal as well as fiberglass can be made with the fiberglass reinforced plastic repair kit. It can be used to repair torn holes, rust holes and damaged surfaces which are difficult to refinish with the usual sheet metal repair procedures.

1. Clean metal to bare surface with No. 16 or 24 grit sandpaper approximately 6" beyond area being repaired.

2. Indent area being repaired about 2" beyonddamaged area.

3. Cut a piece of mat about 1" larger than the surface being repaired, then a piece of cloth (two or three pieces of mat may be used to fill the indented area).

4. Brush the resin mixture on the damaged area and then saturate the layers of mat and cloth being used. Allow the resin mixture to get tacky.

5. Apply the mat and cloth patches, pressing the laminations down tightly with a sheet of polyethylene to produce a tight bond. (The cloth patch is installed last). See Fig. 14.

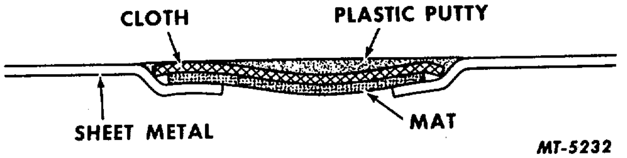

Fig. 14

6. Allow material to cure.

7. Sand and file surface after patches have cured.

8. Mix up a plastic putty mixture and fill low areas.

9. Allow the putty to cure, then sand smooth.

Large Holes (Over 3" Diameter):

1. Clean metal to bare surface and dent in surface being repaired as in items 1 and 2 for "Small Holes".

2. On a piece of polyethylene position a piece of cloth larger than hole being repaired. Saturate with resin mixture. Apply two layers of mat (Fig. 4) saturating both with the resin mixture. Now place the entire patch on the prepared surface and press on to metal. See Fig. 15. Allow the patch to cure, then peel off polyethylene.

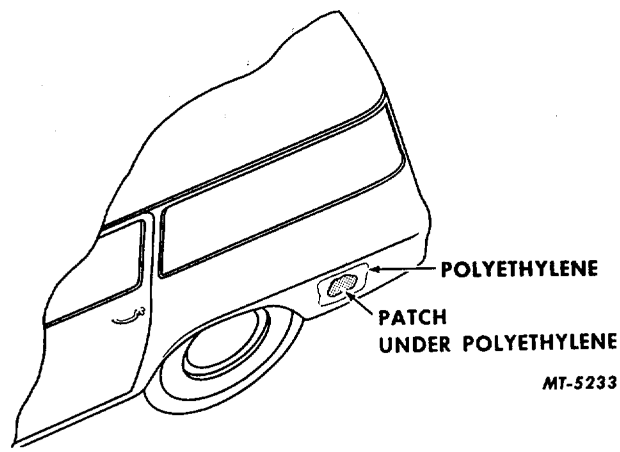

Fig. 15

3. In the resulting low spots, apply plastic putty. Then over the putty position another sheet of polyethylene and squeeze well to remove all air. When putty has cured, remove polyethylene and sand down to a feather edge.

Dents:

1. Clean metal to bare surface.

2. Drill or punch 1/8" holes in the dent to assure a good anchor for patch. See Fig. 16.

3. If the dent is over 1", cover dent with piece of cloth and saturate with resin mixture. Allow to cure.

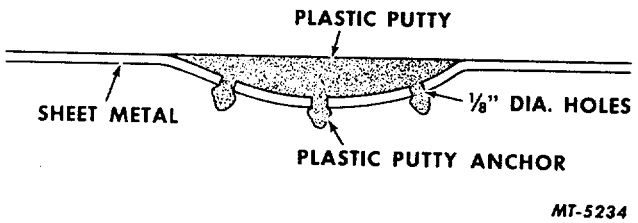

Fig. 16

4. Force plastic putty in dent with a stiff brush to break air bubbles.

5. After putty cures and if any air bubbles appear, open them with a knife and apply more putty.

6. Sand to feather edge.

BODIES AND CABS

S-SERIES WINDSHIELD WIPER AND WASHER

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PRINTED IN UNITED STATES OF AMERICA

INDEX (Continued)

SUBJECT Page

CHAPTER III: WINDSHIELD WASHER

CHAPTER I WINDSHIELD WIPER (ELECTRIC)

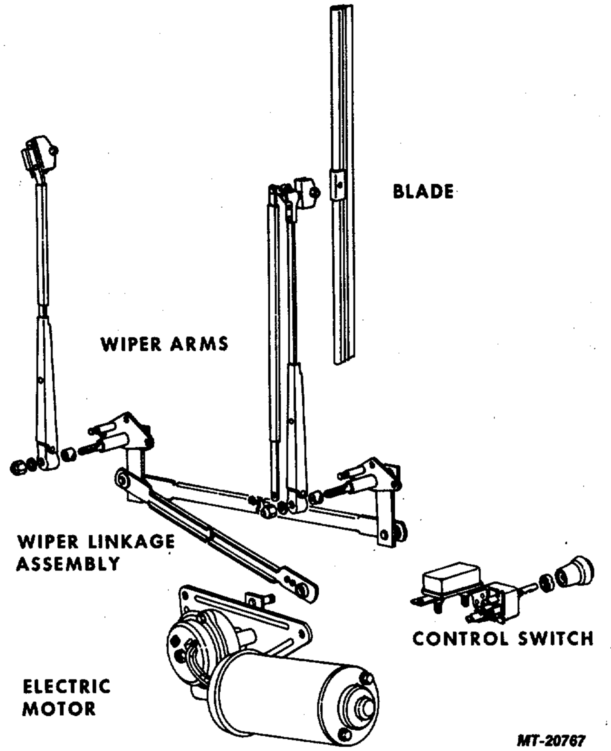

Fig. 1 Electric Windshield Wiper components

DESCRIPTION

The standard windshield wiper available on S-Series Trucks is the electric cowl mounted dual wiper system shown in Fig. 1. Except for the control switch, which is mounted on the instrument panel, all service on the wiper system is performed at front of cab.

OPERATION

When control switch is turned to "LO" or "HI" wiper speed is controlled accordingly. When control switch is turned off, wiper blades move automatically to "park" position on windshield (50 mm or 2 inches up from bottom of windshield). Reciprocating action of wiper arms results from rotation of drive lever on wiper motor.

IMPORTANT

Do not attempt to move wiper blades through their arc by grasping wiper arm. This action can damage motor internal parts or bend wiper linkage. Also, if blades are frozen to windshield, do not operate control switch until blades have been freed.

REMOVAL

Linkage

1. Remove windshield washer hose from fittings on top of cowl.

2. Remove wiper blades and arms (Fig. 2). Do not lose articulating rod end clip.

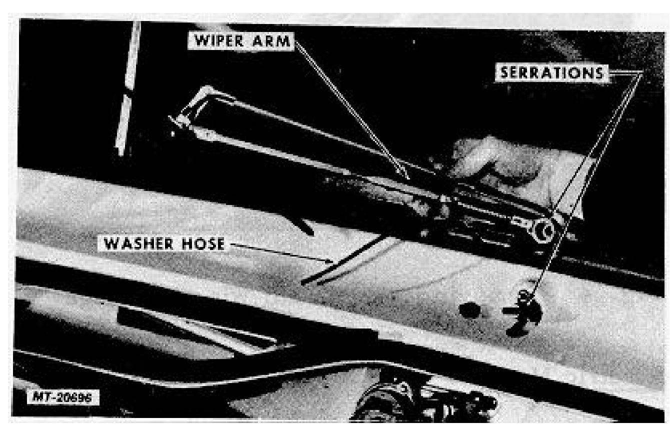

Fig. 2 Removing Wiper Arms

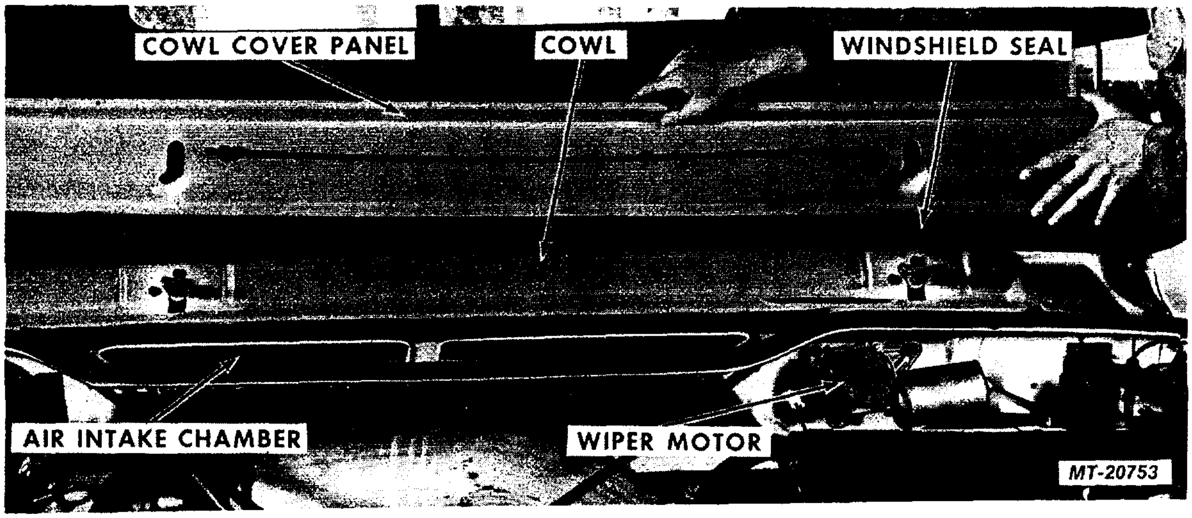

Fig. 3 Removing Cowl Cover Panel

3. Remove seven mounting screws and detach cowl cover panel from top of cowl (Fig. 3).

4. Disconnect washer hose from fitting on bottom of cowl cover panel.

5. Reaching into cowl air intake chamber, unfasten retainer clip from wiper motor drive lever pin and detach linkage rod from drive lever.

6. Remove three mounting bolts from each pivot bracket and lift out complete pivot brackets and wiper linkage assembly from inside air intake chamber (Fig. 4).

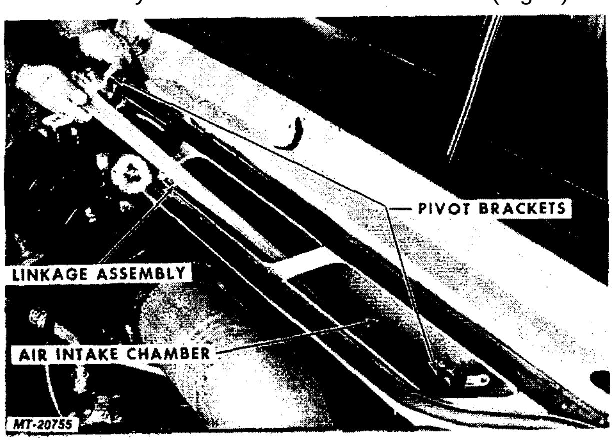

Fig. 4 Removing Windshield Wiper Linkage Assembly

Electric Motor

1. Disconnect wiring harness from wiper motor.

2. If wiper linkage has not previously been disconnected from motor, reach into cowl air intake chamber and unfasten clip from wiper motor drive lever.

IMPORTANT

Where motor only is being removed, stop wiper blades (with key switch) at their opposite to "PARK" position and loosen motor bracket to cowl mounting bolts. This will facilitate detaching of wiper linkage from motor drive lever.

3. Remove wiper motor bracket mounting bolts and detach motor assembly. Drive lever should remove through hole in cowl (Fig. 5).

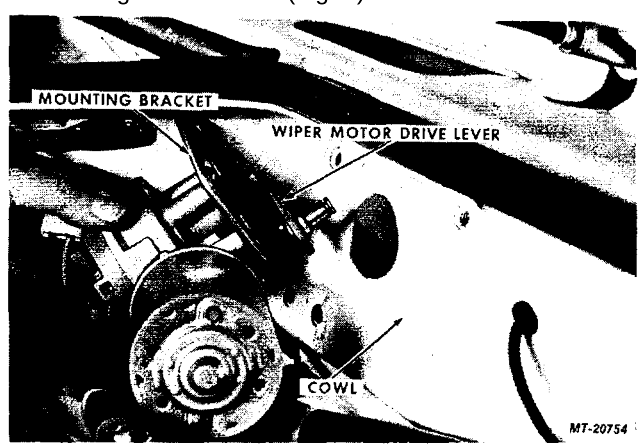

Fig. 5 Removing Windshield Wiper Motor

IMPORTANT

Always disconnect battery ground strap before servicing or removing electrical components.

Control Switch

1. Remove control knob for electric control switch by depressing retaining clip on back of knob with offset or small screwdriver (Fig. 6).

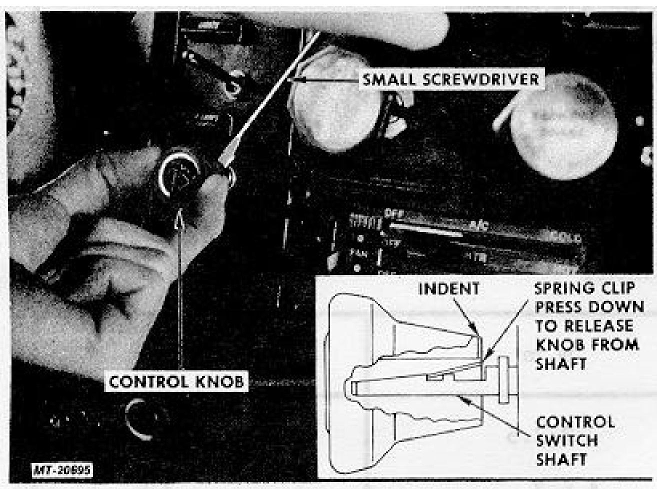

Fig. 6 Removing Control Knob from Switch

2. Remove mounting screws and detach panel to right of wiper control switch and above heater controls.

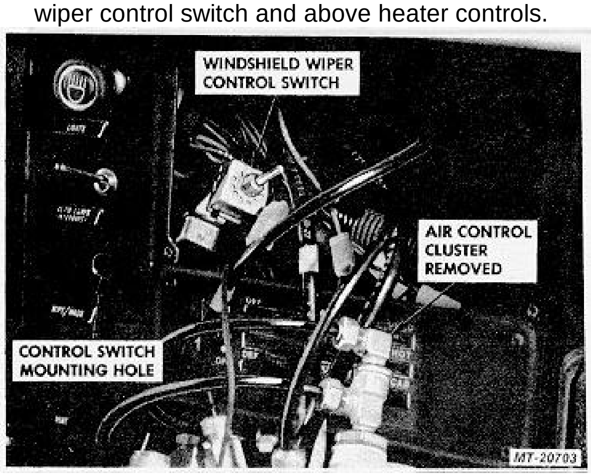

Fig. 7 Removing Wiper Switch from Instrument Panel

3. Remove mounting nut from switch shaft and demount switch assembly from instrument panel (Fig. 7).

4. Disconnect wiring leads and remove switch.

INSTALLATION

Reinstalling of windshield wiper system components is the reverse of removal. Be careful when installing cowl cover panel so as to protect windshield seal from damage. When returning wiper arms to drive shafts, control switch should be in "off" position and blades should be positioned in "park" position on windshield (50 mm or 2 inches up from bottom of windshield). If blades do not park as specified, see "ADJUSTMENT". When blades are correctly positioned, install cap nut and tighten to 6-7 N•m (55-60 in .lbs.).

MAINTENANCE

Service on the windshield wiper system is limited to the replacement of components shown in Fig. 1. Disassembly of either the electric wiper motor or the control switch is not recommended.

ADJUSTMENT

1. Operate wiper motor and turn control switch on instrument panel to "OFF". Wiper blades should automatically move to "park" position on windshield (50 mm or approx. 2 inches up from bottom of windshield).

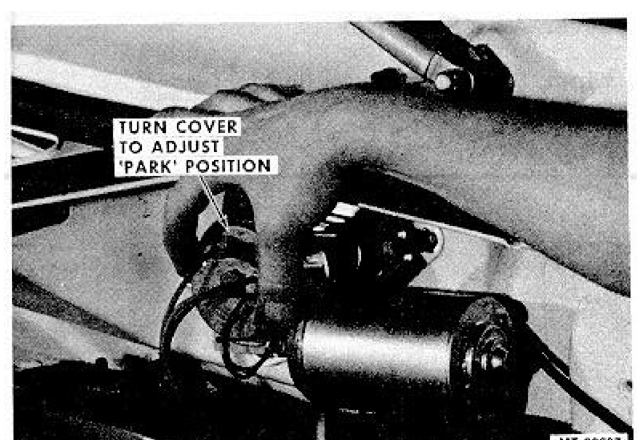

Fig. 8 Adjusting Wiper Blade Park Position

2. If adjustment is required, loosen motor cover mounting screws and turn cover clockwise or counterclockwise as required to set correct "park" position (Fig. 8). Retighten cover screws. (Length of stroke is fixed and cannot be changed.)

SPECIFICATIONS

MOTOR TYPE	Electric, direct current
MANUFACTURER	American Bosch
VOLTAGE	12
CRANK ARM ROTATION	Counter-clockwise
WIPER BLADE LENGTH	36 cm (14 inches)

TORQUE CHART

Application	N•m	Ft. Lbs.
Adjusting Cover Mounting Screws	2-2.5	1.5-2
Bracket to Motor Mounting Screws	4.5-7	3-5
Motor Bracket to Cowl Mounting Bolts	27-30	20-22
Lever Arm Shaft Nut	6-7	4.5-5
Wiper Shaft Cap Nut	6-7	4.5-5
Pivot Brackets to Cowl Bolts	13-16	10-12

TROUBLE SHOOTING (ELECTRIC)

PROBLEM	POSSIBLE CAUSE	REMEDY
Wiper will not operate.	1. No voltage to wiper motor. 2. Binds in wiper arm, shafts or linkage. 3. Link rod loose from drive lever. 4. Faulty switch. 5. Faulty motor assembly.	1. Check for open circuit or blown fuse. 2. Eliminate binds. 3. Secure rod end clip. 4. Replace switch. 5. Replace motor.
Damaged gear teeth.	1. Wiper blades striking windshield molding during operation. 2. Binding in connecting links. 3. Operator stopping blades manually when wiper is operating. 4. Drive arm not held when drive arm nut is tight-ened.	1. Adjust wiper arm park position. 2. Correct linkage. 3. Caution operator. 4. Hold drive arm in vise or by hand when tightening nut.
Wiper will not shut off.	Faulty switch.	Replace switch.
Wiper continually shutting off.	1. Binding condition in wiper arm shafts, connecting links or drive gear and shaft. 2. Faulty harness connections. 3. Faulty motor assembly.	1. Eliminate binds. 2. Correct wiring harness connectors and terminals. 3. Replace motor.
Wiper operates at one speed only.	1. Faulty switch. 2. Faulty connection.	1. Replace switch. 2. Correct wiring.
Wiper motor speed excessive under light load but stalls under heavy load.	Faulty motor assembly.	Replace motor.
Wiper motor noisy.	Faulty motor assembly.	Replace motor.

CHAPTER II WINDSHIELD WIPER (AIR)

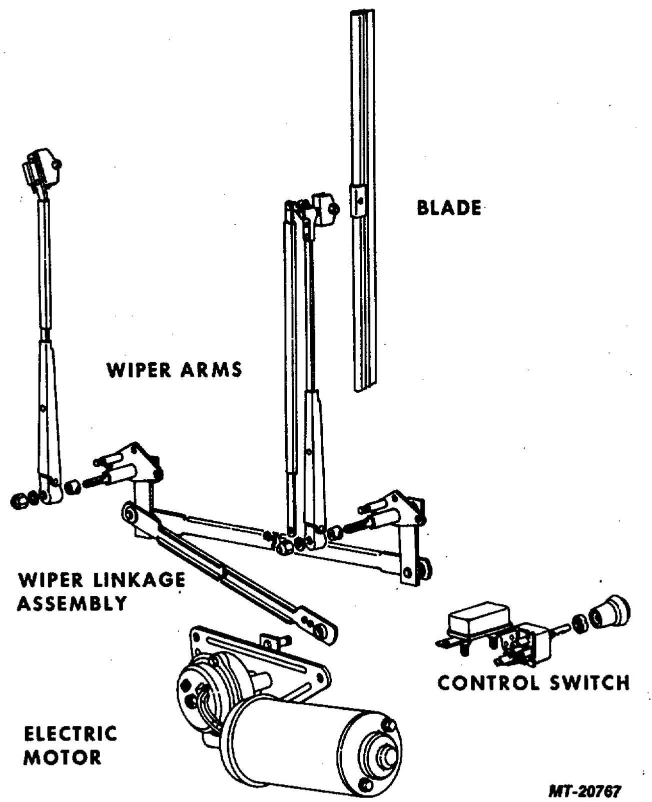

Fig. 1 Air Windshield Wiper Components

DESCRIPTION

Where air brake equipment is specified for S-Series Trucks, an air operated windshield wiper is also available optionally. This air wiper system (Fig. 1) consists of an air operated wiper motor, an instrument panel mounted control valve and the same wiper linkage as used for the standard windshield wiper system.

OPERATION

The air wipers operate in a similar manner to conventional wipers so long as air pressure is supplied to the air wiper system. However, to start wipers, control knob must be pulled out. Wiper speed is then controlled by turning knob clockwise or counterclockwise. Push knob in to stop wiper motor. Reciprocating action of wiper arms results from reciprocating action of drive lever on air wiper motor.

REMOVAL

Linkage

Air wiper linkage removal procedure is the same as required for the standard electric wiper as covered in Chapter I.

Air Motor

1. Disconnect air lines from fittings on air motor.
2. If wiper linkage has not previously been disconnected from air motor, reach into cowl fresh air intake chamber and unfasten clip from air motor drive lever.
3. Remove wiper motor bracket mounting screws and detach air motor assembly from cowl.

Control Valve

1. Remove control valve knob from valve on instrument panel. A small hex key wrench can be used to loosen knob set screws.
2. Remove mounting screws and detach panel to right of control valve.
3. Remove mounting nut from valve shaft and detach wiper control valve from instrument panel.
4. Disconnect air hose from control valve and remove control valve unit.

INSTALLATION

Air wiper components are installed in the reverse order of disassembly procedure. When returning wiper arms to serrated ends of drive shafts, the following steps should be observed to assure correct wiper blade positioning on windshield.

1. With vehicle air pressure at 620 kPa (90 psi) note that wiper motor moves wiper blade to "Park" position when control knob is pushed in. Wiper blades should be 25 mm (approx. 1 inch) up from bottom of windshield.
2. If adjustment is necessary, remove wiper serrated nut from wiper arm and reposition arm and nut to specified wiper position. Adjust each wiper arm individually. Moving arm or nut one serration is equal to approximately five (5) degrees blade travel.

SPECIFICATIONS

MOTOR TYPE	Reciprocating Air
MANUFACTURER	Trico
FREE RUNNING ARC	115 degs.
STOP TO STOP	130 degs.
WIPER BLADE LENGTH	36 cm (14 inches)
BACK PRESSURE VALVE	IH No. 478630-C1

TORQUE CHART

Application	N•m	Ft. Lbs.
Bracket to Motor Mounting Screws	4.5-7	3-5
Motor Bracket to Cowl Mounting Bolts	27-30	20-22
Lever Arm Shaft Nut	6-7	4.5-5
Wiper Shaft Cap Nut	6-7	4.5-5

TROUBLE SHOOTING (AIR)

PROBLEM	PROBABLE CAUSE	SOLUTION
Motor will not operate. correct leaks.	1. No air to motor. 2. Binds in wiper arm shafts or linkage. 3. Defective control valve. 4. Defective air motor.	1. Unplug air line or 2. Eliminate binds. 3. Replace valve. 4. Replace motor.
Motor will not shut off.	Defective control valve.	Replace control valve.
Motor operates erratically.	1. Exhaust port plugged. 2. Binds in wiper shafts or linkage. 3. Air leak in motor.	1. Clean port. 2. Eliminate binds. 3. Replace motor.
Wiper blade strikes wind-shield molding.	Blade "PARK" position out of adjustment.	Adjust "PARK" position.
Motor operates but wipers do not wipe.	Link rod loose from drive lever.	Secure linkage rod end retainer clip.

CHAPTER III WINDSHIELD WASHER

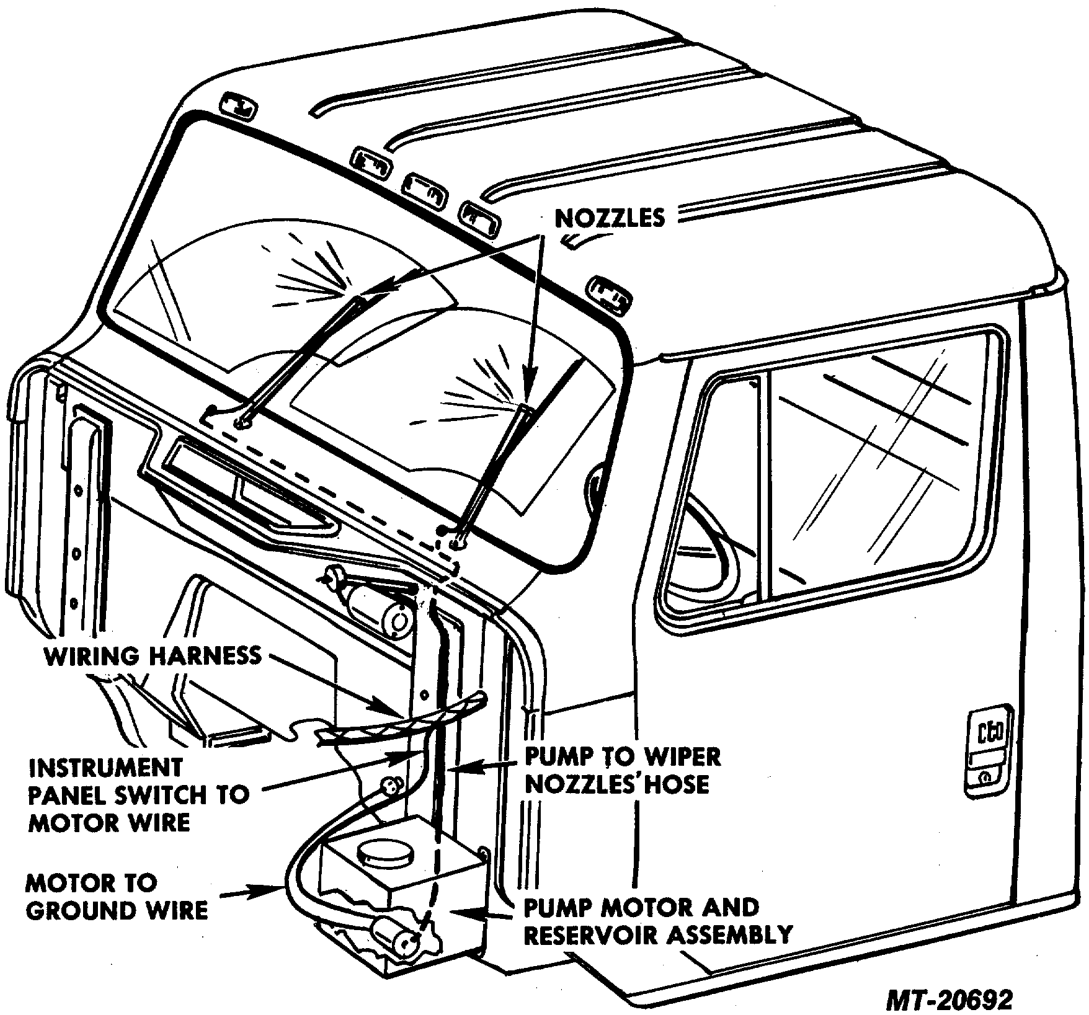

Fig. 1 Windshield Washer Installation (80" Wide Cab Shown)

DESCRIPTION

The windshield washer (Fig. 1) consists of a reservoir mounted motor driven displacement type pump that delivers washer solution to the windshield through hoses and nozzles in the wiper arms. Since the pump motor is integral with reservoir, only the complete assembly is available for service.

OPERATION

Two types of controls are used with the windshield washer namely-an integral with wiper control switch type for electric wipers and an independent control type for air wipers. (Independent switch is mounted on instrument panel directly below wiper control valve.) You can operate windshield washer with either type control simply by pushing in on control switch for as long as you want nozzles to spray. Spray will stop as soon as control is released. MAINTENANCE

A minimum of service is required to keep windshield washer operating. Keep reservoir filled with IH No. 996726-R2 windshield washer solvent and keep wiper nozzles clean. If dirt enters reservoir, remove reservoir and flush out with clean water. Refill reservoir with specified solvent after reinstalling.

REMOVAL AND INSTALLATION

1. Remove the two reservoir-to-cowl mounting bolts and lift complete pump, motor and reservoir from cowl. (Reservoir bottom bolt removal is not required.)

2. Separate wiring connector for instrument panel switch-to-motor wire and motor-to-ground wire from pump motor.

3. Disconnect pump-to-wiper nozzle hose from pump outlet fitting.

4. No further disassembly is required. Do not attempt to remove pump motor from reservoir.

Installation of windshield washer is the reverse of removal procedure. Test the operation of unit and check for leaks after installing.

TROUBLE SHOOTING

IMPORTANT

Be sure an ample supply of IH No. 996726-R2 windshield washer solvent is maintained in reservoir to insure satisfactory operation of windshield washer.

PROBLEM	PROBABLE CAUSE	SOLUTION
Pump will not operate.	1. No voltage to pump motor. 2. Defective switch. 3. Defective motor.	1. Check for open circuit or blown fuse. 2. Replace switch. 3. Replace pump, motor and reservoir assembly.
Pump operates but pressure is weak.	1. Hoses loose, kinked or damaged. 2. Nozzles plugged or dirt in reservoir. 3. Defective motor or pump.	1. Reinstall or replace hose. 2. Clean nozzles and service reservoir as required. 3. Replace pump, motor and reservoir assembly.
Pump operates but no washer solution delivered.	1. No solution in reservoir. 2. Hoses loose, kinked or damaged. 3. Nozzles plugged or dirt in reservoir. 4. Solution frozen. 5. Defective pump.	1. Fill reservoir. 2. Reinstall or replace hoses. 3. Clean nozzles or reservoir as required. 4. Thaw out system and replace washer solvent. 5. Replace pump, motor and reservoir assembly.

BRAKES HYDRAULIC
GENERAL

SINGLE SYSTEM BRAKE COMPONENTS

The text contained herein does not cover particular brake groups or reconditioning brake drums or shoes.

Refer to specific brake group manual sections for brake group service instructions.

Refer to CTS-2779 for instructions pertaining to reconditioning brake drums and shoes.

CONTENTS

CHAPTER I

DESCRIPTION AND MAINTENANCE CHECKS

CONTENTS

DESCRIPTION

The hydraulic system used to actuate the brake mechanism consists of a compensating type master cylinder, in which the hydraulic pressure is originated; individual wheel cylinders, in which the hydraulic pressure is applied, which serve to actuate the brake shoes against the brake drum of each wheel; and the "line" consisting of steel tubing, flexible hose, brackets and unions, interconnecting the master cylinder and wheel cylinders. The master cylinder and wheel cylinders are fitted with pistons, all of which are provided with cup packings, which act as a seal to maintain pressure and prevent loss of brake fluid.

Depressing the brake pedal moves the piston within the master cylinder, thus displacing the brake fluid from the master cylinder through its outlet orifices, tubing and flexible hose connection into the wheel cylinders. The brake fluid, being non-compressible, enters each of the wheel cylinders, causing the cylinder pistons to move outward and actuate the brake shoes. As pressure on the pedal is increased, greater hydraulic pressure is built up within the wheel cylinders and, consequently, greater force is exerted against the shoes.

When the pressure on the pedal is released, the brake shoe retracting springs return the brake shoes to their normal or released position. The return movement of the brake shoes, in turn, causes movement of the wheel cylinder pistons toward their released position, thus forcing the fluid back through the tubing into the master cylinder.

MAINTENANCE CHECKS

The brake system should be checked periodically for evidence of needed repairs.

It is difficult to determine an exact maintenance interval (time or mileage) since vehicles will be used in wide varieties of operational applications and conditions.

Brake adjustment should be checked every 3,000 km (2,000 miles). Brake lining should be inspected every 19,000 km (12,000 miles) or every 12 months which ever occurs first.

Before starting to check out the brake system itself, the following related components on the vehicle should be examined and serviced if found defective.

1. Tires.
2. Shock absorbers.
3. Wheel bearings.
4. Suspension.
5. Wheel alignment.

The following procedure is given as an aid in checking out the brake system.

BRAKE PEDAL

1. Pedal return should be unrestricted when pedal is fully released (see BRAKE PEDAL ADJUSTMENTS in Chapter III).

2. Excessive side movement indicates worn pedal mounting.

3. Interference should not occur when pedal is depressed.

4. There should be ample clearance between pedal and toe board when pedal is fully depressed (brakes applied).

5. Pedal height should be corrected (see BRAKE PEDAL ADJUSTMENTS in Chapter III).

POWER CYLINDER

To check power cylinder for correct operation, refer to the respective "Power Cylinder" section of this Service Manual.

MASTER CYLINDER

1. Fluid level should be 6.4 to 12.7 mm (1/4 to 1/2") from top of reservoir.

2. Master cylinder vent must be clear and unrestricted.

3. Check for external leaks at hydraulic line connections or at push rod end.

4. Check cup clearance of compensating port by watching for surge of fluid in reservoir when pedal is depressed.

5. Internal wear or leaks are indicated by pedal fading away under steady foot pressure (also sign of leak elsewhere in system).

6. To check residual check valve operation, depress and release brake pedal. Open bleeder valve and check for spurt of fluid indicating pressure in lines.

STOP LIGHT SWITCH

If stop lights are inoperative, it would indicate either defective bulbs, defective switch, loose or broken connections or switch improperly positioned.

BRAKE LINES, FITTINGS AND HOSES

1. Check lines for kinks, dents or rupture.

2. Check hoses for abrasion, kinks, soft spots, rupture, collapse, cracks, twists or loose frame supports.

3. Examine all connections for leaks.

4. Carefully check for incomplete ruptures indicated by a bubble between the plys of the flexible hose or a torn inner line (Fig. 1).

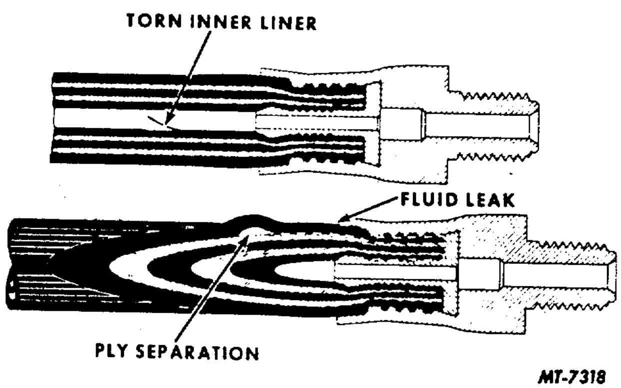

Fig. 1. Flexible Hose Damage

5. Brake line fittings will sometimes become rusted or corroded to the wheel cylinder and/or brake line. Be careful not to twist the line causing a line fracture during removal or installation. Brake line open ends should be capped to prevent the entrance of foreign material.

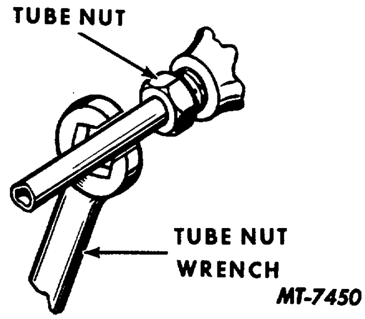

Fig. 2. Use of Tube Nut Wrench

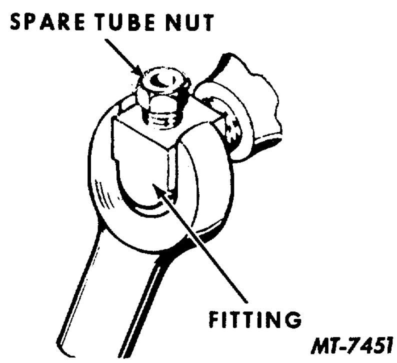

Fig. 3. Protecting Fitting Against Damage During Removal or Installation

Always use correct type and size of wrench on fittings (Fig. 2).

Avoid damage to female fittings by supporting fitting with a spare tube nut during removal or installation (Fig. 3).

6. Use only steel tubing when replacement is required. Use old tubing as a pattern for forming and routing the new. Avoid kinks and sharp bends when forming tube. Use tubing cutter to cut tubing to required length making allowance for flare at each end of the tube.

   Assemble tube nuts on tubing before flaring. After flaring tube, blow out with air pressure to remove any particles of dirt or chips.

   Do not discard old tube nuts until you are certain that new ones are available.

WHEEL CYLINDERS

Pull back rubber boots and check for leaks. If cylinders are disassembled, look for dirt, corrosion or pitting.

HYDRAULIC BRAKE FLUID

As a result of use, brake fluid becomes contaminated and loses some of its original qualities. It is good practice to bleed the brake system until all old fluid is removed when performing major brake work. Also, the old fluid should be bled from the system and replaced with clean brake fluid if any of the hydraulic system parts are corroded, fluid is discolored, contains water or is dirty.

If any of the rubber parts of the hydraulic system are soft or swollen, old fluid should be removed; the hydraulic system should be flushed with alcohol or clean brake fluid and refilled with brake fluid. (All cups and seals should also be replaced.) Do not reuse old brake fluid. For type of fluid, refer to CTS-2412 in your Service Manual under LUBRICATION.

BRAKE GROUPS

1. Check linings for being too thin, uneven wear, damaged, soiled with grease or brake fluid, or for being loose on the shoes. Whenever brake linings or blocks are worn to within .79 mm (1/32") of rivets on light duty vehicles or 1.59 mm (1/16") of rivets on medium or heavy duty vehicles, the brake shoes must be removed and relined. It is recommended that all the brakes be relined at the same time since this will maintain balanced braking of the vehicle. If complete replacement is not desirable or necessary, be sure that all lining on one axle (both sides) is replaced at the same time.

IMPORTANT

Intermixing of various types of lining material other than that specified is not recommended.

2. Examine brake shoes for worn anchor ends, damaged rims or webs, or cracked or broken welds.

3. Mechanical parts should be checked for heat damage, broken ends or loss of tension in shoe return springs, wear or corrosion of shoe hold-down pins, springs and cups, wear on adjusting screw, looseness of mounting or anchors and worn shoe ledges on backing plate.

DRUMS

1. Check brake drums for scores, heat checks, out-of-roundness and oversize.

2. Wheel bearings should be checked for wear. Also, check grease seals for evidence of grease leaks. Refer to WHEEL Service Manual sections.

VACUUM POWER CYLINDER (Hydrovac) AIR CLEANER

Vehicles with vacuum power cylinders, which do not have a direct air source to the engine air cleaner, will have a frame mounted air cleaner (Fig. 4 and 6). This air cleaner may be located either on the outside of the frame or to the inside of the frame.

If this air cleaner is mounted on the outside of the frame, it is suggested that it be relocated inside the frame away from direct road splash from the wheels.

The location of this air cleaner will be on the left frame rail under the cab in the area adjacent to the power cylinder.

Maintenance Interval Replaceable Element Type (Fig. 4)

19,000 km (12,000 miles)

Remove element and clean by tapping gently on a flat surface or use low air pressure. DO NOT WASH OR OIL DRY ELEMENT.

58,000 km (36,000 miles)

Replace element.

Vehicles operating under multi-stop or severe dust conditions will require cleaning or replacement of filter element more often.

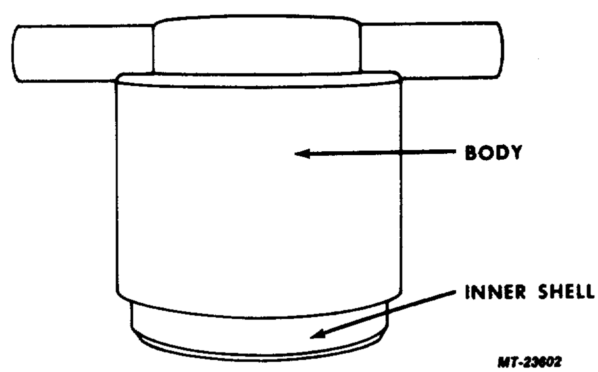

Fig. 4. Air Cleaner Assembly (Replaceable Element Type)

Removal and Installation Procedures of Element (Fig. 5)

1. Turn inner shell counter clockwise with hands or suitable size shop tool.
2. Remove element from shell.
3. Clean inside of air cleaner body and inner shell.
4. Clean or replace element.
5. Position element in inner shell and tighten shell snug. Then turn inner shell 1/8 additional turn.

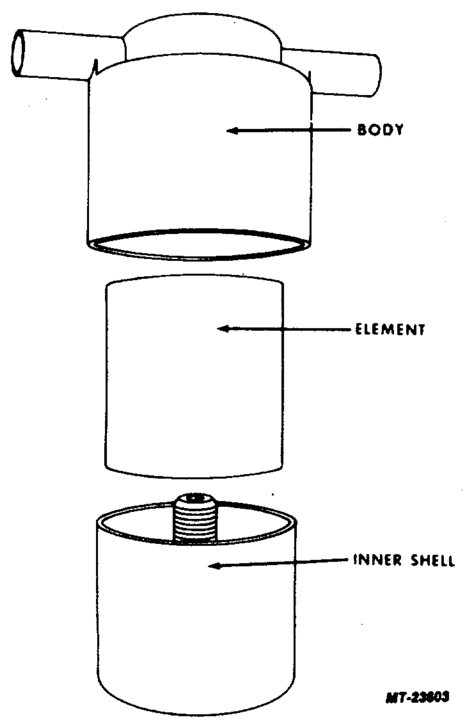

Fig. 5. Exploded View of Replaceable Element Type Air Cleaner

Maintenance Interval of Throw-Away Type (Fig. 6)

19,000 km (12,000 miles)

Remove complete air cleaner assembly and install new air cleaner.

Vehicles operating under multi-stop or severe dust conditions will require replacement more often.

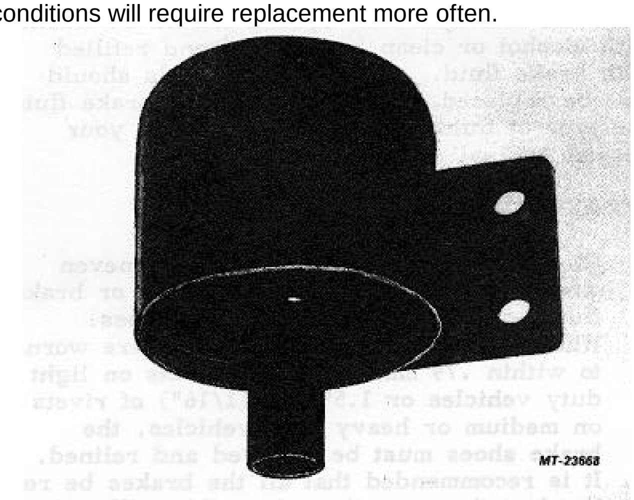

Fig. 6. Throw-Away Type Air Cleaner Assembly

CAUTION

A vehicle accident could result if the vehicle is operated while any of the forgoing items need attention or if any other brake system service requirements are suspected.

CHAPTER II

OPERATION

CONTENTS

MASTER CYLINDER

The combination or compensating type master cylinder (Fig. 1) consists of a barrel and tank casting, residual check valve (L), piston cup return spring (I), piston cup (D), piston (B), piston stop (P), boot (G) and push rod (A).

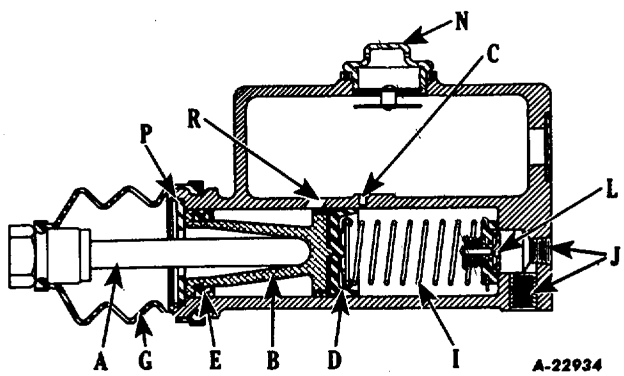

Fig. 1. Typical Master Cylinder

The fluid reservoir or supply tank is cast integrally over the master cylinder barrel. A combination filler and breather plug (N) permits atmospheric pressure on the reserve fluid at all times.

Depression of the pedal causes piston (B) and cup (D) to move forward in the cylinder barrel. A very small forward movement of cup (D) closes compensating port (C) and the pressure stroke commences.

Minimal pressure is built up until the fluid displaced has caused all shoes to go into contact with their drums. Additional pressure on the pedal produces higher hydraulic pressure within the brake system.

Removal of the operator's foot from the brake pedal after each brake application permits the brake pedal and push rod (A) to return independently to their off position.

The return of piston (B) and cup (D) is accomplished by the piston return spring (I).

The piston for this type of unit is designed to carry a primary cup (D) and a secondary cup (E). The construction of the piston is such that reserve fluid from the tank passes through vent (R) in a recessed area. Thus, we have fluid on both sides of the primary cup. The secondary cup (E) is merely a seal to prevent loss of reserve fluid into boot (G).

The primary compensating function is to maintain a constant volume of fluid in the system at all times, regardless of expansion (heat) or contraction (cold). The secondary compensating function is the replacement of additional fluid into the system to counterbalance any loss due to gravity seepage.

The return of piston (B) and cup (D) can be faster in displaced volume than the return of the fluid through fitting (J) into the master cylinder. A momentary vacuum is created in the cylinder barrel and additional fluid is drawn into the system through the drilled holes in piston (B) and past the lip of cup (D). The operating fluid returns more slowly from the wheel cylinders and lines back into the master cylinder barrel. Any excess is bypassed by port (C) into the reservoir. Thus, we have a cylinder full of fluid for the next brake application.

Fig. 2 illustrates a master cylinder equipped with a bleeder valve located in the cylinder barrel. This bleeder valve is commonly used in the larger stroke master cylinders. Its purpose is for expelling any air that may be trapped in the upper head end of the cylinder barrel.

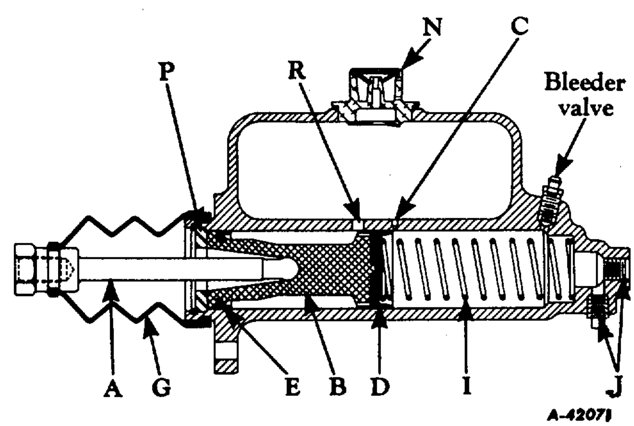

Fig. 2. Typical Master Cylinder with Bleeder Valve

The master cylinder (Fig. 2) is not equipped with a residual check valve. The valve is located in the power cylinder when this master cylinder is used.

Inspect the master cylinder at the time of making brake adjustment for correct fluid level. Fluid should be within 6.4 to 12.7 mm (1/4 to 1/2") from the top of the filler neck. Do not fill the supply reservoir to the top of the filler neck. When removing the supply reservoir filler cap, extreme care must be used to prevent dirt or moisture from entering the master cylinder.

POWER CYLINDER

The power cylinder assembly, whether it be a vacuum power booster or a compressed air booster, is designed to supplement the usual manual brake operation. The power brake units often appear different in shape and arrangement and internal components may also appear different; however, all function in the same manner. The operating force is controlled by a valve mechanism and exerted against a stroking device which converts it into pressure for braking.

Figures 3 and 4 illustrate two typical type vacuum power units. Complete detailed instructions pertaining to operation, description and overhaul for a particular unit may be found elsewhere in this service manual.

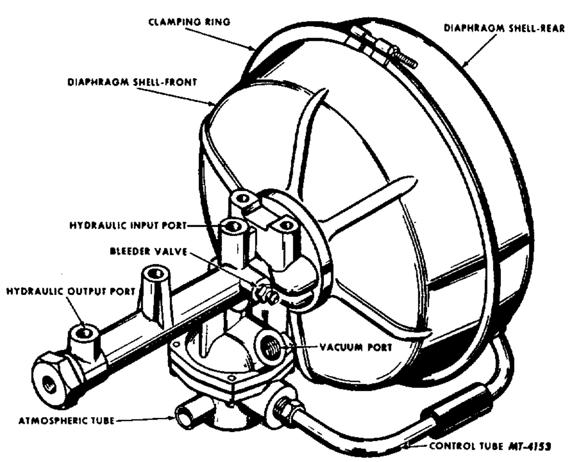

Fig. 3. Vacuum Power Cylinder

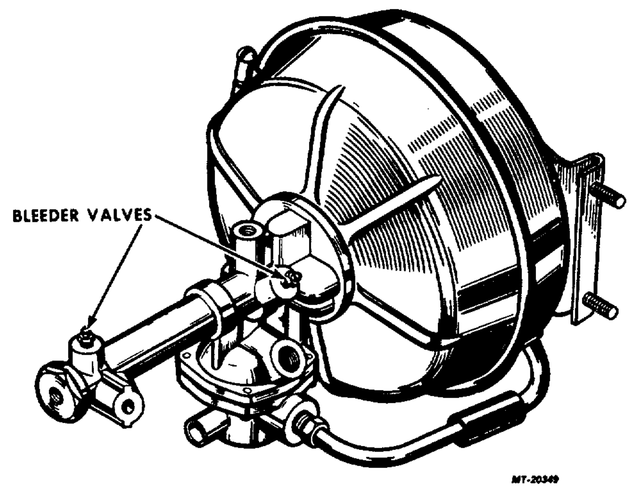

Fig. 4. Vacuum Power Cylinder

RESIDUAL CHECK VALVE

The residual check valve (Fig. 1), item L) maintains 41 to 124 kPa (6 to 18 psi) hydraulic pressure in the hydraulic system beyond the master cylinder to provide sealing of wheel cylinder piston cups with released brakes. The valve isolates a momentary vacuum which may occur in the master cylinder. This pressure will not cause the brake shoes to drag, as the shoe return springs overcome the residual pressure in the hydraulic system.

During manual bleeding the valve assists pumping fluid through the system by closing every time the brake pedal is released. If the valve should fail to hold the residual pressure, a very small leak or even road shock over a period of time could cause increased pedal stroke and a spongy pedal feel.

The residual check valve action can be inspected by cracking a bleeder screw open. A small spurt of fluid will indicate residual pressure.

On vehicles equipped with certain type power cylinders, the check valve is located in the power cylinder slave cylinder tube; where this is the case, no check valve is used in the master cylinder. (Refer to power cylinder section specifications for the particular unit involved.)

WHEEL CYLINDERS

Two types of wheel cylinders are used in the hydraulic brake system. Different combinations of these two types of cylinders are used on different model trucks. Fig. 5 illustrates a singlepiston wheel cylinder and Fig. 6 illustrates a double-piston wheel cylinder. The wheel cylinder assembly is the unit that changes the applied hydraulic pressure into mechanical force to actuate the brake shoes,

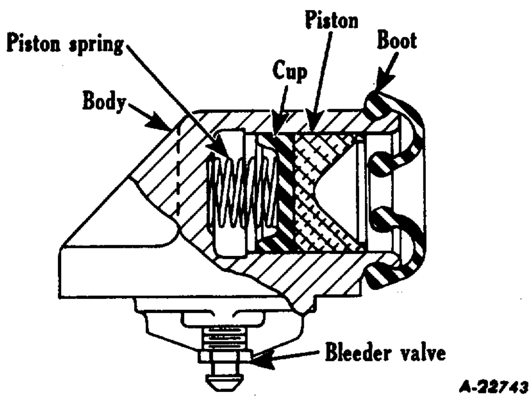

Fig. 5. Typical Wheel Cylinder (Single-Piston Type)

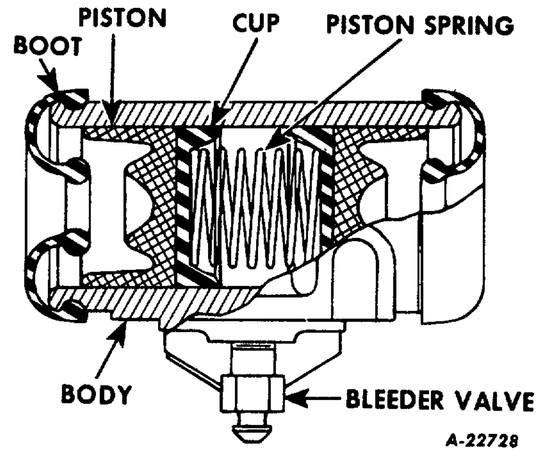

Fig. 6. Typical Wheel Cylinder (Double-Piston Type)

CHAPTER III

CLEANING, INSPECTION AND SERVICE

CONTENTS

MASTER CYLINDER AND WHEEL CYLINDERS

It is possible to rehone most cylinders and place them in good working condition; however, this requires the use of up-to-date honing equipment. A cylinder hone kit is available urlder number SE-1679.

Cylinder castings may be degreased or cleaned with most commercial parts cleaners, provided they are thoroughly rinsed with denatured alcohol or clean brake fluid to remove all traces of solvent. Use compressed air or a lint-free cloth to dry parts after removing them from the cleaning solvent. All hydraulic parts must be thoroughly cleaned and protected (after cleaning) from dust or other air-borne foreign material until reassembly. Do not use cotton waste for cleaning or drying parts, as particles of lint or thread fibers may block the compensating ports when cylinder is placed in service.

Clean rubber parts by washing them in clean denatured alcohol or hydraulic brake fluid.

IMPORTANT

Do not use minter-base cleaning solvents such as gasoline, kerosene, distillant, carbon tetrachloride, acetone, paint thinner, etc. to clean rubber parts. These solvents attack rubber parts, causing them to become soft, tacky and swollen in an extremely short time.

After cleaning, hold the cylinder casting toward a strong light and sight through the cylinder bore. Blemishes such as pitting, scratches and visible wear patterns necessitate unit replacement.

Accumulations of dirt or gummy substances, not removed during the cleaning process, may be removed with crocus cloth or jewelers rouge. A hone (SE-1679) may be used to "clean-up" the cylinder provided its use does not materially increase the diameter of the cylinder bore.

If master or wheel cylinders must be honed, remember that the cylinder diameter must not be materially increased. In other words, scratches and pits in cylinder walls render the unit useless, as honing the bore sufficiently to remove them would increase the bore diameter to the point that new piston cups will not seal properly. The possibility that the cylinder may have been honed during a previous overhaul should not be overlooked.

IMPORTANT

After honing a cylinder and obtaining a blemish free bore, check the maximum piston clearance using a 6.35 mm (1/4") wide feeler gauge with a thickness as follows:

Cylinder Bore		Gauge Thickness	
mm	Inch	mm	Inch
19.050-30.163	3/4-1 3/16	.1524	.006
31.750-36.513	1 1/4-1 7/16	.1778	.007
38.100-Up	1 1/2-Up	.2038 : .	.008

If the piston can be inserted with the feeler gauge in the cylinder bore, the unit should be replaced. If the piston cannot be inserted, the cylinder may be reused.

Be certain that the honed cylinder has no burr at the compensating or inlet ports, as it would damage the new piston cup lip. If a burl or sharp edge is present anywhere in the cylinder bore, it must be removed.

At final inspection, be certain that the master cylinder compensating ports are open. A soft copper wire may be used to probe the compensating port. Do not use a steel wire.

Wheel cylinders should be reconditioned whenever brake lining is replaced because of the following:

1. As lining wears, wheel cylinder rubber cups move back and forth over a new, widened smooth area.

2. Corrosion and foreign matter builds up on the part of the cylinder walls where cups do not work.

3. When new thick lining is installed, cups are pushed closer together and must function over the roughened surface.

4. Since cups no longer seat against smooth cylinder walls, they allow fluid to leak out.

BRAKE PEDAL ADJUSTMENT

When the brake control system is in the released position, the foot brake pedal should have 6.4 mm (1/4") free travel (Fig. 1) before the pressure stroke starts. This free travel is required to prevent blocking of the compensating port in the master cylinder. Brakes will drag if the compensating port becomes blocked due to pressure building up in the system. Shorten the pedal stop rod to allow the piston to uncover the compensating port allowing fluid to escape into the reservoir.

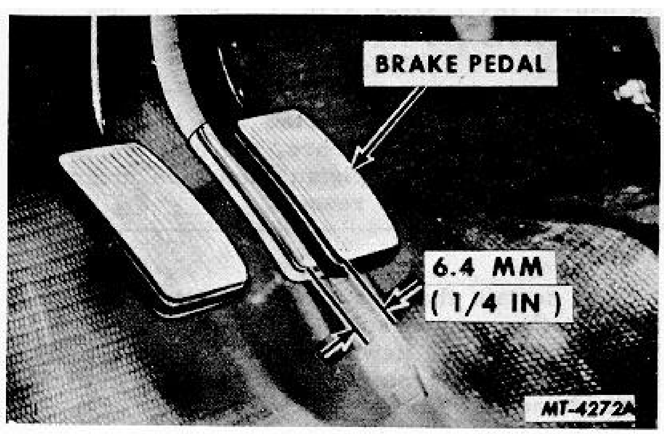

Fig. 1. Brake Pedal Free Travel

BLEEDING BRAKE SYSTEM

The hydraulic brake system must be free of air to function properly. If air becomes mixed with the brake fluid, loss of pedal reserve will result since the air in the hydraulic system compresses. A bleeder valve (screw) is provided at each wheel cylinder for removal of any air in the hydraulic brake system.

Bleeding the brake system consists of forcing brake fluid and any air in the brake fluid out of the hydraulic system at one or more bleed points. There are two methods of bleeding the hydraulic brake system; manual bleeding and pressure bleeding. For either method of bleeding, a supply of clean hydraulic brake fluid is necessary. Do not reuse brake fluid that has been drained from the hydraulic brake system, as the fluid may be contaminated or contain dirt.

The order in which wheel cylinders are bled normally does not affect the quality of the bleeding operation. The following sequence is recommended, however, to reduce the possibility of missing a wheel cylinder: right rear, left rear, right front, left front.

PRESSURE BLEEDING

A pressure bleeder with adapter plate for connection to the master cylinder reservoir is necessary to pressure bleed the brake system. The adapter plate is designed to permit a transfer of fluid to maintain fluid level during brake bleeding.

Hydraulic brake fluid level should be approximately 12.7 mm (1/2") from top of master cylinder reservoir. If, when pressure bleeder adapter plate is removed, fluid level is too high or too low, add or remove sufficient fluid to bring to correct level.

Be sure there is enough brake fluid in the bleeder tank to complete the bleeding operation and the tank is charged with 69-207 kPa (10 30 psi) air pressure.

Remove reservoir cover and attach pressure bleeder hose to master cylinder using proper adapter. Open the valve in the pressure bleeder hose to pressurize the master cylinder and hydraulic system.

Attach a bleeder tube (hose) to right rear wheel cylinder bleeder valve (screw), Fig. 2. Submerge the free end of the hose in a glass jar partially filled with brake fluid. Loosen bleeder valve approximately three-quarter's turn.

When fluid coming from the submerged end of the hose is free of air bubbles, close bleeder valve and remove drain hose. Repeat this procedure at each wheel cylinder.

When bleeding operation is completed, close the valve in the pressure bleeder hose. Enclose connection with shop towel and disconnect pressure bleeder and adapter from master cylinder.

Check hydraulic fluid level to see that reservoir is filled to within 12.7 mm (1/2") from top edge.

Install master cylinder reservoir cover.

MANUAL BLEEDING

Fill the master cylinder fluid reservoir with clean brake fluid. Attach a bleeder tube hose to the right rear wheel cylinder bleeder valve (screw). Submerge the free end of the hose in brake fluid in a partially filled glass jar, Fig. 2.

Apply steady pressure to the brake pedal and open the bleeder valve. When fluid coming from submerged end of hose is free of air bubbles, close bleeder valve and release brake pedal. If pedal goes to the toe board while bleeding a wheel cylinder without removing all air bubbles, close the bleeder valve and release pedal slowly. Repeat bleeding operation at this same wheel cylinder until clean fluid, free of air bubbles, flows from the submerged end of the drain hose. Repeat same procedure at each wheel cylinder until all air is expelled from system. Check level of brake fluid in master cylinder frequently during the bleeding operations and keep master cylinder reservoir at least half full.

Refill reservoir to correct level with new brake fluid and install reservoir cover.

Fluid withdrawn in the bleeding operation or fluid whose cleanliness is questionable should never be used. Fluid should be replenished in the supply reservoir after each cylinder is bled. Should the supply reservoir be drained during the bleeding operation, air will enter the system and rebleeding will then be necessary.

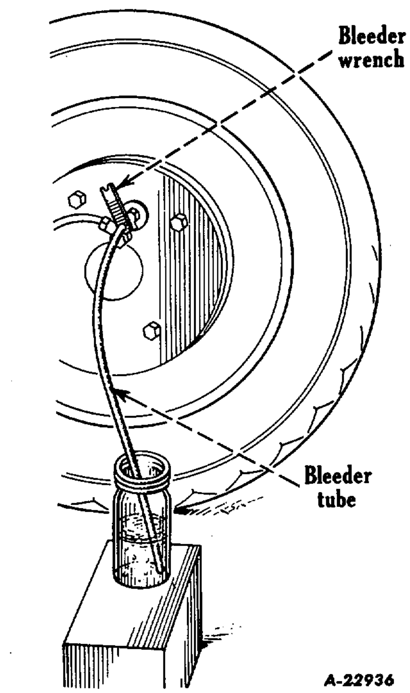

Fig. 2

CHAPTER IV

TROUBLE SHOOTING

Problems pertaining to the brake system are usually those which appear in the TROUBLE SHOOTING CHART. Brake troubles are easily diagnosed if the problem is understood. The driver may report certain symptoms; however, the report may not be of any benefit in your analysis. Be sure to have the driver tell you which of the problems he has encountered. In some instances, you may want to road test the vehicle to assist you in your analysis.

PROBLEM	POSSIBLE CAUSE	REMEDY
Low Pedal (excessive pedal travel to apply brakes)	Shoes improperly adjusted. Worn linings.	Adjust brakes. Replace lining.
	Brake shoes bent or distorted.	Fill reservoir with approved fluid to correct level.
	Air in system.	Bleed system and fill reservoir to correct level.
	Poor quality brake fluid (low boiling point).	Replace with approved brake fluid.
	Soft or weak hoses (expanding under pressure).	Replace.
	Brake drums cracked or too thin (expanding when hot).	Replace.
	Automatic adjuster corroded, distorted or broken.	Repair or replace and lubricate.
	Leak in system.	Check system for leaks with brakes applied. Repair leaks.
	Power cylinder leakage.	Repair or replace power cylinder assembly.
Dragging Brakes (slow or incomplete release of brakes, either one wheel or all wheels)	Mineral oil in system.	Disassemble, clean and flush system. Replace piston cups through-out system. Fill system with approved brake fluid, bleed system and refill with fluid.
	Insufficient pedal height.	Check pedal for alignment, bind or being bent; incorrectly positioned stop light switch.
	Shoes improperly adjusted.	Adjust brake shoes.
	Shoes distorted or incorrect.	Replace with new lined shoes.
	Linings soiled with mineral oil or grease.	Replace linings.

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PROBLEM	POSSIBLE CAUSE	REMEDY
Dragging Brakes (slow or incomplete release of brakes, either one wheel or all wheels) (Continued)	Shoe return springs weak or incorrect. Normally encountered with one wheel drag.	Replace with new springs.
	Shoe ledges grooved or rusted.	Smooth ledges and lubricate.
	Loose backing plate.	Tighten.
	Parking brake improperly adjusted.	Adjust parking brake cables.
	Parking brake cables sticking, dirty or corroded.	Free up and lubricate.
	Wheel bearings loose or worn.	Adjust or replace.
	Fluid sluggish.	Flush and refill with approved fluid.
	Brake lines, hoses or connections kinked, clogged, dented or collapsed.	Repair or replace.
	Master cylinder compensating ports blocked by swollen cups or binding pedal or linkage.	Replace cups and/or check pedal and linkage alignment.
	Faulty residual check valve(s) in master cylinder or power cylinder.	Replace valve(s).
	Wheel cylinder cups swollen.	Flush hydraulic system with alcohol to remove contaminated fluid and replace all cups and seals.
	Wheel cylinder bore rough or corroded.	Repair or replace wheel cylinders.
	Brake pedal linkage binding or misaligned.	Free up linkage, align and lubricate
	Control valve or power cylinder defective.	Replace defective part or power unit.
	Master cylinder bore rough or corroded.	Repair or replace master cylinder.
	Brake pedal bent.	Straighten or replace.
	Stop light switch incorrectly positioned.	Adjust position of stop light switch.
	Broken master cylinder piston return spring.	Replace spring.

PROBLEM	POSSIBLE CAUSE	REMEDY
Spongy Pedal (springy sensation to pedal upon application)	Warped brake shoes.	Replace shoes.
	Shoes not centered in drum causing partial lining-to-drum contact.	Adjust brake shoe anchors.
	Brake drums tapered, out-of-round or worn thin.	Refinish if practical or replace.
	Air in system.	Bleed and refill system with approved hydraulic fluid.
	Hoses soft or weak (expanding under pressure).	Replace hoses.
	Faulty residual check valve(s) in master cylinder.	Replace valve(s).
	Wheel cylinder cups soft or swollen.	Flush hydraulic system with alcohol to remove contaminated fluid and replace all cups and seals.
Hard Pedal (excessive pedal pressure required to stop vehicle)	Shoes worn, distorted or damaged.	Replace brake shoes.
	Inadequate lining to drum clearance.	Properly adjust brake shoes.
	Linings worn, glazed, soiled (brake fluid or grease) or of poor quality.	Replace linings.
	Brake lines, hoses or connections kinked, collapsed, dented or clogged.	Repair or replace.
	Master cylinder cups swollen.	Flush hydraulic system with alcohol to remove contaminated fluid and replace all cups and seals.
	Master cylinder bore rough or corroded.	Repair or replace master cylinder.
	Brake shoe anchors out of adjustment.	Adjust anchors.
	Brake shoe ledges rusted or grooved.	Clean and smooth ledges and lubricate.
	Wheel cylinder cups swollen.	Flush hydraulic system with alcohol to remove contaminated fluid and replace all cups and seals.
	Wheel cylinder bore rough or corroded.	Repair or replace wheel cylinders.
	Power cylinder check valve defective or sticking	Replace.
	Vacuum lines to power cylinder loose, broken or collapsed.	Tighten or replace.
	Low vacuum supply to power cylinder.	Check for restricted, kinked or leaking line; also engine vacuum.
	Control valve, power cylinder, piston or diaphragm defective.	Replace defective part or power cylinder.

PROBLEM	POSSIBLE CAUSE	REMEDY
Grabbing or Pulling (severe reaction to pedal pressure and out-of-line stops)	Tires not properly inflated.	Inflate tires to correct pressure.
	Spring U-bolts loose.	Tighten U-bolts to correct specs.
	Shoes improperly adjusted.	Adjust brake shoes.
	Brake shoes distorted or incorrect.	Replace with new correct shoes.
	Linings incorrect, loose on shoes or soiled w/grease or brake fluid.	Install new correct linings.
	Brake shoe anchors not properly adjusted (causes incorrect lining to drum contact).	Adjust brake shoe anchor.
	Loose brake backing plate.	Tighten backing plate mounting bolts and readjust brakes.
	Brake shoe return springs weak, broken or incorrectly installed.	Replace or install correctly.
	Automatic adjuster parts, if equipped, corroded, distorted or broken.	Free up and lubricate or replace.
	Wheel bearings loose.	Adjust wheel bearings.
	Brake drum too thin (expand when hot).	Replace drum.
	Brake drum scored hard, spotted or out-of-round.	Refinish or replace drum.
	Lines, hoses or connections kinked, clogged, collapsed or dented.	Repair or replace.
	Master cylinder bore rough or corroded.	Repair or replace master cylinder
	Wheel cylinder cups swollen.	Flush hydraulic system with alcohol to remove contaminated fluid and replace all cups and seals.
	Wheel cylinder bore rough or corroded.	Repair or replace wheel cylinder.
	Wheel cylinders mismatched.	Replace with correct cylinders.
	Pedal linkage binding.	Free up and lubricate.
	Power cylinder control valve defective.	Replace control valve.
	Power cylinder diaphragm plate binding and suddenly releasing.	Clean, repair and lubricate.
	Power cylinder control valve rod binding at pedal.	Free up and lubricate.

PROBLEM	POSSIBLE CAUSE	REMEDY
Fading Pedal (pedal falling away under steady foot pressure).	Brake drums cracked or thin (expanding when hot causing too much clearance. Replace brake drums.	
	Poor quality brake fluid (low boiling point).	Replace with approved brake fluid.
	Hose or line connections loose, ruptured or damaged causing leakage.	Tighten or replace.
	Primary cups of master cylinder pistons worn or damaged; master cylinder bore corroded or worn.	Repair or replace master cylinder.
	Wheel cylinder cups worn or damaged; bores worn or corroded.	Repair or replace wheel cylinder.
Noise and Chatter (squealing, clicking or scraping noise upon application of brakes)	Brake shoes twisted, distorted, incorrect or broken; cracked welds.	Replace brake shoes.
	Linings worn out, glazed, incorrect, loose or soiled w/grease or brake fluid; foreign matter imbedded in linings; incorrect grind or lining position.	Replace with new lined brake shoes.
	Brake shoe rerurn springs weak; anchor pins or backing plate loose or defective; hold-down parts defective.	Tighten or replace parts and lubricate all points of wear.
	Shoe ledges rough or grooved.	Smooth ledges and lubricate.
	Brake drums thin, cracked, loose or scored.	Refinish or replace.
	Power cylinder control valve defective causing excessive noise.	Repair or replace valve.
	Power cylinder check valve broken or leaking.	Replace valve.

CHAPTER V

TORQUE CHART

BRAKE GROUP MOUNTING BOLT-NUT

Tighten the brake group mounting bolts to the torque values listed from the nut side. Since some of the mounting holes in the steering knuckles are of conical design, the knuckle bolts must utilize conical mounting nuts to coincide with the mounting holes in the knuckle. These conical nuts have a smooth cone surface and the torque values are considerably higher than the torque values for regular nuts or prevailing type lock nuts.

FRONT AXLE BRAKE GROUP MOUNTING BOLTS WITH CONICAL TYPE NUTS

BOLT SIZE	TORQUE	
	Newton-Meters (N•m)	Foot Pounds (ft. lbs.)
1/2"	135.6-162.7	100-120
5/8"	298.3-325.4	220-240

FRONT AND REAR AXLE BRAKE GROUP MOUNTING BOLTS WITH REGULAR NUTS OR PREVAILING TORQUE TYPE LOCK NUTS

BOLT SIZE	TORQUE	
	Newton-Meters (N•m)	Foot Pounds (ft. lbs.)
7/16"	74.6-81.4	55-60
1/2"	115-129	85-95
9/16"	155.9-169.5	115-125
5/8"	216.7-237.3	160-175
3/4"	373.0-406.7	275-300

BRAKES HYDRAULIC

BRAKE GROUP ADJUSTMENT AND SERVICING

TWO SINGLE-END WHEEL CYLINDERS MOUNTED BETWEEN EACH SHOE TOE AND OPPOSITE SHOE HEEL, AUTOMATIC BRAKE SHOE ADJUSTMENT

IH CODE	SIZE	
	CENTIMETERS (cm)	INCHES
04112	38.1 x 8.9	15 x 3 1/2
04118	38.1 x 7.6	15 x 3
04120	35.9 x 6.3	14 x 2 1/2
04128	38.1 x 7.6	15 x 3
04131	38.1 x 8.9	15 x 3 1/2
04132	38.1 x 12.7	15 x 5

CONTENTS

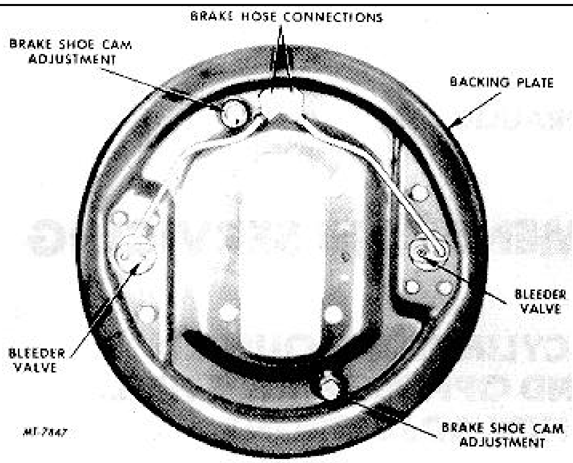

Fig. 1 External View

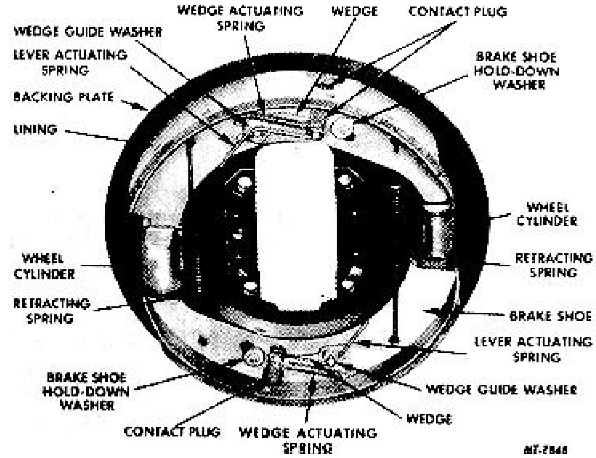

Fig. 2 Internal View

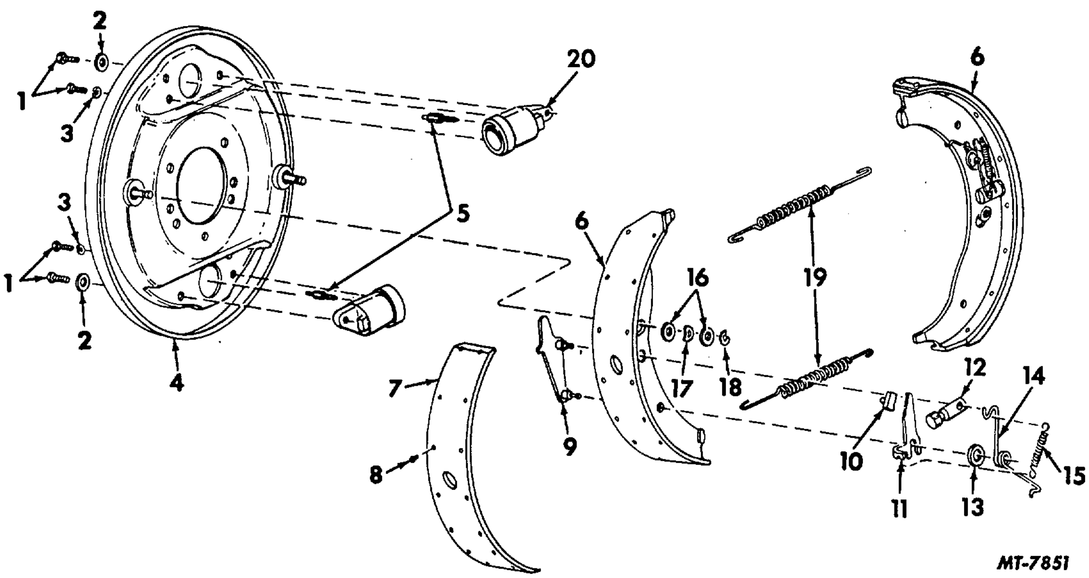

Fig. 3 Exploded view of Brake Group

LEGEND FOR FIG. 3

KEY	DESCRIPTION	KEY	DESCRIPTION
1	Bolt, Wheel Cylinder Mounting	11	Wedge, Automatic Adjuster
2	Washer, Wheel Cylinder Mounting Bolt	12	Plug, Drum Contact
3	Washer, Lock, Wheel Cyl. Mtg. Screw	13	Washer, Wedge Retainer
4	Plate, Brake Backing	14	Spring, Adjuster Torsion
5	Valve, Wheel Cylinder Bleeder	15	Spring, Wedge
6	Shoe, Brake	16	Washer, Shoe Guide
7	Lining, Brake Shoe	17	Wave Washer, Shoe Guide
8	Rivet, Brake Lining	18	"C" Washer, Shoe Guide
9	Lever, Automatic Adjuster	19	Spring, Shoe Retracting
10	Guide, Adjuster Wedge	20	Wheel Cylinder

DESCRIPTION

These self-adjusting type brakes have two single end wheel cylinders, each operating a forward acting shoe providing directional braking response. The closed end of the wheel cylinder has a slotted ramp which is the self-centering sliding anchor for the opposite shoe. The two wheel cylinder pistons apply equal amounts of hydraulic force to each shoe toe.

Shoes are adjustable manually by means of two hex head friction spring locked studs, exposed on the backing plate (Fig. 1). Each stud rotates an adjuster cam located under a brake shoe table. Shoe hold-downs consist of two plain washers, multi-rattle wave washer between and a C-clip fitted over the extended shank of the cam stud. Two retracting springs are hooked between the shoes and have their longer shanks connected to the anchor end of the shoes.

The function of the contact plug type self adjusting mechanism is to maintain a nearly constant previously set running clearance between brake shoe and drum throughout the life of the brake lining.

The self adjusting mechanism is contained entirely in the brake shoe. This mechanism incorporates a contact plug located in the center of the lining and is the lining wear sensing component. This plug is pinned (lever actuating pin) in a free rotatable manner to the adjusting lever, which in turn makes contact with the manually operated adjusting cam. This lever in turn is pinned (lever pivot pin) in a rotatable manner through a hole in the shoe web. As lining wear progresses, the contact plug is gradually depressed upon successive brake applications and a spring-actuated wedge with serrated teeth on the angular surface advance between the lever-actuating pin and a stationary but rotatable serrated wedge pin, thereby maintaining the adjustment.

Force is exerted by the lever actuating spring on the lever actuating pin acting through the wedge and wedge guide pin so as to maintain firm contact between these parts while the brake is in the released position.

Shoe adjustment is accomplished by the adjusting lever changing position with relation to the shoe web as the contact plug is depressed. The adjusting lever then comes to rest against the adjusting cam, causing the shoe to remain in the advanced or adjusted position.

BRAKE SHOE REMOVAL

1 Position vehicle on floor stands so that the wheels are free to turn.

2. Remove wheel hub and drum assemblies.

3. Secure pistons in wheel cylinders with cylinder clamps.

4. Remove brake shoe retracting springs.

5. Remove brake shoe guide "C" washer, two shoe guide washers and wave washer from each shoe. Refer to Fig. 3 (items 16, 17 and 18).

6. Pull shoes free from adjuster cams and then rotate shoe from brake group freeing ends of wheel cylinders.

7. After shoes are removed disassemble self adjuster mechanism on each shoe:

   a. Disconnect wedge (coil) spring from finger on wedge and remove spring.

   b. Unhook torsion adjuster spring from shoe web.

   c. Work torsion adjuster spring coil from lever pivot pin and slide U-hook off plug-lever pin.

   d. Pull adjuster lever from opposite side of shoe and contact plug out of shoe table, freeing wedge retaining washer, wedge and wedge guide.

CLEANING AND INSPECTION

Thoroughly clean all parts (except drums) free of dirt and grease with cleaning solvent and wipe dry.

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.

DRUMS, SHOES AND LINING

For complete details pertaining to reconditioning drums and shoes, refer to CTS-2779.

(Cont'd. on next page)

IMPORTANT

Contact plug must be replaced when new lining is installed. Do not use oversize thickness lining, even though drums are rebored. Do not lubricate adjuster mechanism.

If new lining has no contact plug hole, cut a 19.05 mm (3/4") hole and deburr the edges. Locate this hole by making a proper template of the shoe table.

WHEEL CYLINDERS

Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.

Some brake groups have wheel cylinder piston stops and the wheel cylinder must be removed for reconditioning.

RETRACTING SPRINGS AND SELF-ADJUSTING MECHANISM COMPONENTS

Inspect retracting spring for distortion such as nicks, twisted shanks or spread of coils. Damaged spring must be replaced.

Inspect self-adjusting mechanism components for damage or wear, any piece of which the condition is considered questionable must be replaced.

REINSTALL BRAKE SHOES

1. Position wedge guide in shoe web hole on side away from brake backing plate, with serrations facing away from shoe table. Lay wedge with serrations matched against guide and slot aligned over the lever pivot pin hole shoe web (Fig. 4).

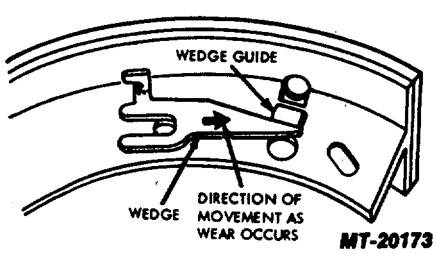

Fig. 4

2. Insert contact plug into the web recess and guide it into the shoe table with plug shank over the wedge guide and wedge. Insert adjuster lever pins through shoe from the opposite side and mate the actuating (center) pin with the plug shank hole (Fig. 5).

3. Assemble wedge washer over shoulder of pivot pin.

4. Slide U-hook of tension spring on pin over contact plug shank.

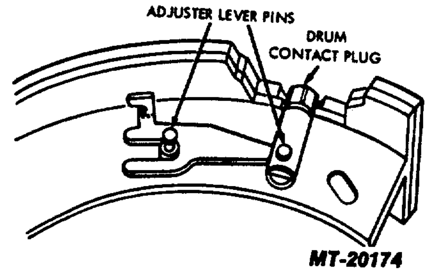

Fig. 5

5. Hook one end of wedge (coil) spring on the U-hook, then install coil of torsion spring over the pivot pin and pull free spring hook over the edge of the shoe web. Hook free end of wedge spring over finger on wedge (Fig. 6).

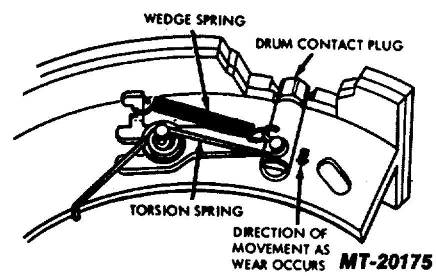

Fig. 6

6. Press lightly upon contact plug to allow wedge to move and fully retract the wedge against the lever pivot pin. In this position, the plug should be even with lining surface + 0.00 to-0.512 mm (+ 0.00 to-0.006 inch If plug is high, clamp shoe in a vise so that the jaws of the vice bear against the adjuster lever (Fig. 7) and dress down the plug with a file. Take care not to create a flat spot on the lining. An alternate method is to dress the plug when the shoes are ground to a true radius; however, lever must be blocked in its extended position.

7. Make sure that brake backing plate, wheel cylinder anchor bolts and cylinder mounting screws are tightened securely.

8. Install shoes on hold-downs, locating each retracting spring so that its long shank is hooked at the anchor end of the shoe.

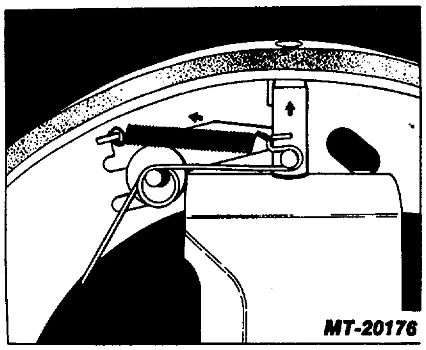

Fig. 7

When installing shoe on hold-down, free end of adjuster lever should bear against manual adjuster cam which should be fully backed off to position shown in Fig. 8.

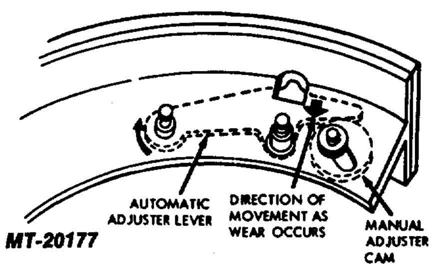

Fig. 8

9. Install flat washers and hold-down "C" washers.

10. Install brake shoe return springs.

11. Remove wheel cylinder clamps.

12. Back off manual adjustment cams.

13. Center each shoe before installing drum by sliding shoe up or down in its anchor slot until the leading and trailing edges of linings are equal distances from the rolled edge of brake backing plate. 14. Repack wheel bearings (refer to LUBRICATION, CTS-2412).

15. Reinstall wheel bearings, new seals and install hub and drum assembly. Adjust wheel bearings. Refer to WHEELS, RIMS and TIRES Section (CTS-2032) for proper instructions pertaining to repacking bearings and bearing adjustment.

16. Adjust brakes by performing the initial manual adjustment, referring to LINING CLEARANCE ADJUSTMENT procedure.

17. If wheel cylinders were rebuilt or replaced the brakes will require bleeding. Refer to BRAKES HYDRAULIC, General (CTS-2055 for single system or CTS-2470 for split system).

18. Remove floor stands from under vehicle.

LINING CLEARANCE ADJUSTMENT

Adjust Each Shoe, in Turn: With drum installed, rotate adjuster cam stud and drum in forward direction of drum rotation until a light drag is noticeable (Fig. 9). Do not apply excessive force on the stud -13.6 N•m (120 inch pounds) maximum. Back off adjuster stud (6 to 12 degrees) until drum turns freely. After the manual adjustment is performed, the automatic adjusters will now maintain normal facing-to-drum clearance.

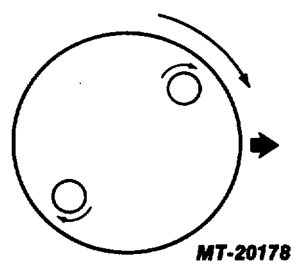

Fig. 9

BRAKES HYDRAULIC

BRAKE GROUP ADJUSTMENT AND SERVICING

TWO SINGLE-END WHEEL CYLINDERS MOUNTED BETWEEN EACH SHOE TOE AND OPPOSITE SHOE HEEL ADJUSTMENT SHOE AND ADJUSTING CAM

IH CODE	SIZE	
	CENTIMETERS (cm)	INCHES
04108	30.8 x 5.7	12 1/8 x 2 1/4
04109	33.0 x 5.7	13 x 2 1/4
04111	38.1 x 5.7	15 x 2 1/4
04112	38.1 x 8.9	15 x 3 1/2
04118	38.1 x 7.6	15 x 3
04120	35.9 x 6.3	14 x 2 1/2
04128	38.1 x 7.6	15 x 3
04131	38.1 x 8.9	15 x 3 1/2
04132	38.1 x 12.7	15 x 5

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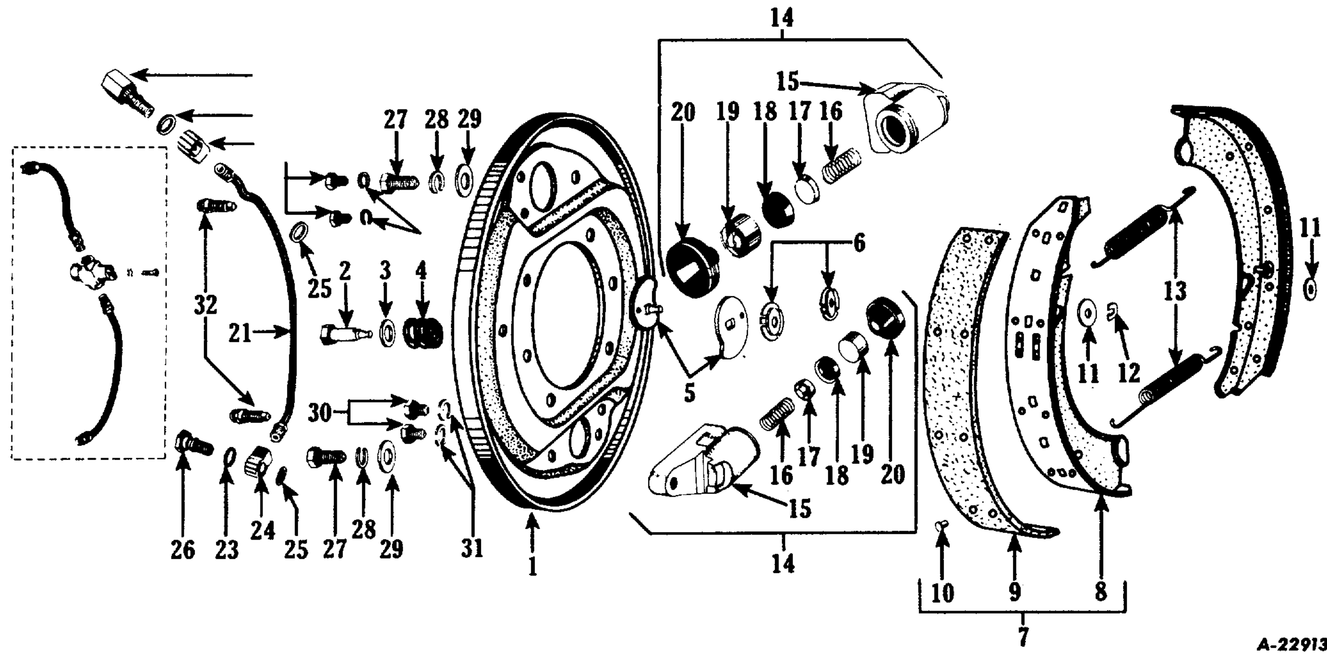

Fig. 1 Exploded View

LEGEND FOR FIG. 1

Key	Description	Key	Description
1	Plate assembly, brake backing	18	Cup, piston
2	Stud, adjusting cam and shoe guide	19	Piston assembly
3	Washer, plain, cam stud	20	Boot
4	Spring, adjusting cam	21	Tube assembly, connector, wheel cylinder
5	Cam, shoe adjusting		
6	Washer, spring, anti-rattle, shoe guide	22	Bolt, fitting, inlet, brake line to cylinder & tube
7	Shoe & lining assembly		
8	Shoe	23	Gasket, bolt
9	Lining	24	Fitting, inlet, fluid, connector tube
10	Rivet, lining	25	Gasket, fitting
11	Washer, plain, shoe guide	26	Bolt, fitting, inlet, connector tube to cylinder
12	Washer, "C", shoe guide stud		
13	Spring, retracting, brake shoe	27	Screw, anchor, cylinder
14	Wheel cylinder assembly	28	Lockwasher, cylinder anchor screw
15	Body, wheel cylinder	29	Washer, plain, cylinder anchor screw
16	Spring	30	Screw, fastening, wheel cylinder
17	Filler, piston cup	31	Lockwasher, fastening screw
		32	Valve, bleeder, cylinder

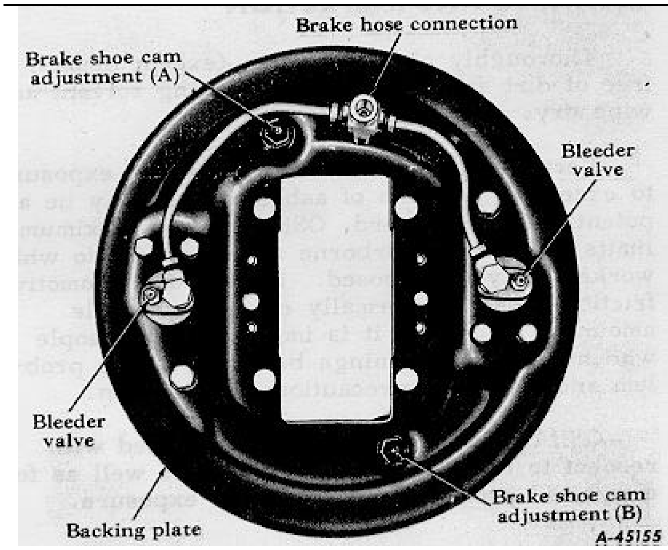

Fig. 2 External View

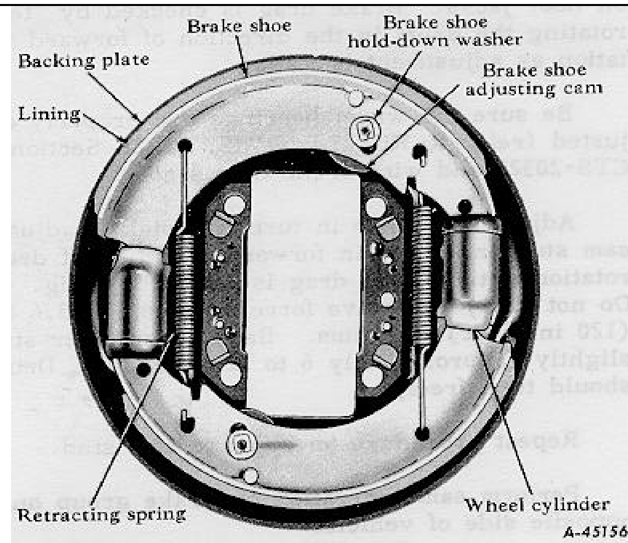

Fig. 3 Internal View

DESCRIPTION

These self-centering type brakes have two single end wheel cylinders, each operating a forward acting shoe providing directional braking response. The closed end of the wheel cylinder has a slotted ramp which is the self-centering sliding anchor for the opposite shoe. The two wheel cylinder pistons apply equal amounts of hydraulic force to each shoe toe.

Shoes are adjustable manually by means of two hex head friction spring locked studs, exposed on the backing plate (Fig. 2). Each stud rotates an adjuster cam located under a brake shoe table. Shoe hold-downs consist of two plain washers, multi-rattle wave washer between and a C-clip fitted over the extended shank of the cam stud. Two retracting springs are hooked between the shoes and have their longer shanks connected to the anchor end of the shoes.

Upon brake application, the wheel cylinder pistons transmit pressure to the toes of the shoes, forcing the shoe linings into contact with the brake drum. If the vehicle is moving forward, the drag of the drum against the shoe lining produces "self-energization" which tends to help rotate the shoes outwardly about their anchor points. This action multiplies the forces exerted against the drum and produces additional braking effect. Both shoes are forward acting (primary shoes), self-energizing in the forward direction of drum rotation.

If the vehicle is moving backward, the drag of the drum on the linings is in the opposite direction and produces "de-energization" which tends to move the shoe heels away from their anchor blocks. Piston forces at the shoe toes are large enough to overcome this action, but the shoes tend to rotate inwardly about their anchor points and attempt to leave the drum. Both shoes are reverse acting since neither is self-energized in the reverse direction of drum rotation.

Cylinder anchor block sides are aligned on the axle radius. As the shoes roll upon their anchor blocks to contact the drum, the heels may also slide radially upon the anchor block surface. The shoes thus automatically "selfcenter" in relation to the drum.

The self-energization factor causes this brake to be approximately three times as effective during forward operation as it is during reverse operation; therefore its use is generally confined to the front axle of vehicles in conjunction with a rear axle brake of a type providing effective stopping ability in reverse as well as forward motion.

LINING CLEARANCE ADJUSTMENT

Lining to drum clearance adjustment is required when shoes are relined and, on occasion, to compensate for normal lining wear. Clearance should be sufficient to avoid "brake drag" and yet close to afford a good "pedal reserve".

Manually operated and vacuum-hydraulic actuated brakes require adjustment (or relining) when pedal reserve approximates 2"; that is, when the brake pedal drops to within 2" of floor board on hard application.

Adjustment is made with the vehicle resting on floor jacks. Brake drag is checked by "feel", rotating the drum in the direction of forward rotation as adjustment is made.

Be sure the wheel bearings are properly adjusted (refer to WHEELS, RIMS, TIRES Section, CTS-2032) and with brake drums cool.

Adjust each shoe in turn by rotating adjuster cam stud and drum in forward direction of drum rotation until a light drag is noticeable (Fig. 4). Do not apply excessive force on stud -13.6 N•m (120 in. lbs.) maximum. Back off adjuster stud slightly (approximately 6 to 12 degrees). Drum should turn freely.

Repeat procedure on opposite cam stud.

Perform same operation on brake group on opposite side of vehicle.

BRAKE SHOE REMOVAL

Refer to Fig. 1 for numbers in parenthesis.

1. Position vehicle on floor stands so that the wheels are free to turn.
2. Remove wheel hub and drum assemblies.
3. Secure pistons in wheel cylinders with cylinder clamps.
4. Remove brake shoe retracting springs.
5. Remove each shoe hold-down "C" washer (12) and washer (11).
6. Pull shoes free from adjuster cams and then rotate shoe from brake group freeing ends of wheel cylinders.

If wheel cylinder connector tubes (21) are removed, mark wheel cylinder ports to which tubes are attached to avoid error in re-assembly. Difficulty will be encountered in bleeding operation if tubes are assembled in wrong location.

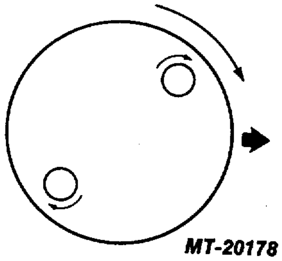

Fig. 4 Brake Adjustment

CLEANING AND INSPECTION

Thoroughly clean all parts (except drums) free of dirt and grease with cleaning solvent and wipe dry.

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.

DRUMS, BRAKE SHOES AND LINING

For complete details pertaining to reconditioning drums and shoes, refer to CTS-2779.

WHEEL CYLINDERS

Inspect wheel cylinders for signs of fluid leakage or deteriorated rubber dust boots. If brake fluid is leaking out of wheel cylinders, replace or recondition wheel cylinders.

Some brake groups have wheel cylinder piston stops and the wheel cylinder must be removed for reconditioning.

The two wheel cylinders mounted on one brake are identical; HOWEVER, CYLINDERS FOR LEFT OR RIGHT HAND BRAKES HAVE OPPOSITE CASTINGS.

Clean mating surfaces of cylinders and backing plate before assembly to insure proper alignment.

RETRACTING SPRINGS

Inspect retracting spring for distortion such as nicks, twisted shanks or spread of coils. Damaged spring must be replaced.

ADJUSTING CAM AND SHOE GUIDE STUDS

Adjustment cam and shoe guide studs are equipped with friction springs. They should easily turn with a wrench, but should not be loose. If frozen, lubricate with penetrating oil and work free.

REINSTALL BRAKE SHOES

Refer to Fig. 1 for numbers in parenthesis.

1. Make sure that the backing plate and wheel cylinder mounting bolts are tightened securely.

2. Install spring anti-rattle washer (6) on cam and shoe guide stud (2), pronged side facing adjusting cam (5).

3. Place shoe assembly on backing plate with cam and shoe guide stud protruding through shoe slot. Locate shoe toe in piston slot and shoe heel in anchor block.

4. Replace hold down washer (11) and "C" washer (12) on cam and shoe guide stud. Crimp "C" washer on stud.

5. Repeat steps 1, 2 and 3 for second shoe.

6. Replace shoe retracting springs (13).

When replacing shoe retracting springs (13), place spring end with long hook in heel of shoe and then, with brake spring pliers, stretch spring to secure short hook end in toe of opposite shoe.

7. Back off manual adjustment cams.

8. Center each shoe before installing drum by sliding shoe up or down in its anchor slot until the leading and trailing edges of lining are equal distances from the rolled edge of brake backing plate.

9. Repack wheel bearings (refer to LUBRICATION, CTS-2412).

10. Reinstall wheel bearings, new seals and install hub and drum assembly. Adjust wheel bearings. Refer to WHEELS, RIMS and TIRES Section (CTS-2032) for proper instructions pertaining to repacking bearings and bearing adjustment.

11. Adjust brakes by performing the initial manual adjustment, referring to LINING CLEARANCE ADJUSTMENT procedure.

12 If wheel cylinders were rebuilt or replaced the brakes will require bleeding. Refer to BRAKES HYDRAULIC, General (CTS-2055 for single system or CTS-2470 for split system). 13. Remove floor stands from under vehicle.

BRAKES HYDRAULIC
RECONDITIONING BRAKE DRUMS, SHOES, ROTORS AND PADS

The text herein is to provide the actual reconditioning of brake drums, rotors, shoes and disc brake pads. For the disassembly and reassembly of brake groups and servicing of other particular components, refer to appropriate section of the service manual.

CONTENTS

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DRUM BRAKES

INSPECTION OF DRUMS

The friction surface of brake drums must be smooth, true and concentric. Make certain with a visual check that drums are not barrel shaped, bellmouthed, scored or eccentric.

Hard or chill spots, Fig. 1, in brake drum may produce pedal pulsation and roughness or brake surge. If these effects are present, drum should be replaced.

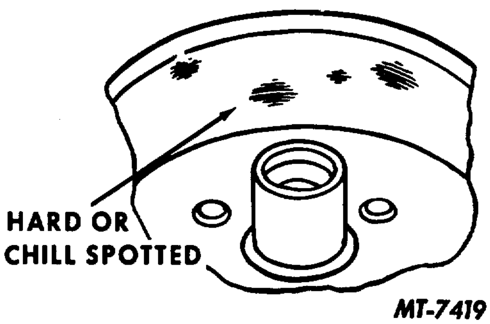

Fig. 1 Hard or Chill Spotted Drum

A barrel shaped drum (Fig. 2) results from overheating. If this barrel shaped condition is not corrected, the braking surface is reduced and uneven lining wear results.

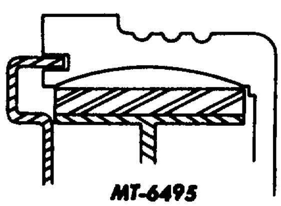

Fig. 2 Barrel Shaped Drum

Extreme pressure which over a period of time will create a bellmouthed drum as shown in Fig. 3. Brake linings on a bellmouthed brake drum will make contact only on the inner surface of the drum. In addition to cutting the braking surface to a minimum, it will also cause uneven and rapid wear.

Scored drums are the result of worn linings to the point where the drum-to-shoe contact is made or an accumulation of small steel particles imbed themselves in the brake lining (Fig. 4). The steel particles form a tough scale which is sometimes harder than the drum. As a result, deep grooves are formed in friction surface of drum.

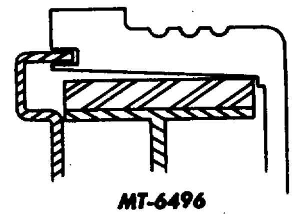

Fig. 3 Bellmouthed Drum

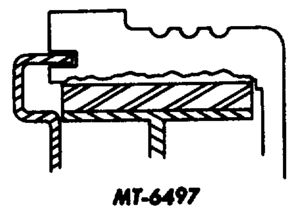

Fig. 4 Scored Drum

Brake drum scoring never improves but continually gets worse until both lining and brake drum are useless. Attempting to reline brakes without turning scored brake drum surface will quickly destroy new lining and make effective braking impossible.

Brake lining in an eccentric or out-of round drum cannot make full contact with the drum resulting in rapid or uneven lining wear and could even cause brakes to seize or chatter. Maximum allowable out-of-round or eccentricity should be .25 mm (.010 in.)

If inspection shows that any of the preceding conditions exist, brake drum should be either turned or replaced. To assure a balanced braking system, always install turned or new brake drums in pairs on each axle.

Any time a new brake drum is to be installed on a vehicle, the runout should be checked as follows. Place the new brake drum with hub and wheel assembled in lathe making certain drum is centered. Mount Dial Indicator SE-1848 on lathe and check runout about 12.7 mm (.5 in.) in from edge of drum as shown in Fig. 5. Runout must not exceed .25 mm (.010 in.).

Before assembling drum, hub and wheel, all parts must be clean and free of foreign matter.

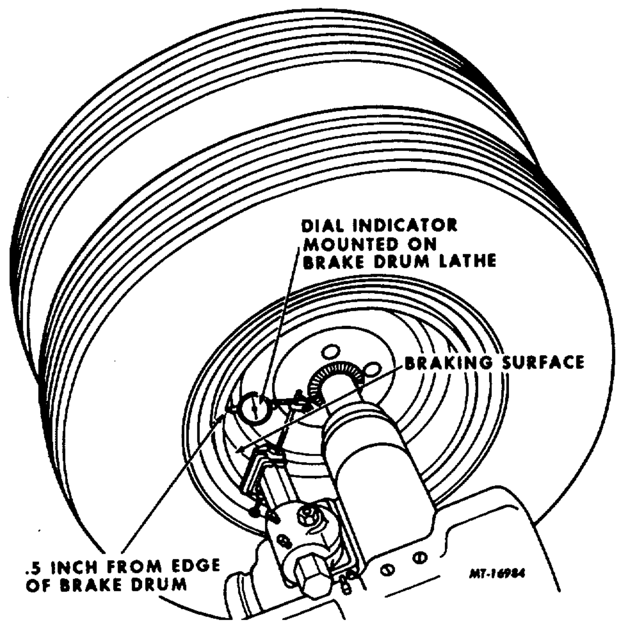

Fig 5 Checking Drum Runout on Brake Drum Lathe

REFINISHING BRAKE DRUMS

On brake drums manufactured after January 1, 1971, the maximum diameter to which drum can be worn is stamped or cast into drum. Drum should be discarded if worn beyond this limit.

Minor scores on brake drum can be removed with fine emery cloth or steel wool, but always clean emery or steel wool particles from drum after this operation. More heavily damaged or out-of-round drums should be ground or turned on brake drum lathe.

If depth of scoring, bellmouth or barrel shaping exceeds .13 mm (.005 in.), measured with micrometer across part or all of brake surface, drum should be refinished. Reboring or remachining limits must not be exceeded and no heat checks, cracks or bluing is evident.

Use a micrometer also to check for an out of-round drum. Make check by measuring drum brake surface diameter at various points, 45° apart around circumference. Eccentricity (out of-round) should not exceed .25 mm (.010 in.) on diameter.

Remember that each time brake drums are turned, less metal remains to absorb the heat developed by braking action. Brake drums containing less metal will operate at a higher temperature. As a result, brake fade, slow recovery and erratic wear will be more noticeable. Also, extremely high temperatures shorten lining life and cause heat checks and cracks (Fig. 6) to form on inner surface of drums. These conditions will become progressively worse until drums fail.

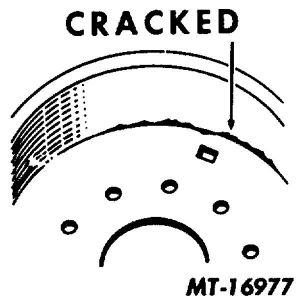

Fig 6 Cracked Drum

REMACHINING DRUMS

Brake drums that are otherwise in good condition can be turned in a lathe. However, it must be remembered that the recommended remachining or rebore limit for brake drums 355 mm (14 in.) diameter and under must not exceed 1.52 mm (.060 in.) diameter (total cut) and discarded at 2.29 mm (.090 in.) over original diameter.

Brake drums with a diameter over 355 mm (14") may not be increased more than 2.03 mm (.080") diameter (total cut) and discarded at 3.05 mm (.120") over normal diameter.

These dimensions hold true for both drums, which have maximum diameter identification, as well as drums which are not.

IMPORTANT

The dimension located on the drum is the discard dimension. Never remachine drums to maximum wear or discard diameter.

There are some drums which appear to have an exception to this; however, this is not true.

Example:

Original Diameter 11 1/32 or 11.030 inch
Maximum remachining limit 11.090 inch
Maximum wear or discard limit 11.120 inch

While an 11 inch diameter drum would be:

Original diameter	11.000 inch
Maximum Remachine Limit	11.060 inch
Maximum Wear or Discard Limit	11.090 inch

To recondition a brake drum in a lathe (Fig. 7), the drum must be mounted so that it is centered. Use proper size cone to provide accurate centering. Turn drum, taking only light cuts and remove just enough material to clean up drum. Then grind the finished surface if grinder is available or use emery cloth on a straight piece of wood and polish the drum friction surface.

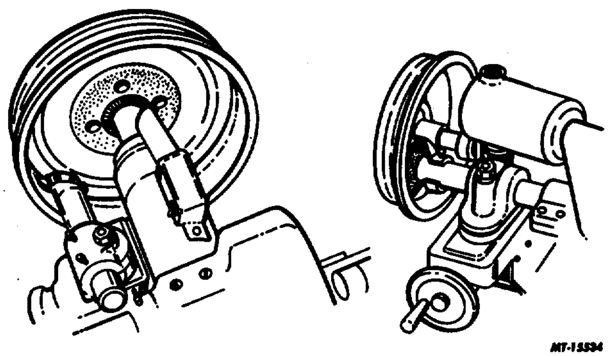

Fig. 7 Reconditioning Drum on Brake Drum Lathe

Brake drums should be cleaned thoroughly with a steam cleaner or hot water. Do not use a solvent which leaves an oily residue. If inspection shows the drums may be used without remachining, rub friction surface with fine emery cloth or sandpaper to remove any foreign deposits. If drum has been reconditioned, clean friction surface with fine emery cloth or sandpaper and wash. Next examine very carefully to see that no metal chips remain in drum.

INSPECTION OF SHOES

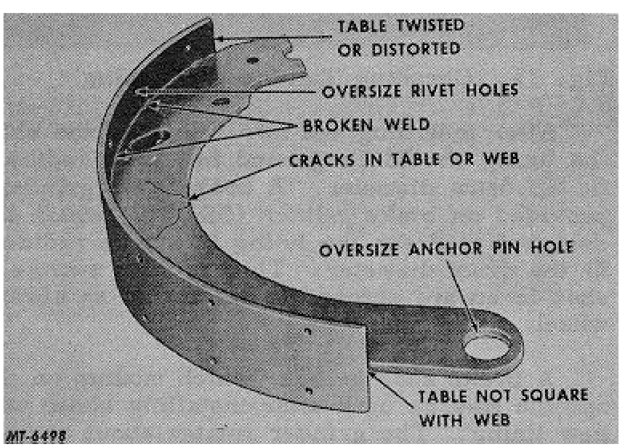

Figure 8 Defects to be looked for on Brake Shoe

When brake linings or blocks are worn to within .8 mm (1/32") on light duty vehicles or 1.6 mm (1/16") on medium and heavy duty trucks of rivets, the brake shoes must be removed and relined. It is recommended that all the brakes be relined at the same time since this will maintain balanced braking on the vehicle. If complete replacement is not desirable or necessary, be sure that all lining on one axle (both sides) is replaced at the same time.

Examine shoes carefully and discard those which have any defects as shown in Fig. 8.

REPLACING LINING ON SHOES

When removing worn lining from shoes, drill out old rivets if possible to prevent distorting shoe table. After the old linings are removed from the shoes, the shoes should be cleaned and buffed to remove all dirt and grease. Grease is one of the greatest deteriorating agents of lining.

Discard used lock washers after removing lining bolts. Use new washers when installing new lining. Replace bolts and nuts if signs of distortion or wear are present.

Do not handle new brake linings or relined shoes with greasy hands or allow linings to come in contact with mineral oil or grease.

Care should be used in selecting the correct thickness of lining for each brake shoe and drum. Usually the standard thickness will be used. If the drum has been turned or become worn, increasing the diameter, oversize lining may be required.

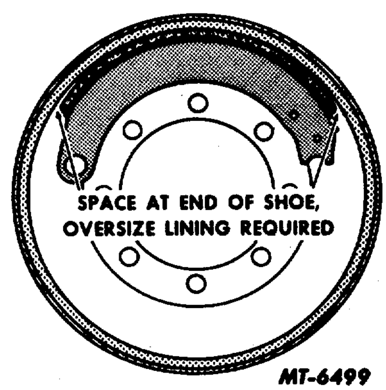

Fig 9 Lining Selected too thin

If it is not known how much material has been removed from the drum during the turning operation, the following simple test may be used to help select the proper lining.

Hold standard size lining snugly to the shoe, position it against the inner surface of the drum, forcing it into contact with the drum surface. The lining is now in the same position as during a brake application. If space is noted at the ends of the shoe (shoe can be rocked), oversize lining is required (Fig. 9). If lining selected is too thick, only the ends of the lining will contact the drum, see Fig. 10.

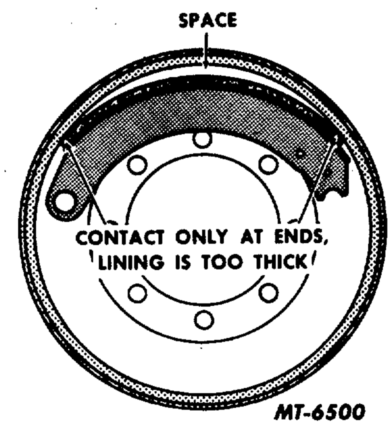

Fig. 10 Lining Selected Too Thick

The lining must be installed on the shoe so that it fits smoothly and evenly, contacting the shoe throughout the entire radius. If gaps occur between the rivets, difficulty will be met in adjusting the brakes in that "spongy" or rubbery pedal may occur which makes satisfactory brake application impossible.

To insure complete contact and avoid gaps between lining and shoe, secure lining to shoe with "C" clamp so that rivet or bolt holes are in alignment. Position "C" clamp as close to the holes as possible, clamping the lining firmly in place.

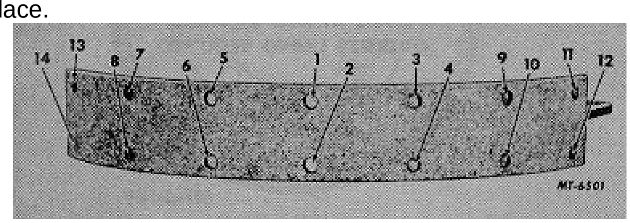

Fig. 11 Sequence in Securing Brake Lining to Shoe

When securing brake lining to shoes, start with the center rivet or bolt and work toward the ends as shown in Fig. 11. When securing brake block lining to shoe, use the sequence as shown in Fig. 12. Always use new lock washers when installing bolt on lining and tighten nuts to 89-111 Nm (20-25 ft. lbs.) torque.

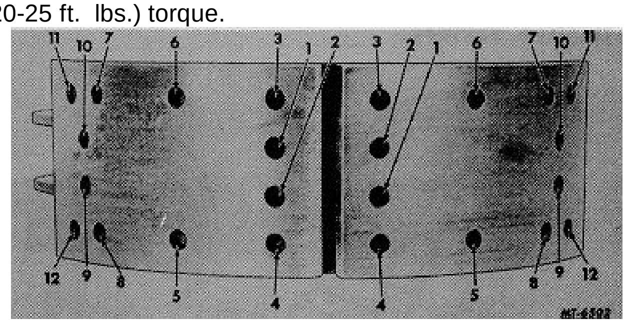

Fig. 12 Sequence in Securing Brake Block Lining to Shoe

When riveting linings, use a roll set to upset the rivets. A star set may split the tubular end of rivet and prevent a tight fit.

After the lining is installed, check tightness of lining to shoe, (Fig. 13) with a .203 mm (.008 in.) feeler gauge at any point along the arc of shoe and lining.

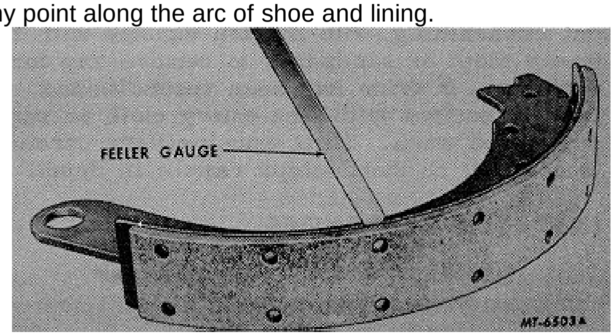

Fig. 13 Checking Tightness of Lining

After installing the new lining on the shoes, the lining should be ground in a true radius to fit the drum diameter. A brake shoe grinder is provided on brake reliner (SE-1272) which is designed to dress the lining in a true radius and fit the drum diameter. This grinder swings the shoe in an arc across the surface of an abrasive wheel.

A brake shoe grinder which mounts on the spindle may be used after installing shoes with new lining. The grinder rotates about on its axis and the grinding head equalizes the distance between the two brake shoe lining surfaces and drum surface. Grind new lining approximately 1.78 mm (.070 in.) less than the inside diameter of brake drum. Make certain that the brake is fully released before grinding.

DISC BRAKES

INSPECTION OF ROTORS

Inspect rotors for lateral runout, parallelism, (Fig. 14), cracks or burnt marks.

The disc brakes may have a slight amount of runout or wobble due to tolerances which are required in machining the large flat surfaces of the rotor.

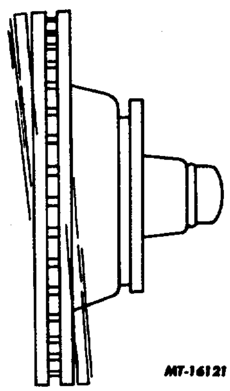

Fig. 14 Rotor Lateral Runout

Lateral runout is the movement of the rotor from side to side as it rotates. Excessive runout causes the rotor faces to knock back the disc pads and can result in chatter, excessive pedal travel, pumping or fighting pedal and vibration during the braking action. This condition can be due to a warped rotor, loose wheel bearing and, especially if symptoms develop immediately after sharp turns, deflection in steering or suspension.

Runout is measured by a dial indicator SE1848 (Fig. 15) set against the rotor surface approximately 25.4 mm (1 in.) from outer edge of rotor. Runout should not exceed .105 mm (.004 in.) Excessive runout will kick back the shoes, cause an increase in pedal travel needed to apply the brakes, and pedal vibration will be felt during applications. It also contributes to "grab", "pull" and noise problems.

Do not overlook wheel bearing adjustment. Wheel bearings which are loose can cause excessive runout indication.

If rotor runout exceeds .105 mm (.004 in.) either refacing or new rotor assembly will be required.

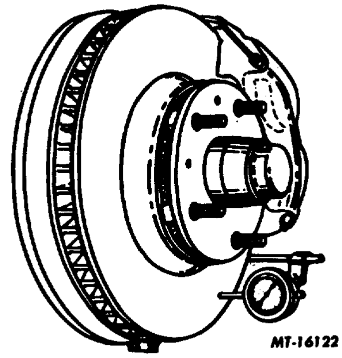

Fig. 15 Dial Indicator Installation

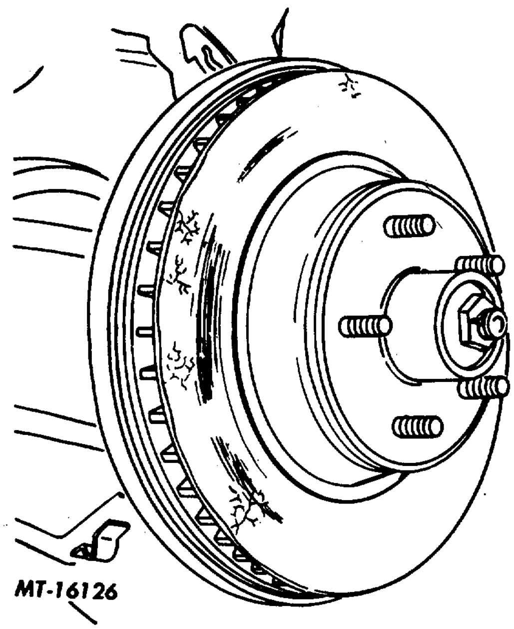

Fig. 16 Rotor Not Satisfactory for Service

Rotors should be inspected for parallelism. Parallelism refers to the amount of variation in thickness' of the rotor (Fig. 17).

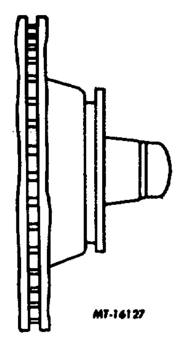

Fig. 17 Rotor Parallelism or Variation In Thickness

Excessive variation can cause pedal vibration or fight, front end vibrations and possible "grab" during the braking action--a condition comparable to an out-of-round brake drum.

To make the thickness variation or parallelism check on the rotor at the same time the runout is being checked, use a micrometer to check the variation in thickness of the rotor at four equal points around the rotor (Fig. 18).

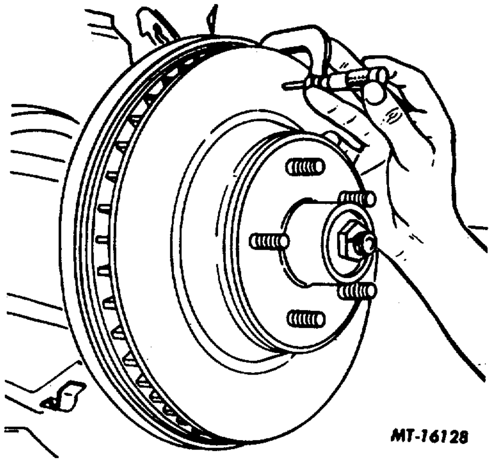

Fig. 18 Checking Rotor with Micrometer

If the thickness varies more than .0127 mm (.0005 in.) refacing of the rotor will be required; or replace it if the rotor will not true up before minimum allowable thickness is obtained.

REMACHINING ROTORS

The rotors can be remachined to provide a new, smooth braking surface (Fig. 19). If the rotor will not true up before minimum allowable thickness (see Specifications) is obtained, it must be replaced.

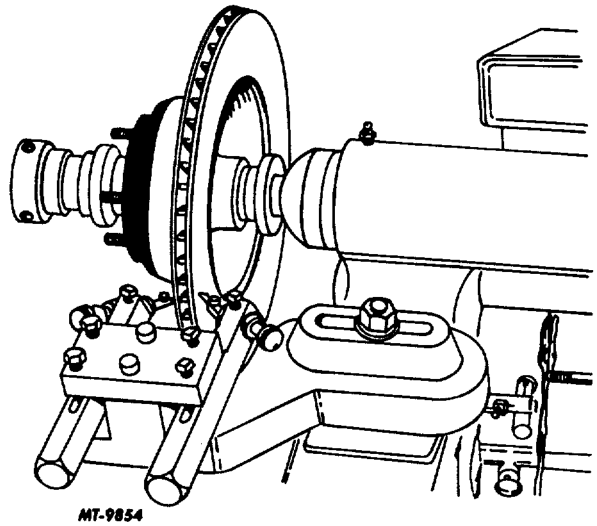

Fig. 19 Correct Method of Refacing Rotor

IMPORTANT

Rotors are identified by the minimum allowable thickness they can be used. Any rotor thinner than the minimum dimension must not be used.

Removal of too much metal would cause overheating and, more important, a thin rotor could permit the seals in the cylinder to "uncover".

To uncover a seal in the cylinder would result in loss of hydraulic brake fluid. An uncovered seal would not be apparent at first, but as the pads wear, more travel of the cylinder would be required; and since the rotor would be too thin, the seals could leak.

ROTOR REMACHINING SPECIFICATIONS						
Brake Group Code No	Rotor Original Thickness (New)		Minimum Allowable Remachining Thickness		Minimum Use- able Thickness	
	in.	mm .	in	mm.	in	mm
04135	1.240	31.50	1.195	30.353	1.180	29.97
04138	1.180	29.97	1.135	28.429	1.120	28.45
04139	1.180	29.97	1.135	28.429	1.120	28.45
04140	1.180	29.97	1.135	28.429	1.120	28.45

The terms micrometres, micro-inch or surface finish or smoothness are different from runout and parallelism. These terms refer to degree of how smooth the flat surface is. However, if good, sharp tools and proper cutting feed and speed are used when remachining the rotor, you should be within the .381-2.032 micrometres (15-80 micro-inch) tolerances.

INSPECTION OF PADS

The disc brake pads or shoes can be inspected for wear on the vehicle. It is normal for the inboard lining to show more wear than the out board lining. Always install new pads assemblies in complete axle sets at both wheels on an axle.

Since lining on disc brakes will be bonded (code 04135) and riveted (codes 04138, 04139 & 04140) the useable thicknesses will be different.

Pads with bonded lining (code 04135) must be replaced when lining is worn to .7937 mm (1/32 in.) or less.

Pads with riveted lining (codes 04138, 04139 & 04140) must be replaced when lining is worn to 3.1750-4.7625 mm (1/8 to 3/16 in.) or less.

It is suggested that the pads be replaced whenever they are removed for an inspection or for any other service and they are found to be worn to 2.778 mm (7/64 in.) from shoe surface with bonded material, or from rivet heads to brake lining surface.

DRUM REPLACEMENT

Different assembly methods are used to hold brake drums in their piloted position on hub while wheels are dismounted.

LIGHT DUTY VEHICLES

Drums which are mounted against wheel flange on light duty vehicles are secured to studs either with speed nut fasteners or by swagging the piloting shoulder of stud to drum. To replace an original drum proceed as follows:

Where threaded fasteners (Fig. 20) are used simply unthread speed nuts and lift drum from flange.

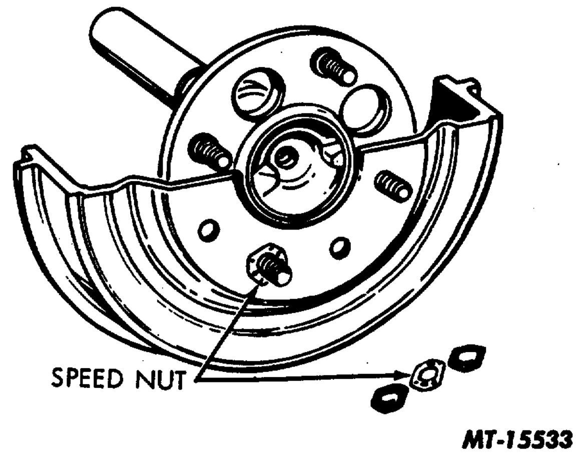

Fig. 20 Threaded Fastener Type Drum Mounting

If swaged stud mounting (Fig. 21) is used, chuck a stud cutter in an electric drill, align cutter over each stud and cut away the swaged material. Separate drum from hub and discard drum.

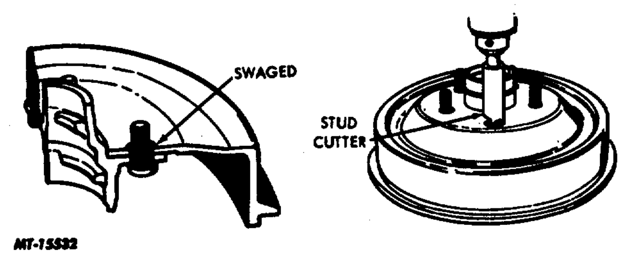

Fig. 21 Swaged Stud Type Drum Mounting

MEDIUM AND HEAVY DUTY VEHICLES

Drum replacement on medium and heavy duty vehicles requires the removal of nuts from bolts securing hub and drum together. The hub and drum can then be separated.

MOUNTING NEW DRUM TO HUB

Clean exposed hub or axle mounting flange with wire brush or coarse file. Use straight edge across surface of flange to make sure it is not bent. Remove excess paint from edge of drum hub hole and wash rust preventive sealer from drum with solvent.

Before installing a replacement drum wash the drum thoroughly with high grade denatured alcohol to remove <u>all</u> protective grease, oil or other residue. <u>DO NOT use gasoline, mineral spirits or oil</u>.

In most situations replacement drum, whether for previously speed nut retained type or swaged-on type, can be secured with the speed nuts (Fig. 20). However, if swaging is desired, recommended procedure is as follows.

1. Obtain appropriate size peen punch (SE-855-7 for 1/2" stud; SE-1103 for 9/16" stud).

2. Position new drum over studs in hub and temporarily fasten it against hub flange by placing oversize washer over three studs and tightening wheel nuts against them.

3. Using peen punch over stud, align stud and drum in press with stud properly supported. Press the stud shoulder in place against drum.

4. Repeat pressing operation on next open stud.

5. Reposition washers and repeat pressing operation until all studs have been swaged.

6. To assure hub and drum concentricity, take a light machining cut on drum in drum lathe.

When assemblying hub and drum together on medium and heavy duty vehicles, pay special attention to the bolt heads so that they are ,aligned properly in the drum (Fig. 22).

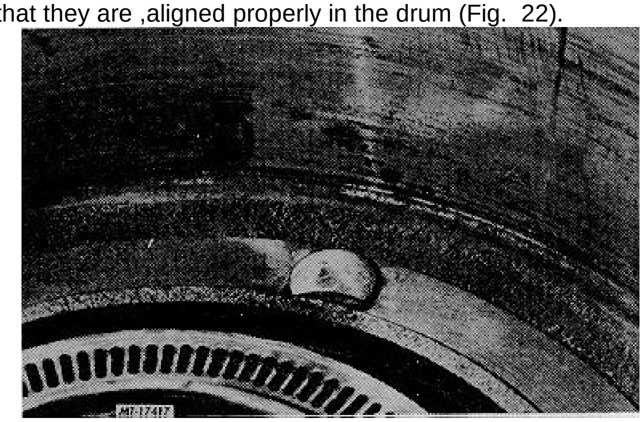

Fig. 22 Drum Bolt Alignment

Refer to Torque Chart for Bolt Tightening sequence and proper torque values of hub to drum mounting bolts as well as rim and wheel mountings.

TORQUE CHART

HUB TO DRUM

Nominal Size		TORQUE N.m	Ft Lbs
1/2"		95 - 115	70 - 85
9/16"		144 - 170	105 - 125
5/8"		194 - 237	145 - 175
3/4"		346 - 407	250 - 300

Tighten hub-to-drum bolts alternately, across from 'each other.

RIM AND WHEEL MOUNTINGS

	Cast Wheels (Rim Clamp)		
5/8"		217 - 237	160 - 157
3/4"		237 - 271	175 - 200
	Disc Wheels - Light Truck		
5/8"	In-Out Coined Mounting	237 - 304	175 - 225
5/8"	Flanged Nut Mounting	373 - 439	275 - 325
	Disc Wheels - Standard Mounting		
11/16"	Flanged Nut Mounting	475 - 542	350 - 400
3/4"	Standard Square Cap Nut Mounting (13/16" Across Flats)	610 - 678	450 - 500
3/4"	Standard Hex Cap Nut Mounting (1-1/2" Across Flats)	610 - 678	450 - 500
1-1/8"	Standard Hex Cap Nut Mounting (1-1/2" Across Flats)	610 - 678	450 - 500
	Disc Wheels - Heavy Duty Mounting		
1-1/8'	HD Hex Cap Nut Mounting (1-3/4" Across Flats)	882 - 949	650 - 700
15/16"	HD Square Cap Nut Mounting (15/16" Across Flats)	1017 - 1220	750 - 900
1-5/16"	HD Hex Cap Nut Mounting (1-3/4" Across Flats)	1017 - 1220	750 - 900

PARKING BRAKE ADJUSTMENT AND SERVICING

ENCLOSED DRUM - TWO SHOE (DCM)

CODES 04009,04014,04036,04043

INDEX

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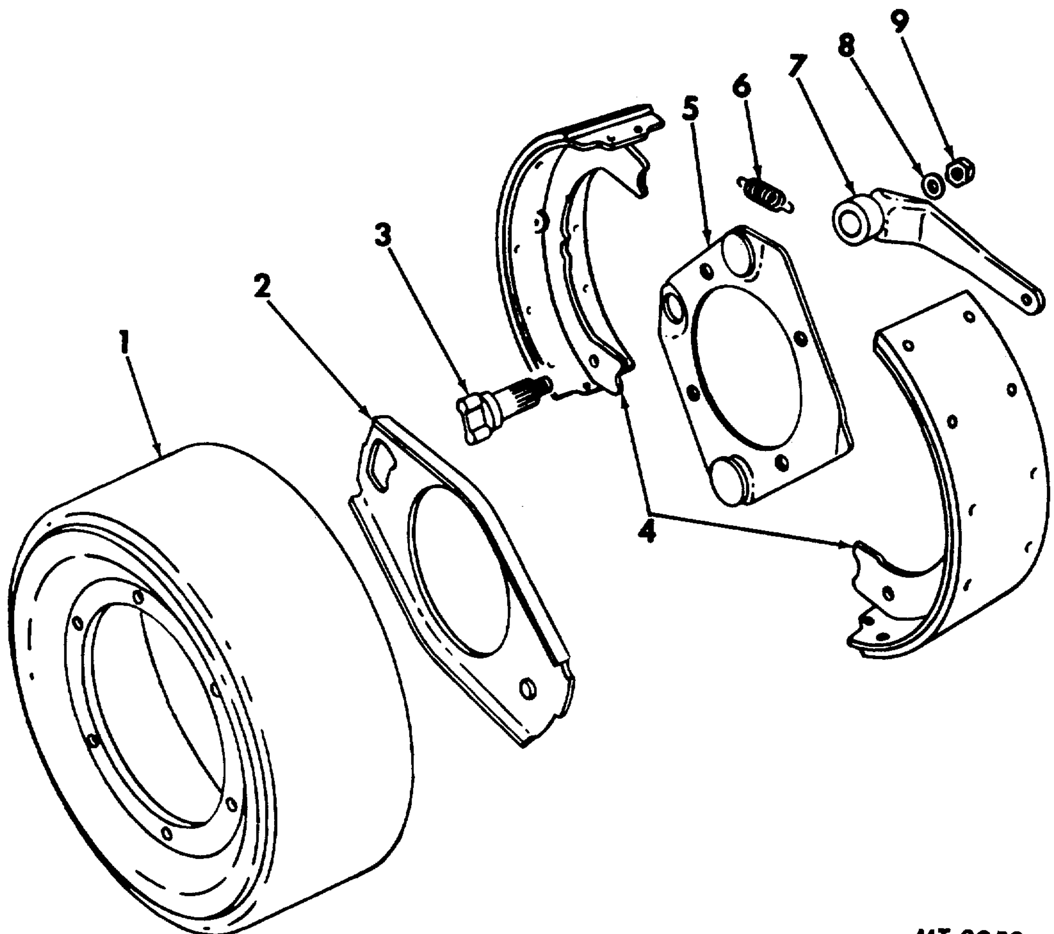

Fig. 1 DCM Parking Brake
(Exploded View)

Legend for Fig. 1

Key	Description	Key	Description
1.	DRUM, brake	6.	SPRING, return
2.	STRUT	7.	LEVER, operating
3.	CAM-SHAFT	8.	WASHER
4.	SHOE, brake	9.	NUT, lock
5.	PLATE, backing		

DESCRIPTION

The Model DCM parking brake features a balanced design which provides improved mechanical efficiency and equally divides the input force between both shoes. This extends lining life and reduces transmission rear bearing stress.

The DCM brake operates both as a parking and an emergency brake. Equal torque output is exerted in either direction of vehicle travel with minimum input force and stroke. Stops are controlled with maximum protection against damage to vehicle chassis components. Cam design applies brake with either direction of lever movement.

DISASSEMBLY

There are only nine (9) parts in the DCM parking brake. The following instructions are given as an aid in disassembling and reassembling this unit.

Refer to Fig. 1 for parts identification during "Disassembly" and "Reassembly".

Disconnect end yoke pin connecting control rod or cable, whichever is applicable, to brake operating lever (7).

Remove brake drum mounting bolts and pull drum (1) free of brake or drop prop-shaft, whichever is necessary. Pull one shoe off the anchor pin sufficiently to allow the strut (2) to be pulled free of the retaining lance on the shoe table. Lift the strut (2) away from the cam shaft (3) and pull it free from the retaining lance on the other shoe.

Remove both shoe return springs (6). Brake shoes (4) can now be removed by lifting them off the anchor pins.

The backing plate (5) may be removed after the four mounting bolts are removed. These bolts are shoulder bolts having a thin head to provide clearance for the strut (2).

To remove operating lever (7) from camshaft (3) unscrew lock-nut (9) from cam-shaft and pull lever free. Cam-shaft assembly may then be pulled out of back plate (5).

CLEANING, INSPECTION AND REPAIR

If linings are oil soaked or greasy, replace with new lining preparatory to replacement. If linings are not greasy, brush dirt from them with a wire brush; then wipe off with a cloth. Wash all parts other than brake lining in a clean cleaning solvent and dry with compressed air.

Inspect brake shoe linings for wear, cracks or breakage. If linings are worn to near rivets they must be replaced. Inspect brake drum for deep scores or damage, and if damaged, replace.

If linings are worn too near rivet heads, or are otherwise damaged, punch out old rivets and remove linings from brake shoes. Install new linings tightly against brake shoes using new rivets. Umbrella type rivets may be used for increased lining life. Compress rivets tightly using riveting equipment. If any other parts of the brake assembly show signs of wear or damage, replace as required.

REASSEMBLY

Reassembly of the parking brake unit is essentially the reverse of disassembly, however, a few suggestions mentioned below may prove helpful.

When installing the operating lever (7) on the cam-shaft (3), the cam must be in the neutral position. Position the operating lever on the cam-shaft so that it will connect with the linkage.

The cam-shaft lock-nut (9) should be tightened sufficiently to prevent the assembly from rocking, but still allow it to turn freely.

It is important that the brake shoe return springs (6) be installed on the lever side of the brake shoes (4) as they act as both a hold down and return spring.

LUBRICATION

The only lubrication required on the parking brake unit is to apply a thin coating of grease to all bearing surfaces.

DO NOT overlubricate brake parts.

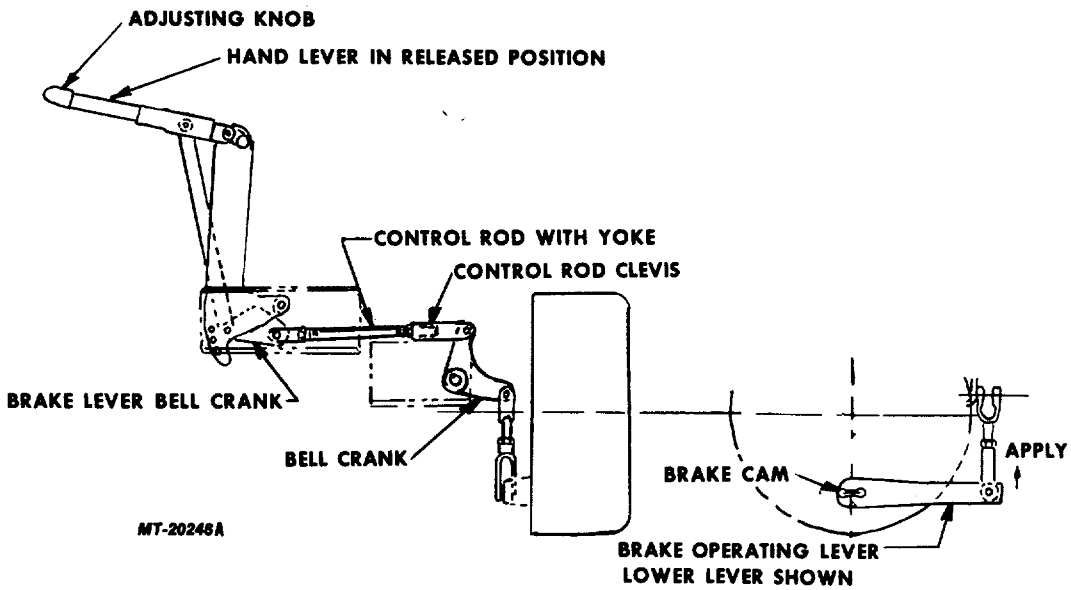

Fig. 2 Parking Brake Adjustment in the Orscheln Hand Lever

ADJUSTMENT

Adjustment of brake will be required when replacement of lining, shoes or drum is required.

Refer to Figure 2 pertaining to the nomenclature in the following adjustment procedure.

1. Block wheels to prevent vehicle from moving.
2. Position parking brake hand lever in released position (forward).
3. Assemble control rod with yoke to brake lever bell crank if disconnected.
4. Move brake operating lever in apply direction to a position where contact is made with the brake cam but without any shoe movement. This will remove excess clearance in mechanism (approximately 6.35 to 9.53 mm, 1/4" to 3/8", free play at lever).
5. Adjust clevis until hole in clevis aligns with mating hole in bell crank.
6. Assemble clevis to bell crank and tighten clevis locknut.
7. If vehicle is equipped with Orscheln parking brake lever (over-center type), turn adjusting knob on end of hand lever until a force of 41 kg (90 lbs) is attained to apply the parking brake.

The Orscheln (parking) brake lever is the over-center locking type. It is tightened (while released) by turning the adjusting knob clockwise. When properly adjusted, it pulls over center with a distinct click.

PARKING BRAKE BURNISHING (W/Orscheln Lever)

The following burnishing procedure is required to be performed on new vehicles or whenever the parking brake lining and/or drum is replaced.

<u>Vehicles with Orscheln Lever</u>

1 The vehicle must be loaded near rated GVW.

2. Release parking brake, turn adjusting knob until a force is obtained to apply the brake (over-center position of the lever) which will result in the vehicle making a somewhat lighter than normal stop (3-5 ft per second) without wheel lockup.
3. Make ten (10) stops from 16 km/h (10 mph) on a dry hard surface road using only parking brake to stop vehicle.
4. After each stop, release parking brake and drive vehicle at 32 km/h (20 mph) for 4 km (2.5 miles) to cool the brake.
5. Readjust parking brake linkage (between hand lever and brake assembly) and hand lever adjusting knob to suit operational requirement considering load and road grades for vehicle operation.

COOLING SYSTEM

GENERAL

CONTENTS

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INTRODUCTION

The purpose of the cooling system is to maintain the most efficient operating temperature of an engine without causing damage to the components. Approximately 1/3 of the energy produced when fuel burns is converted into power by the engine. The other 2/3 of the energy must be disposed of by the exhaust system and the cooling system or engine damage will result.

Basically, the circulation of coolant through the cooling system relies upon the water pump. The water pump draws coolant from the radiator and forces it through the water jackets and cylinder heads, where it accumulates heat. The coolant then flows to the upper radiator tank and down through the radiator where it is cooled by air drawn through the radiator fins.

The damages or effects caused by cooling system neglect are usually gradual and are therefore often overlooked. This manual provides the reader basic component knowledge, maintenance procedures, service intervals, trouble-shooting and coolant and inhibitor recommendations.

COOLANT

The selection and maintenance of the engine coolant is as important to long engine life as the selection and changing of the engine lubricating oil and oil filters. The following section provides IH's recommendations for selecting the engine coolant and maintenance of the coolant inhibitors.

A. COOLANT SELECTION

IH engines will operate successfully with a water/anti-freeze mixture or inhibited water as the coolant. Never use water alone as it allows rust, scale deposits and corrosion to occur within the engine.

1 <u>Water</u>

Water used in the cooling system must meet the following standards:

a. Total Hardness-not to exceed 170 parts per million (10 grains/gallon maximum) to prevent scale deposits. Water containing dissolved magnesium and calcium (the usual reason for water hardness) above the specified amount will cause scale deposits to develop in the engine.

b. Chlorides-not to exceed 40 parts per million (2.5 grains/gallon maximum) to prevent corrosion.

c. Sulfates-not to exceed 100 parts per million (5.8 grains/gallon maximum) to prevent corrosion.

d. Dissolved Solids-not to exceed 340 parts per million (20 grains/gallon maximum) to minimize sludge deposits, scale deposits, corrosion or a combination of these.

If any of the above requirements cannot be met, use distilled, de-ionized or de-mineralized water. Water samples can be tested by water treatment laboratories to determine if local water supplies meet these standards. "Softened" water that is prepared using common salt (sodium chloride) contains excessive amounts of chlorides which will interfere with the water softening capabilities of coolant filters using ion-exchange resins.

2. <u>Anti-Freeze</u>

IH Anti-Freeze and Coolant contains all necessary inhibitors and has been tested for use in IH products. It is an ethylene glycol type anti-freeze and compatible with chromate and non-chromate type coolant filters.

Several factors should be considered for successful operation when using ethylene glycol type anti-freezes.

a. The boiling point of ethylene glycol anti-freeze solutions is higher than plain water but their ability to transfer heat is less. Therefore in hot weather, coolant temperatures will run higher than systems containing plain water. This also holds true for engine lubricating oil and transmission oil temperatures where oil to water coolers are used.

b. An anti-freeze concentration greater than 68% will adversely affect freeze protection and heat transfer rates. Anti-freeze concentrations between 68 and 100% actually have a higher freezing point than a 68% anti-freeze concentration. Due to the higher freezing point and reduced heat transfer rates, concentrations greater than 68% should not be used. It is also important to remember that anti-freeze may retain its freeze protection for more than one season but coolant conditions must be added to maintain corrosion protection. The following chart illustrates the freezing point of anti-freeze according to its percentage

Freezing Point C (F)	Percentage Anti-Freeze Concentration by Volume	Specific Gravity @ 16 deg. C (60 deg. F)
0 deg. (+32)	0	1.000
-7 deg. (+20)	15	1.025
-12 deg. (+10)	25	1.040
-18 deg. (0)	33	1.053
-23 deg. (-10)	40	1.062
-29 deg. (-20)	45	1.07n
-34 deg. (-30)	48	1.074
-40 deg. (-40)	53	1.080
-46 deg. (-50)	56	1.088
-51 deg. (-60)	59	1.092
-57 deg. (-70)	62	1.095
-63 deg. (-80)	65	1.097
-68 deg. (-90)	67	1.098
-69 deg. (-92)	68	
NOTE: As shown below, a further increase in anti-freeze volume increases the freezing point.		
-63 deg. (-80)	71	1.100
-57 deg. (-70)	75	1.106
-51 deg. (-60)	79	1.110
-46 deg. (-50)	83	1.113
-40 deg. (-40)	87	1.117
-34 deg. (-30)	91	1.119
-34 deg. (-30)	95	1.123
-22 deg. (- 8)	100	1.127

of concentration.

c. Anti-freeze containing sealer or antileak additives should not be used in IH engines. These additives may cause plugging problems in the cooling system and restrict coolant flow.

d. Anti-freeze formulated with methoxy propanol or propolene glycol is not recommended for use in IH engines due to a reaction with engine internal seals, coolant hoses and potential fire hazard due to lower flash points than ethylene glycol type anti-freeze.

3. Coolant Conditioners

All cooling system inhibitors, including those in anti-freeze solutions, become depleted through normal operation. If the inhibitors in antifreeze are allowed to become depleted, the antifreeze becomes corrosive and attacks and coats the metallic surfaces of the cooling system. This coating reduces the heat transfer. Cooling system conditioners which contain these inhibitors must be added to maintain corrosion protection. These conditioners are available as a liquid or in a coolant filter.

The two types of recommended conditioners are as follows:

a. IH coolant conditioner is a complete inhibitor system, of a non-chromate type, which provides corrosion protection, pH control for maintaining an acid-free coolant and water softening to prevent the formation of mineral deposits. It is compatible with both water and IH anti-freeze and coolant.

b. Coolant filters which are coolant conditioners of the universal borate type are approved for use on IH truck engines. These borate type spin-on filters are compatible with IH anti-freeze and coolant and with IH cooling conditioner water solutions.

Soluble oil is not recommended for use on IH truck engines as its use will reduce heat transfer. There are no miracle additives that will increase heat transfer or prevent overheating. Conditioned water is still the best coolant.

COOLANT SYSTEM COMPONENTS

The following is a list of the major components making up the cooling system. Points of inspection of each component are covered in general terms.

A. RADIATOR

This component is one of the most important as this is where most of the heat of the system is dissipated. The radiator is made up -of the following parts:

1. Top and Bottom Tank-look for leaks, particularly where tank is soldered to core. Vibration and pulsation from pressure can fatigue soldered seams.

2. Filler Neck-the sealing seat must be smooth and clean. Cams on filler neck must not be bent or worn so as to allow loose fitting cap. Ensure overflow tube is not plugged.

3. Tubes-because these are very small, they can become clogged, or partially so, by rust and scale. The general condition of the cooling system and operating temperature are indications as to the cleanliness of the tubes. Another good test is to feel the core for cold spots.

4. Fins-these thin metal sheets radiate or pass off the heat picked up by the tubes.. They should be kept free of bugs, leaves, straw and other interference to allow free passage of air. Bent fins should be straightened for maximum heat dissipation.

5. Radiator Cap-(Pressure-Sealing Type). Its purpose is to hold the cooling system under a slight pressure, increasing the boiling point of the cooling solution and preventing loss of the solution due to evaporation and overflow.

   The cap (Fig. 1) has a spring-loaded valve, the seat of which is below the overflow pipe in the filler neck. This prevents the escape of air or liquid while the cap is in position. When the cooling system pressure reaches a predetermined point, the cap valve opens and will again close when the pressure drops below the predetermined point.

   When removing the pressure type cap from the radiator, perform the operation in two steps. Loosen the cap to its first notch to raise the valve from the gasket and release the pressure through the overflow pipe. In the first stage position of the cap it should be possible to depress the cap approximately 3 mm (1/8"). The depression can be adjusted

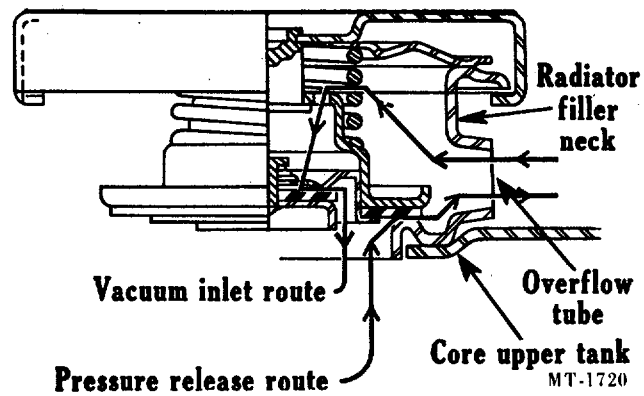


Fig. 1 Radiator Cap (Pressure Type)

   by bending the prongs on the cap. Care should be taken when bending the prongs to ensure the cap is not too loose as this would prevent proper sealing. Then slowly continue to turn cap counterclockwise until you can remove it.

NOTE: When removing the cap, loosen it slowly and then pause to allow the pressure to bleed. This will avoid possible burning by hot water or steam.

6. Reservoir System-(if so equipped). The reservoir installation consists of a simple, plastic reservoir mounted near the radiator cap, coolant lines and a special radiator cap (Fig. 2). Once the radiator cap is installed, it should not be removed except when the cooling system is cold and for refilling after the entire system is drained. With this system, coolant make-up originates from the reservoir. Coolant overflowing from the radiator enters the reservoir to be conserved until drawn back into the cooling system (engine and radiator) when it cools down. The reservoir installation provides a means of removing air from the cooling system and keeping the coolant level at a maximum fill condition.

The following illustrations explain the operation of this system under conditions that exist in the cooling system.

Fig. 3: Initial condition of the system. The reservoir is filled to the "FULL" line. The radiator has been filled to the filler neck. Engine has started and as system begins to warm up, expanding air in the system is expelled through the open vacuum valve and out the radiator overflow tube into the reservoir where it escapes at the reservoir overflow outlet.

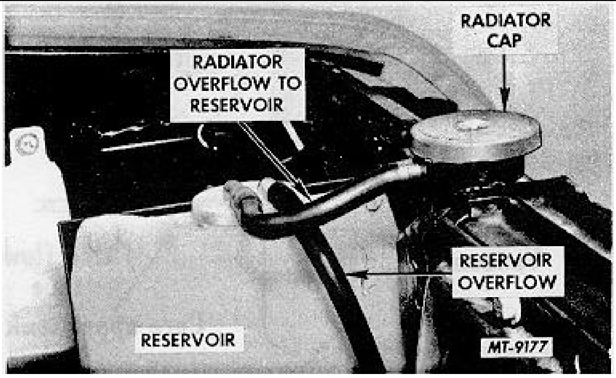


Fig. 2 Coolant System Reservoir Installation

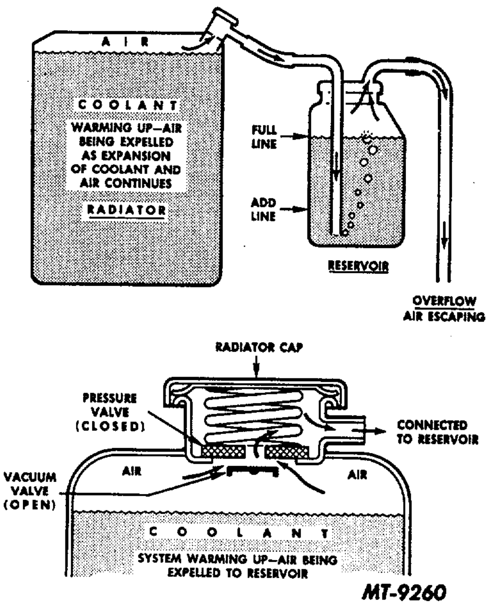


Fig. 3 System Warming Up

Fig. 4: As the cooling system approaches normal operating temperature, the vacuum valve in the radiator cap closes, the cooling system pressure rises to pressure controlled by the cap pressure valve setting and no further air or coolant' escapes the cooling system.

Fig. 5: In the event the cooling system becomes overheated to the extent that pressure rises above the established setting (controlled by the pressure valve in the radiator cap), excess coolant will be expelled through the radiator overflow into the reservoir. Coolant discharged from the radiator in excess of the reservoir capacity would overflow from the reservoir. Under this circumstance the engine should be shut down, allowed to cool and the cause of the overheating corrected.

Fig. 6: After the initial cooling system fill

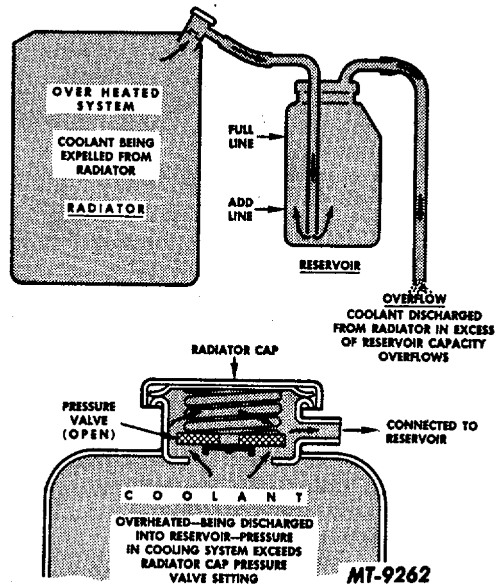


Fig. 4 Normal Operating Condition

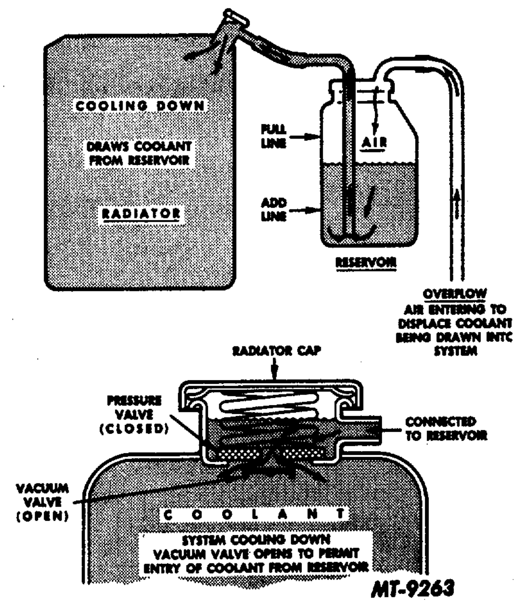


Fig. 5 Overheated System

and the engine and cooling system have been operated to normal temperature and the engine is then shut off, the system in cooling down will draw coolant from the reservoir to replace air expelled from the system during the warm-up period. As the warm-up and cool-down cycle is repeated during operation of the vehicle, air accumulated in the system will gradually be expelled until a maximum fill condition is reached in the cooling system. The coolant level in the reservoir will rise and fall between the "ADD" and "FULL" lines.

NOTE: Any make-up coolant is to be added to the reservoir, since the radiator cap should not normally be removed.

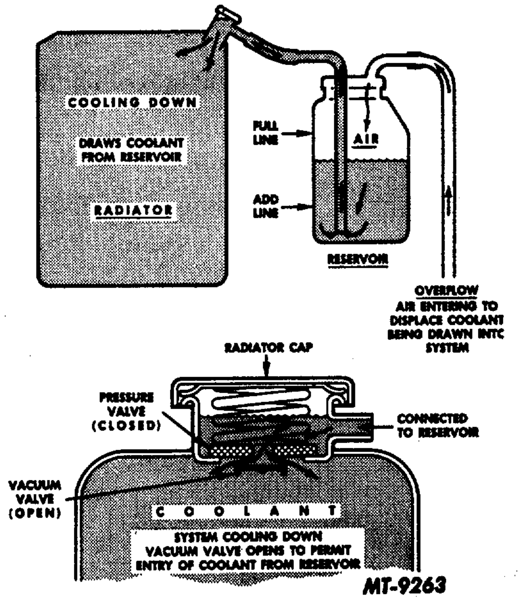


Fig. 6 System Cooling Down

For special filling of this type cooling system, refer to MAINTENANCE Section in this manual.

B. ENGINE WATER JACKET

The water jacket permits coolant to be circulated around the cylinder walls, combustion chamber and valve assemblies. Some of the coolant passages are small and can become clogged if the cooling system does not receive the proper maintenance.

Close inspection should be given to the following areas:

1. Core Plugs-These are sometimes mistakenly termed "freeze plugs". The plugs are present due to engine block casting methods and not to protect against expansion from freezing. Core plugs that show signs of leaking or rusting through should be replaced. Refer to respective Engine Manual for core plug replacement.

2. Drain Plugs-The drain plugs located in the water jacket should receive seasonal care and kept free of rust and scale.

3. Gaskets-Must be in good condition to prevent both internal and external leaks. If there are external leaks around gaskets, there may also be internal leaks into the engine. Proper tightening of the head bolts with a torque wrench is essential for preventing leaks around the head gasket.

C. WATER PUMP

The water pump circulates the coolant through the cooling system. It should be checked carefully for leaks and proper lubrication and if leaking or in bad condition, it should be rebuilt or replaced promptly. For water pump rebuild, refer to respective Engine Manual.

D. FAN AND BELTS

The fan should be checked for loose or bent blades. A loose blade could work free during operation and cause damage. A bent blade will reduce the fan's efficiency.

Fan belts must be adjusted for proper tension. Refer to respecting Engine Manual or Operator's Manual for proper belt tension.

E. THERMOSTAT

Thermostats provide a means of retarding or restricting the circulation of coolant during engine warm-up. An inoperative thermostat can cause engine overheating and a subsequent loss of coolant. Thermostats can be tested by submerging in hot water and noting the opening and closing temperature. Use an accurate high temperature thermometer for making this test. Refer to Engine Manual for proper opening and closing temperatures.

F. HOSES AND CLAMPS

Hoses and clamps should be checked regularly as they are often the source of hidden trouble. Hoses may appear in good condition on the outside but the inside may be partially deteriorated. If there are any doubts about a hose doing its job, replacement should be made. Clamps should be inspected to ensure they are strong enough to hold a tight connection.

G. TRANSMISSION OIL COOLER

On some trucks equipped with automatic or semi-automatic transmissions, the transmission oil is circulated through an oil cooler or heat exchanger. The function of this unit is to control transmission temperature and thereby keep oil in the proper temperature range for its most efficient lubrication. This is accomplished by using engine heat to bring transmission temperature up or by using the cooling system to dissipate any excessive heat generated within the transmission.

Leakage due to corrosion or an improper seal will cause contamination between the cooling system and transmission.

EFFECTS OF COOLING SYSTEM NEGLECT

A neglected cooling system can lead to inefficient engine operation, either directly or indirectly. Most of the problems may be traced to overheating; however, an engine that is running too cold can be just as troublesome.

Overheating may lead to troubles such as the following:

1. Burned valves.
2. Pinging or knocking.
3. Vapor lock.
4. Poor lubrication-increased engine wear.
5. Sticking valve and valve lifters.
6. Short spark plug life.
7. Engine hot spots.
8. Need for higher octane fuel.

Overcooling often results in the following:

1. Excessive fuel consumption.
2. Sludge formation in crankcase.
3. Corrosive acids found in crankcase.

COOLING SYSTEM MAINTENANCE

A. COOLING SYSTEM INHIBITORS

1. <u>Systems With Coolant Filters</u>
   Properly inhibited coolant will keep the engine free of rust, scale deposits and corrosion. New vehicles are delivered with IH anti-freeze and coolant and may be equipped with a coolant filter. The coolant filter should be changed according to the intervals contained in the respective Operator's Manuals.

2. <u>Systems Without Coolant Filters</u>

   Vehicles without a cooling system must have the coolant inhibitors replenished by adding IH cooling conditioner. The conditioner should be added as recommended in the respective Operator's Manuals.

   A complete drain, flush and refill with water and conditioner, or IH anti-freeze and coolant is recommended once a year. This includes all vehicles irregardless of yearly mileage.

   If the cooling system has been permitted to become rusty or dirty, use IH cooling system cleaner and neutralizer carefully following cleaning recommendations on the container.

3. <u>Coolant Testing for Inhibitor Strength</u>

   Coolant should be checked for reserve alkalinity using test strips available from various sources at each oil change. Indication of a low alkalinity condition necessitates a need to add IH cooling conditioner, change cooling filter or to drain contaminated coolant.

B. DRAINING THE COOLING SYSTEM

When the cooling system of a vehicle is drained, some coolant is likely to be retained in the pockets of the cooling system. This is especially true in engines equipped with oil coolers or heat exchangers having a tube bundle. If only water with cooling conditioner is used and these engines are drained and then exposed to freezing temperatures, the water conditioner will freeze and possibly rupture one or more of the tubes. The resulting leak will be difficult to locate and could eventually damage the engine by mixing the cooling with the engine oil.

To avoid damage, take one or the following precautions when draining for shipment or storage in freezing temperature:

a. Fill the cooling system with antifreeze solution, operate engine until the thermostat opens or until circulation is observed in the radiator circuit, then drain.

b. If conditioned water is used, drain the engine, then blow out the residual solution in the cooler tubes with compressed air through one of the drain cocks or plugs on the cooler.

C. CLEANING THE COOLING SYSTEM

1. Coolant shut-off cocks to heaters and other accessories should be open to allow complete circulation during cleaning, flushing and draining. Run the engine with the radiator covered if necessary until temperature is up to operating range 72-84 degs. C (160-180 degs. F). Stop engine, remove radiator cap carefully (if so equipped) and drain system by opening drain cocks on radiator and crankcase.

2. Allow engine to cool, close drain cocks and pour cleaning compound into radiator according to directions. Fill system with water.

3. Place a clean drain pan to catch over-flow and use to maintain level in radiator.

Avoid spilling solution on vehicle paint.

4. Replace radiator cap (if so equipped) and run engine at moderate speed, covering radiator if necessary, so the radiator reaches a temperature of 84 degs. C (180 degs. F) or above but does not reach the boiling point. Allow the engine to run at least two hours at 84 degs C (180 degs. F) so the cleaning solution will take effect. Do not drive vehicle or allow liquid level in radiator to drop low enough to interfere with circulation.

NOTE: Stop engine as often as necessary to prevent boiling.

5. With the engine stopped, feel the radiator with bare hands to check for cold spots, and then observe the temperature reading. Where there is no change in temperature for some time, drain the cleaning solution.

6. If clogging of the core is relieved but not fully corrected, allow the engine to cool, pressure-flush the system (See Pressure Flushing) and repeat cleaning operation.

7. If clogging of core, indicated by low temperature spots on the core, is not relieved; radiator core must be removed for mechanical cleaning. Mechanical cleaning requires removal of upper and lower tanks and rodding out the accumulated rust and scale from the water passage of the core.

D. PRESSURE FLUSHING

1. Disconnect the upper radiator hose which connects the radiator core to the engine water outlet and -remove thermostat from engine water outlet.

2. Clamp a convenient length of hose to the radiator core outlet opening and attach another suitable length of hose to the radiator inlet opening to carry away the flushing stream.

3. Connect the flushing gun to compressed air and water pressure and clamp the gun nozzle to the hose attached to the radiator outlet opening.

4. With radiator cap (if so equipped) on tight, fill core with water. Apply air pressure in short blasts to prevent core damage.

5. Continue filling radiator with water and applying air pressure in short blasts until the water comes out clear.

6. Clamp the flushing gun nozzle firmly to a hose attached securely to the engine water outlet opening. Fill engine block with water, partly covering water inlet opening to permit complete filling.

7. Apply compressed air to blow out water and loose sediment. Continue filling with water and blowing out with air until flushing stream comes out clear.

8. For badly clogged engine water jackets that do not respond to regular pressure flushing, remove engine cylinder head and core hole plugs and with a suitable length of snall copper tubing attached to the flushing gun nozzle, flush the water jackets through the openings.

9. If the vehicle is equipped with a heater connected to the cooling system, flush the heater following the same procedure as for the radiator core.

10. After completing the flushing operation, clean out the radiator overflow pipe, inspect the water pump, clean the thermostat and the radiator cap control valve (if so equipped). Check thermostat for proper operation before installation. See "Thermostat".

11. Blow insects and dirt from radiator core air passages using water, if necessary, to soften obstructions.

E. TEST EQUIPMENT

To aid the serviceman in maintaining the cooling system at top efficiency, various items of test equipment are available. Among these are the Cooling System Pressure Tester and the Hydrometer.

1. SE-1870 Cooling System Pressure Tester
This equipment may be used in detecting the hard-to-find leaks in the cooling system. Any leak from cracked or warped cylinder heads or blown gaskets (internal or external) can be located easily and in a short time with the pressure tester. Adapters are available with the tester which permit the testing of radiators on trucks having the cabover-engine design (Fig7). Pressure caps can also be tested , with the pressure tester.

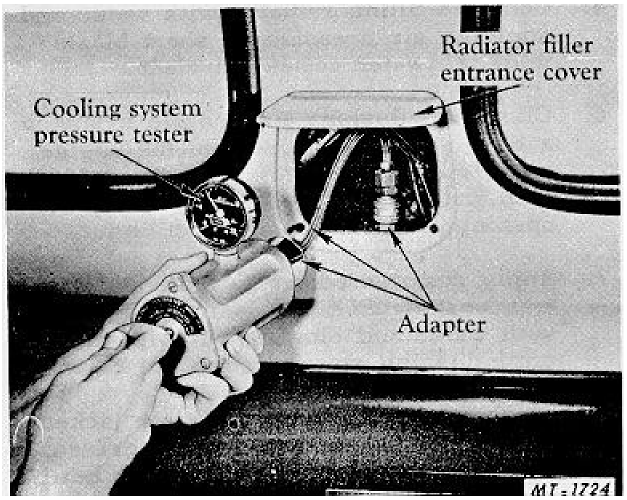


Fig. 7 Using SE-1870 Cooling System Pressure Tester with Adapter

2. <u>Hydrometers</u>
   Hydrometers (Fig. 8) are used to test the freezing protection of an antifreeze solution and work on the principle of specific gravity or weight of the antifreeze solution. They are simple to use if used in the proper manner. When using the hydrometer, the solution must be at least 44 degs. C (110 degs. F), the temperature and level must be noted correctly and the float must be able to move freely. Read only the hydrometer scale corresponding to the type antifreeze solution in the radiator. Keep hydrometer clean inside and out and treat it with the same care as given any other precision instrument.

3. <u>SE-2384 Pressure Tester</u>
   This tester (Fig. 9) consists of a heavy duty pump complete with adapters for remotely applying pressure to the cooling system at the radiator fill neck. The pump is equipped with a pressure gauge, manual pressure relief valve and hose assembly with twist-on clamp bracket to receive the adapters. The adapters can be quickly attached together for a small or large filler neck either with a shallow or deep neck.

4. <u>SE-2395 Antifreeze and Battery Tester</u>
   This tester (Fig. 10) is designed for quick and accurate checking of antifreeze protection and battery specific gravity readings. Coolant may be checked hot or cold with a minimum amount of coolant or battery acid required. Operating instructions are included with the tester.

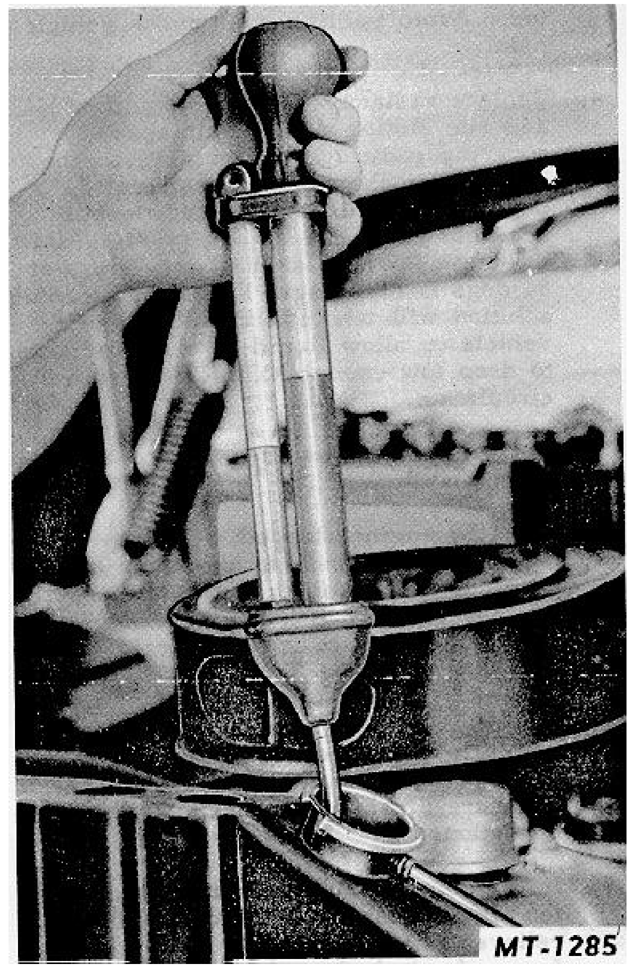


Fig. 8 Using Hydrometer to Test Antifreeze Solution

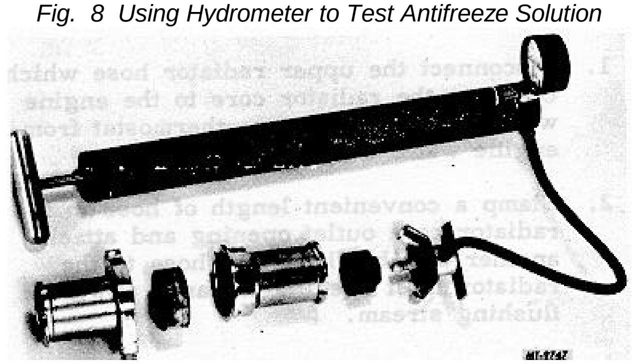


Fig. 9 SE-2384 Cooling System Pressure Tester

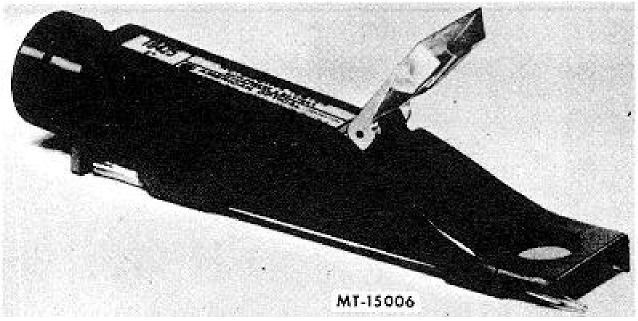


Fig. 10 SE-2395 Antifreeze and Battery Tester

TROUBLE SHOOTING

A. CAUSES OF COOLANT LOSS:

1. Leaks and seepage-may be either external or internal.

External leaks easy to locate, may occur at radiator, heater, water pump, core plug hole, hose connections, radiator cap, drain cocks and gaskets.

Internal leaks are more difficult to locate since these leaks occur at cracks and faulty head gaskets. Internal leaks are indicated by a decrease in coolant level and the presence of coolant in crankcase. Correct this condition immediately or serious damage to engine will result.

2. Boiling-may be caused by any of the following:

   a. Radiator or other parts of cooling system clogged with rust or scale.
   b. Grille or. bug screen clogged.
   c. Radiator core fins damaged.
   d. Thermostat defective-stuck closed.
   e. Water pump leaking air into system. f. Radiator hose collapsed or rotting inwardly.
   g. Radiator pressure cap defective.
   h. Cylinder head loose causing exhaust gas leakage into cooling system.
   i. Water pump impeller corroded or loose on shaft.
   j. Antifreeze protection inadequate causing partial freeze-up.

3. After-Boil-Boiling which may occur in a cooling system after the engine is -shut off even though it did not occur during operation is known as after-boil. This condition which usually happens to cooling systems that need attention, occurs because the coolant is still picking up heat from the engine and the heat is not being dispersed by circulation through the radiator. Other causes of after-boil are over-protection or use of high-temperature thermostat with alcohol type antifreeze, improper installation of the thermostat, or a thermostat that is operating improperly.

4. Foaming-Foaming of coolant may also cause coolant loss. This occurs only with a very dirty cooling system and under severe operating conditions. Usually an air or exhaust leak in the system contributes to foaming and this is caused by a faulty gasket, leaky radiator hose or water pump seal. Foam is an excellent insulator and can seriously interfere with proper circulation.

5. Evaporation-Evaporation reduces the amount of coolant in the system. This is a common occurrence where alcohol base types of antifreeze are used. A faulty pressure cap may also be the cause of evaporation.

B. CAUSE OF OVERHEATING

1. Cooling System
   a. Low coolant supply.
   b. Leaks at any of the following: gaskets, hose connections, water pump, radiator, heater, core plugs, drain cock or plugs, cracked head or block.
   c. Broken or loose fan belt.
   d. Radiator clogged.
   e. Collapsed or clogged hose.
   f. Defective pressure cap.
   g. Worn or corroded impeller on water pump.
   h. Foaming.
   i. Radiator air flow obstructed.
   j. Bent fan blade.
   k. Improper or defective thermostat.
2. Ignition System
   a. Ignition timing late.
   b. Defective spark advance.
3. Fuel System
   a. Carburetor set too lean.
   b. Valves timed late or leaking.
   c. Intake manifold leaking.
   d. Leak in vacuum operated accessories.
4. Miscellaneous
   a. Clogged muffler or tail pipe.
   b. Stiff re-built engine.
   c. Dragging brakes.
   d. Low engine oil level.
   e. Engine overloaded.

Cause of Overcooling:

1. Missing thermostat.
2. Defective thermostat stuck open.
3. Short runs and intermittent driving.

ELECTRICAL
ALTERNATOR
IH

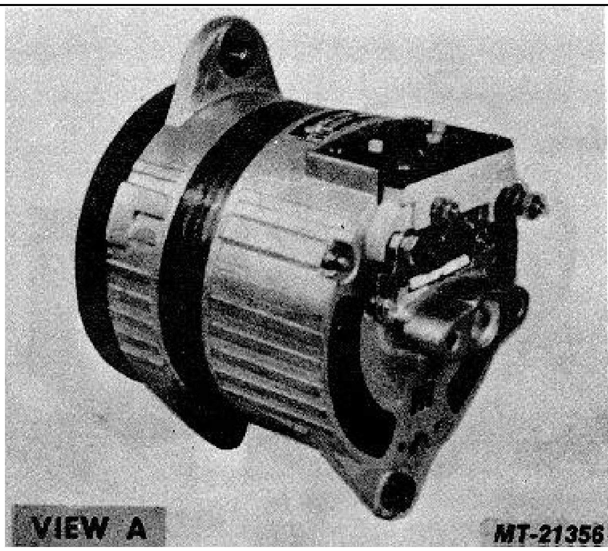
CODE	RATING
08141	65 Amp
08142	85 Amp
08143	105 Amp
08158	145 Amp

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

IDENTIFICATION CHART

IH Identification			
Code	Part Number	Mfgr's. No.	Rating
08141	514089-C91	2310JB	65 Amp
08142	513303-C91	2510JB	85 Amp
08143	513542-C91	2610JB	105 Amp
08158	527890-C91	2810JB	145 Amp



DESCRIPTION

The IH heavy duty alternators (View A) are 14 volt self load limiting alternators which feature a fully adjustable, built-in solid state voltage regulator.

The alternators incorporate a 22.2 mm (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. The rotor shaft may be rotated in either direction.

Six silicone 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. An external relay terminal is also provided for operation of chargelight relays or other accessories which might require power from such a source.

The alternators have ungrounded output terminals so that they may be used on either positive or negative ground systems. Aside from connecting the proper vehicle wires to the correct output terminals, no other wiring is required on the alternator, eliminating field relays or ignition switch connections.

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. The diode trio, so called because it consists of three (3) diodes, converts a small amount of alternator current from the stator into direct current which is used as a signal to turn on the 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.

TROUBLE SHOOTING

Before performing trouble shooting procedures on the vehicle, be absolutely certain that wiring is not defective and belts are not slipping, as these problems are common.

To determine if the problem lies in the regulator or the alternator, connect an accurate voltmeter across the battery with the engine stopped, and note the reading. The engine should now be started. If the voltmeter reading rises excessively, the charging system may be defective or may require adjustment. Remove the nylon screw from the regulator and with the engine at approximately 1000 RPM, attempt to bring the voltage to its proper value (13.8-14.2 V approximately) by turning the adjusting screw back and forth with a small screwdriver (see Fig. 1).

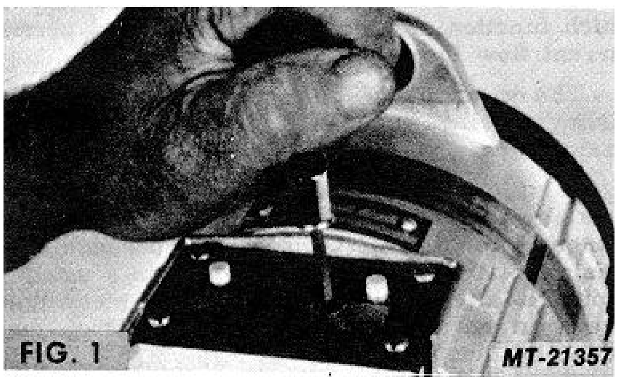


FIG. 1

If the voltage is excessively high and cannot be lowered by means of the adjustment, the regulator is probably defective and should be replaced. If the output voltage cannot be raised, either the alternator, regulator or diode trio may be at fault. To determine if the fault is in the regulator or in the alternator, perform the following test.

Connect one end of a short jumper lead to the negative alternator output terminal and connect the other end of the jumper to a short stiff piece of wire at least 38 mm (1 1/2") long. A piece of paper clip wire will be suitable. Insert this wire into the small hole in the end of the brush holder so that it firmly contacts the outer brush terminal. (see Fig. 2).

If the voltmeter reading now rises with the engine at a fast idle, the alternator is OK and the fault is in the regulator or diode trio. Remove the diode trio and test (see "COMPONENT TESTING"). If the diode trio tests OK, the regulator should be replaced.

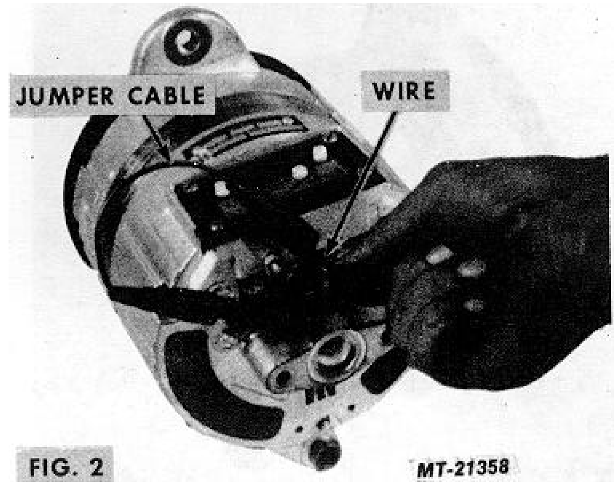


FIG. 2

If the voltage fails to rise when performing this test, remove the regulator and carefully inspect it for a printed circuit track which has burned open. If this condition is found, replace the regulator. Check the brush spring caps and their contact screws for dirt or corrosion and clean if necessary. If the alternator does not operate after performing either or both of these operations, the alternator should be removed for repair or replacement.

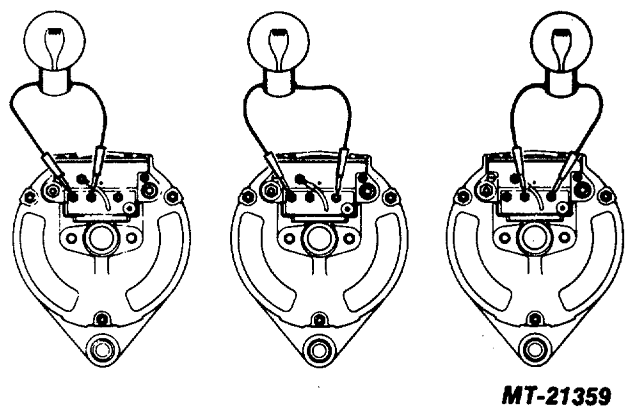


FIG. 3

The alternator may also be checked for output across each phase by using a test light as shown in Fig. 3. The test light should be constructed from a two filament sealed beam unit connected in such a manner that the filaments are in parallel. Such a light will act as a load a as well as an indicator, and should light with equal brilliancy on each phase. If the lamp is noticeably dimmer on one or two phases, a defective diode trio or power diode is indicated. If the diode trio tests OK, then the alternator must be removed and dismantled for further tests.

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.

ADJUSTMENT

Prior to adjusting alternator voltage, the wiring, connections and belt tension should be checked and repaired as needed. The batteries should be fully charged and the engine should be running at a fast idle. Turn off all vehicle loads such as lights, radios, heaters. air conditioners, etc. when checking or adjusting voltage. An accurate voltmeter should be connected across the batteries to determine the charging voltage. Do not rely on dash mounted vehicle instruments. These are excellent indicators but usually lack the extreme accuracy required for regulator adjustment. Remove nylon screw (plug) from the regulator (see Fig. 1), and with a small screwdriver carefully turn the adjusting screw clockwise to raise or counter-clockwise to lower the voltage. The ideal voltage setting will be a value which maintains a fully charged battery without resulting ill all excessive usage of battery water.

When turning the voltage adjustment screw, do not attempt to force it past its stop as damage will result. Be sure to replace the screw (plug) in the regulator adjustment hole to prevent the entrance of water and dirt.

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 Fig. 4).

3. Remove lead from diode trio to terminal on regulator housing. Loosen inner nut, which will allow blue regulator lead to be withdrawn from under head of terminal screw. Remove regulator (see Fig. 4).

4. Lift brush and spring assemblies out of housing (see Fig. 4).

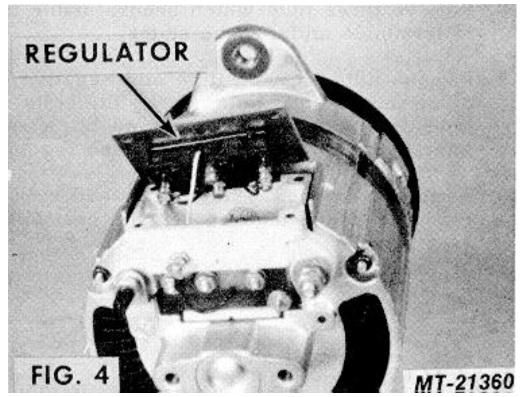


FIG. 4

5. Remove three nuts and lift diode trio off of A/C terminal studs (see Fig. 5).

6. Remove three self locking nuts and through bolts.

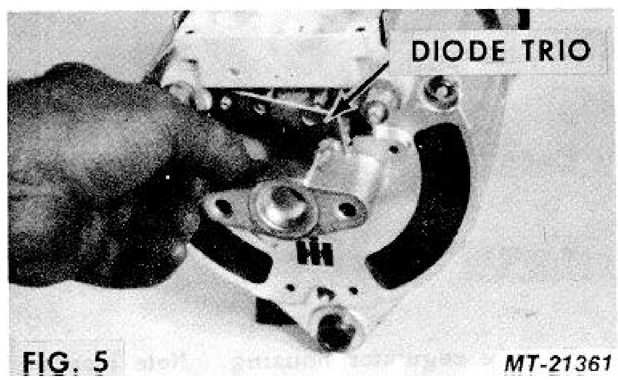


FIG. 5

7. 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 Fig. 6).

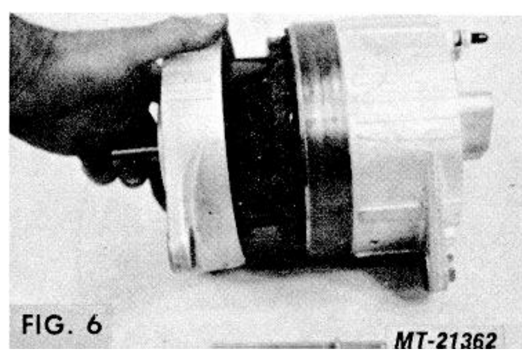


FIG. 6

8. Remove three nuts which secure stator leads to terminals and remove stator.

9. 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 Fig. 7).

10. Remove three hex head screws and remove capacitor connected between the heat sinks (see Fig. 7).

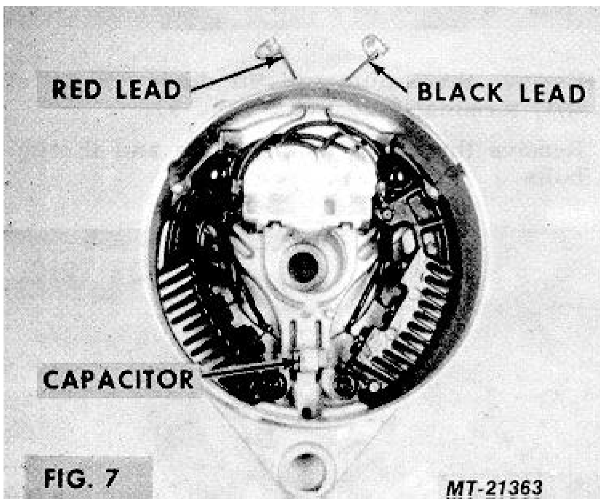


FIG. 7

11. Remove regulator housing. Note location of gasket which seals brush compartment (see Fig. 8).

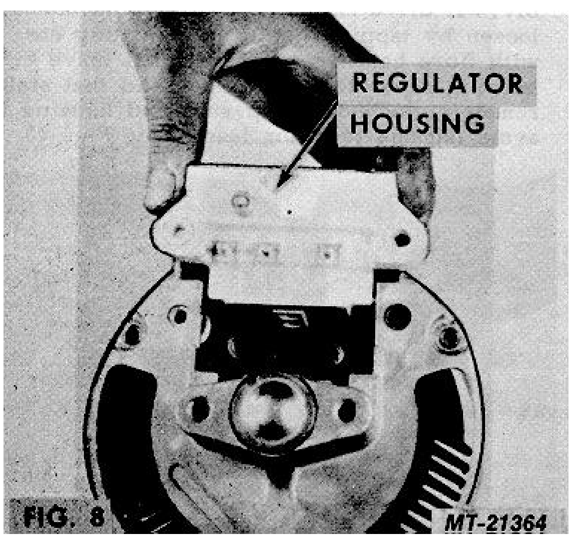


FIG. 8

12. Remove terminal stud insulating bushings from housing. There are two bushings in each terminal hole (see Fig. 8).

13. 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 Fig. 9).

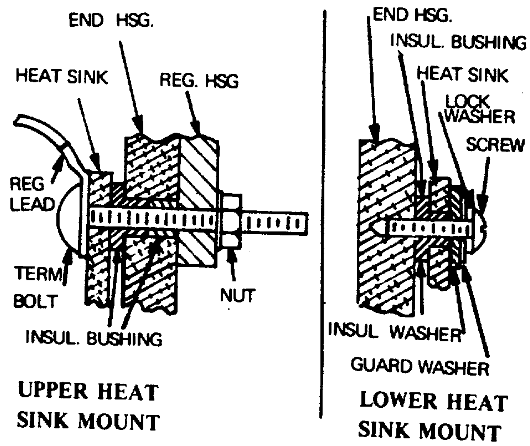


Fig. 9

14. Pry flanged dust cap out of housing (see Fig. 10).

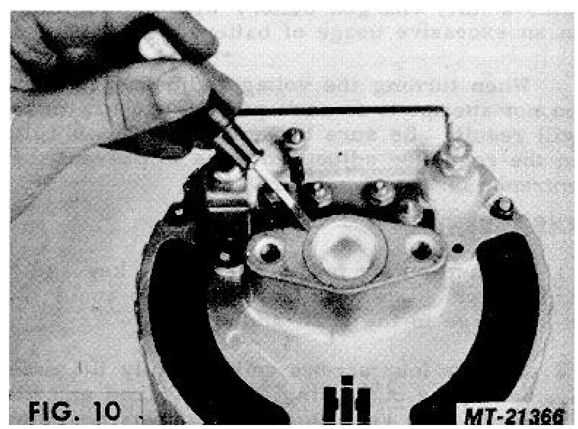


FIG. 10

15. 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, using Snap-On Tool Co., No. CG-40-11 with CG-40-4 (see Fig. 11).

16. Using a puller or arbor press, remove the drive end housing and bearing assembly from the rotor shaft (see Fig. 11A).

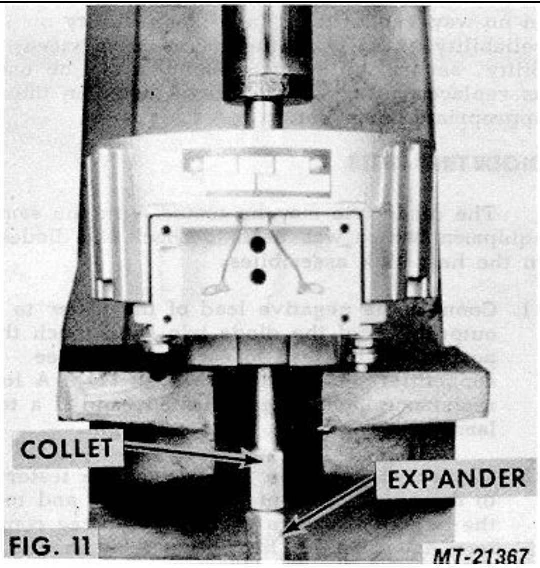


FIG. 11

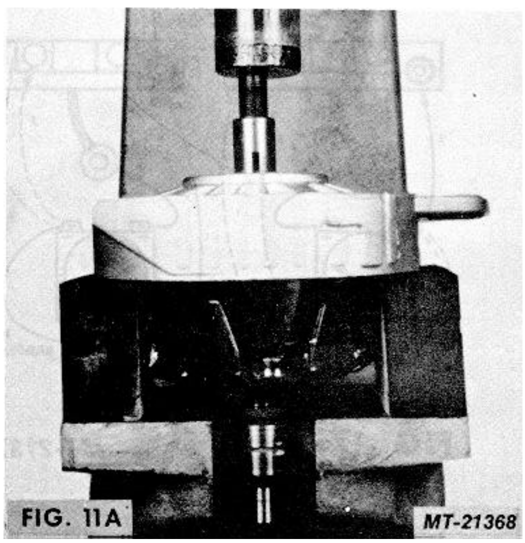


FIG. 11A

17. Remove four screws and bearing retainer and press bearing out of drive end housing (see Fig. 12).

COMPONENT TESTING

Before performing these tests, carefully inspect all parts for wear, cracks, breakage or other mechanical defects. Discard all damaged parts.

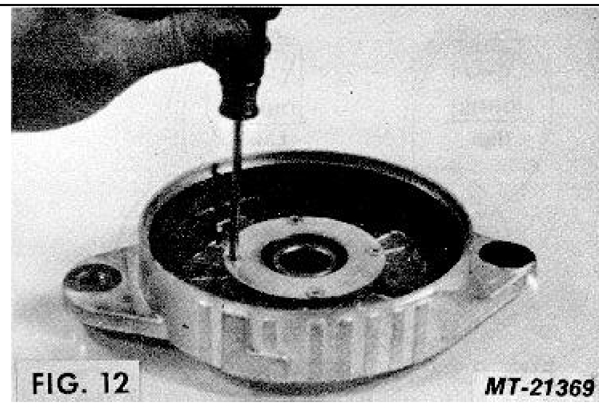


FIG. 12

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. Be sure the diode trio has been removed from the A/C studs and 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 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. 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 lights, the diode is shorted (see Fig. 13).

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 and 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 Fig. 14.)

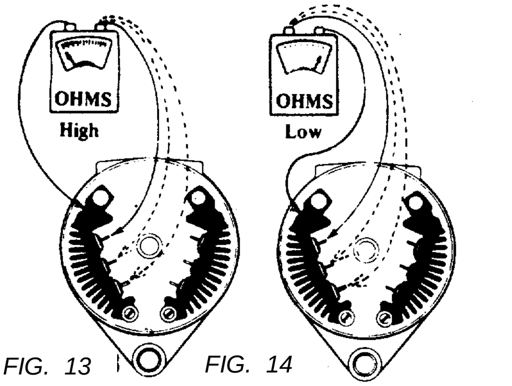


FIG. 13 FIG. 14

POSITIVE HEAT SINK TEST

MT-21370

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. If a low resistance reading is obtained or if the test lamp lights, the diode is shorted (see Fig. 15).

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. 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 Fig. 16).

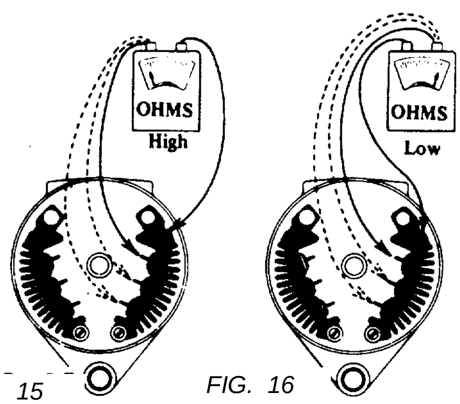


FIG. 15 FIG. 16

NEGATIVE HEAT SINK TEST

MT-21371

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.

DIODE TRIO TESTS

The diode trio may be tested with the same equipment which was used to check the diodes in the heat sink assemblies.

1. Connect the negative lead of the tester to the output lead of the diode trio, and touch the positive tester lead to each of the three copper terminal pads (see Fig. 17). A low resistance should be indicated, and if a test lamp is being used, it should light.

2. Connect the positive terminal of the tester to the output lead of the diode trio and touch the negative lead to each of the three copper terminal pads. A high resistance should be indicated and if a test lamp is being used, it should not light. Discard any diode trio which does not pass all of these tests.

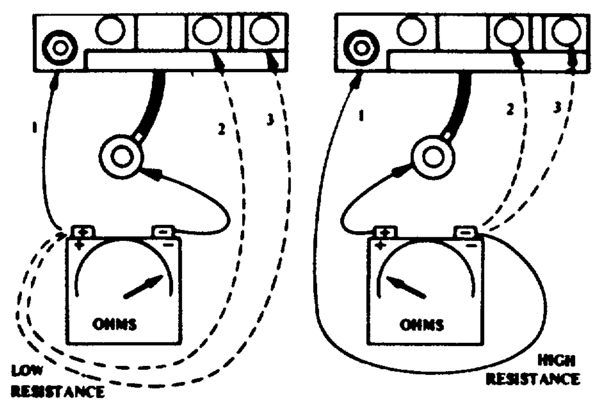


FIG. 17 DIODE TRIO TEST

MT-21372

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 Fig. 18).

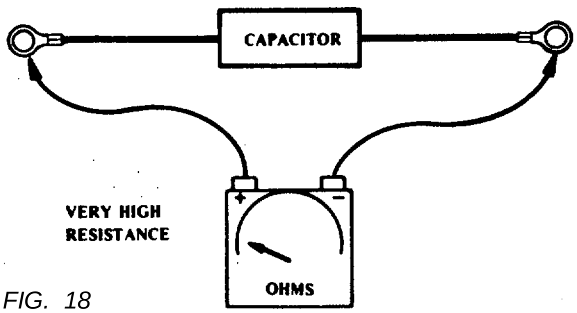


FIG. 18

MT-21373

VOLTAGE REGULATOR TEST

The regulator circuitry contains devices connected in such a manner that parallel or "sneak" circuits exist making it impossible to electrically test each individual component, as several will be in the circuit at the same time. For this reason, point to point resistance checks with an ohmmeter may be inconclusive or misleading. The regulator can be most accurately tested by installing it in an alternator known to be serviceable.

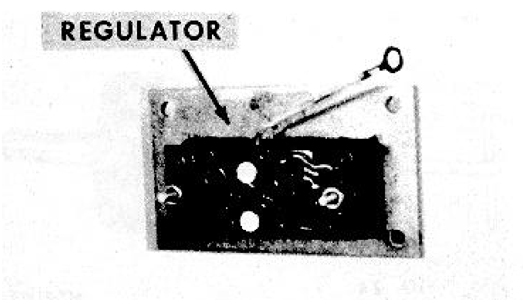


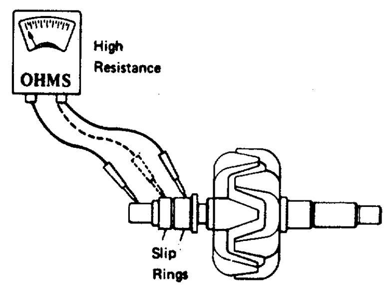
FIG. 19 MT-21374

The voltage regulator assembly consists of a number of individual components such as capacitors, resistors, diodes and transistors, mounted upon and electrically connected by a printed circuit panel. Because these components are permanently fastened to the panel, their replacement is not recommended. When it has been determined that a voltage regulator is unserviceable, it should be discarded and a new assembly installed in its place (see Fig. 19).

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 Fig. 20).



ROTOR COIL GROUND TEST

FIG. 20 MT-21375

2. Check rotor coil resistance by connecting the ohmmeter across the two slip rings (see Fig. 21). The resistance of the rotor should be within the following limits:

2310JB	4.9-5.5 Ohms
2510JB	2.3-2.7 Ohms
2610JB	2.3-2.7 Ohms
2810JB	1.9-2.3 Ohms

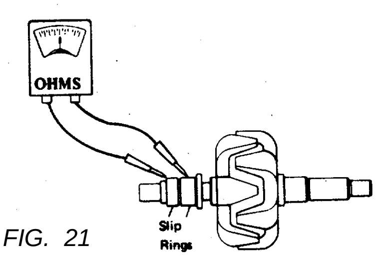


FIG. 21

ROTOR COIL RESISTANCE TEST

MT-21376

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

Due to the extremely low resistance of the stator windings it is difficult to measure their resistance with a conventional ohmmeter. The stator should therefore be tested for grounds and continuity between phases with a test light. A 12 volt test light is preferred.

Do not attempt to check stators in this manner while they are still connected to the heat sinks. Remove the stator from the alternator before testing (see Fig. 22 for stator test). Discard any stators which appear overheated and have charred insulation, 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.

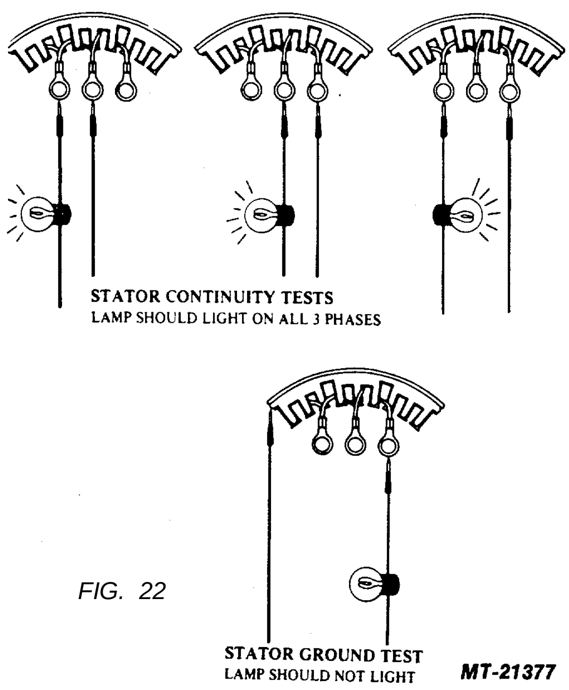


FIG. 22 MT-21377

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.

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 Fig. 23).

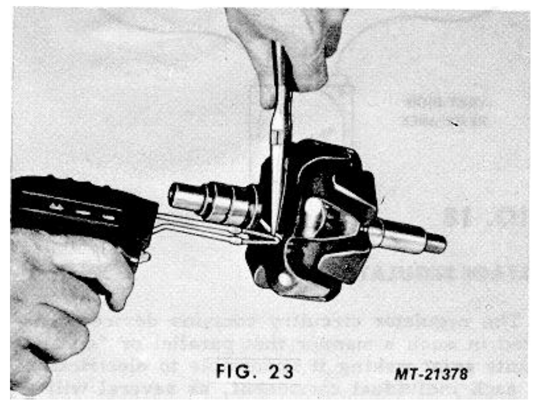


FIG. 23 MT-21378

2. With a suitable puller, the slip ring assembly may now be pulled from the shaft (see Fig. 24).

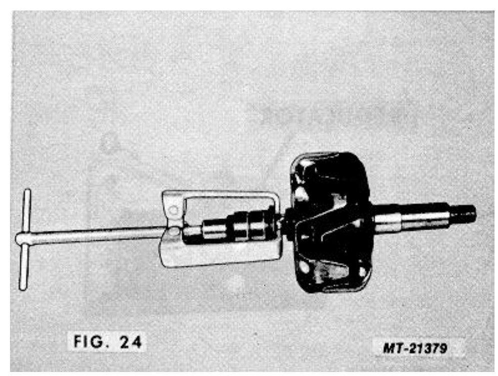


FIG. 24 MT-21379

3. Clean the rotor shaft and apply a small amount of Loctite 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 Fig. 25).

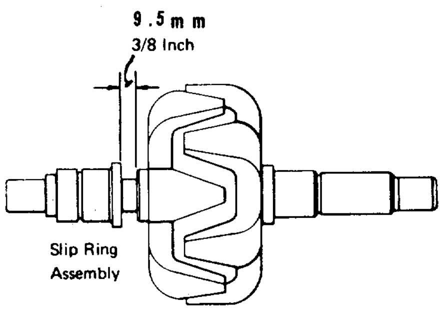


Fig. 25

LOCATION OF SLIP RING

MT-21380

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 Fig. 9).

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 Fig. 7).

4. Install two insulating bushings on each terminal bolt and install regulator housing.

5. 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 Fig. 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 onto 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 N.m (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. Install diode trio and three nuts.

13. 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

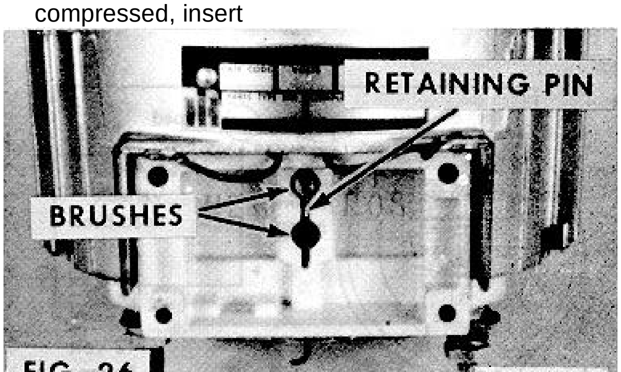


FIG. 26

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 Fig. 26).

14. Attach red and black leads to regulator. Attach blue regulator lead to diode terminal screw by placing the spade terminal under the head of the screw. Tighten nut on terminal screw (see Fig. 4). Install regulator.

    Be sure that the red and black leads are properly routed through their slots in the regulator housing. Install four regulator screws. <u>Withdraw brush retaining pin before tightening these screws</u>.

15. Install diode trio lead and nut.

16. 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 to .012 inch).

CAUTION

DO NOT FORCE OR POUND PULLEY ON SHAFT.

TESTING

Because of the integral regulator used on this alternator, the test block hookup is very simple, consisting of connecting the positive and negative output leads. If a commercial test block is not available, the test setup shown in Figure 27 may be used.

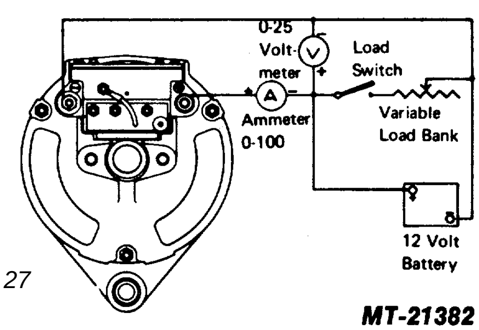


FIG. 27

Before beginning the test and after the battery has been connected, momentarily flash the field by connecting a jumper between the diode trio terminal and the alternator positive output terminal (see Fig. 28). This will restore the residual magnetism which may have been weakened by handling or repair procedures.

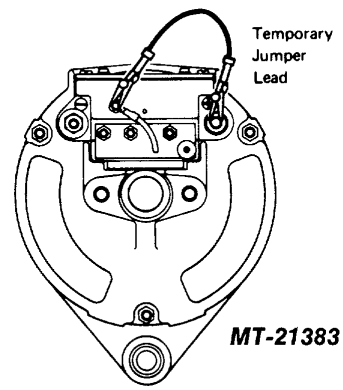


FIG. 28

VOLTAGE REGULATOR REPLACEMENT

REMOVAL

1. Remove four screws and carefully lift regulator free of housing. Remove red and black leads from regulator noting their position to facilitate assembly of new regulator (see Fig. 4).

2. Remove lead from diode trio to terminal regulator housing. Loosen inner nut which will allow blue regulator lead to be withdrawn from under head of terminal screw. Remove regulator (see Fig. 4).

3. Lift brush and spring assemblies out of housing (see Fig. 4).

INSTALLATION

1. Install brushes.

   When brush springs have been compressed, hold them in place by passing a pin through the retainer hole (see Fig. 26). A suitable pin can be made from a piece of 1.6 mm (1/16") drill rod.

2. Attach red and black leads to regulator with shake-proof spring lockwashers and nuts supplied. Attach blue regulator lead to diode terminal screw by placing the space terminal under the head of the screw. Tighten nut on terminal screw (see Fig. 4). Install regulator.

Continued on Page 14

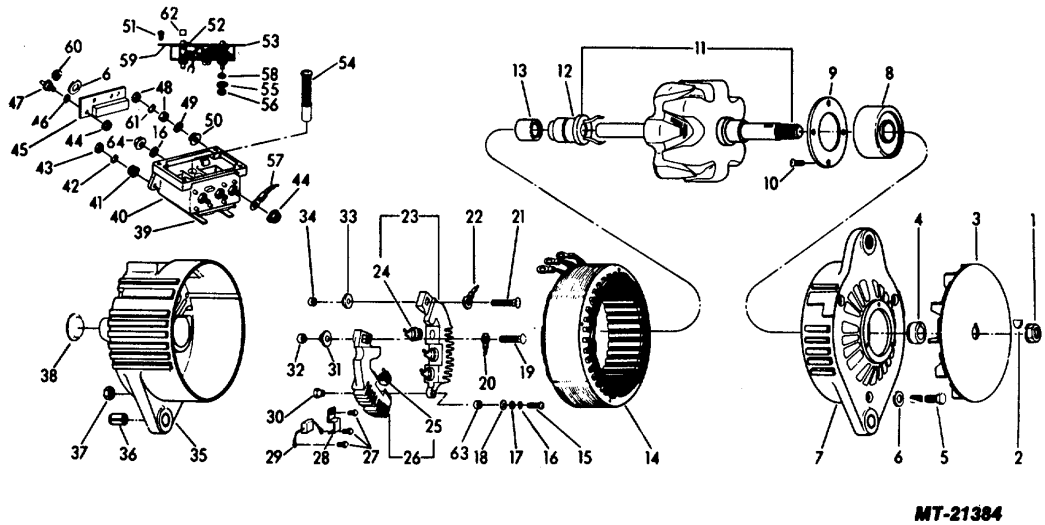


FIG. 29 EXPLODED VIEW OF ALTERNATOR

LEGEND OF EXPLODED VIEW OF ALTERNATOR

Key	Description
1	NUT
2	KEY, Woodruff
3	FAN, Assembly
4	SPACER, Fan
5	SCREW, (3)
6	WASHER, Belleville (6)
7	HOUSING, Drive End
8	BEARING, Drive End
9	RETAINER, Bearing
10	SCREW, (4)
11	ROTOR, Assembly
12	SLIP RING, Assembly
13	BEARING, Roller
14	STATOR, Assembly
15	SCREW, (2)
16	WASHER, Lock (3)
17	GUARD, Washer (2)
18	WASHER, Insulation (2)
19	SCREW, Terminal (+)
20	LEAD, Assembly (+)
21	SCREW, Terminal (-)
22	LEAD, Assembly (-)
23	RECTIFIER, Assembly (-)
24	DIODE, W/Lead (3)
25	DIODE, W/Lead (3)
26	RECTIFIER, Assembly (+)
27	SCREW, (5)
28	CLAMP
29	CAPACITOR
30	BUSHING, Insulator (2)
31	BUSHING, Insulation
32	BUSHING, Insulation
33	BUSHING, Insulation
34	BUSHING, Insulation
35	HOUSING, Slip Ring End
36	BUSHING, Slideable
37	NUT, (3)
38	CAP, Dust
39	GASKET
40	HOLDER, Assembly
41	NUT
42	WASHER, Lock
43	NUT
44	NUT, (4)
45	TRIO, Diode
46	WASHER, Lock
47	TERMINAL, Assembly
48	NUT, (2)
49	WASHER, Plain
50	NUT
51	SCREW, (4)
52	SCREW (Plug)
53	REGULATOR, Voltage
54	BRUSH, (2)
55	WASHER, Lock (2)
56	NUT, (2)
57	WIRE, Terminal (3)
58	WASHER, Lock
59	GASKET, Regulator
60	NUT (3)
61	WASHER, Lock
62	CAP, Protector (2)
63	BUSHING (2)
64	NUT

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

3. Connect diode trio lead to regulator housing.

4. Install protector caps (2) supplied to terminal screws (see Fig. 1).

5. Adjust voltage output as instructed under ADJUSTMENT.

ELECTRICAL

BATTERY

(FLEETRITE, INTERNATIONAL)

LOW MAINTENANCE AND MAINTENANCE FREE TYPES

CONTENTS

SAFETY PRECAUTIONS

BATTERIES CAN EXPLODE !

Batteries generate explosive gases. Keep sparks, flames, burning cigarettes or other ignition sources away at all times.

BATTERIES CONTAIN SULPHURIC ACID!

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 safety 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.

IMPORTANT

Do Not smoke, strike a match or bring any 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 acid, such as filling batteries, wear safety goggles. 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 them 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 being 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 vent.

DO NOT ATTEMPT TO CHARGE A FROZEN BATTERY. Allow the battery to warm to 15.5° C (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 of 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 safety glasses. Never lean over the battery during the starting operation. Follow precaution to avoid making a spark or bringing a flame near the battery.

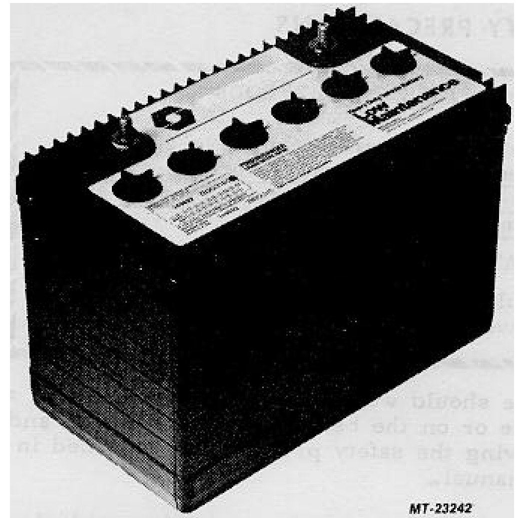


Fig. 1 Low Maintenance (Conventional) Battery

DESCRIPTION

The storage battery is an electro-chemical device. It stores chemical energy which can be released as electrical 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 smoothes out or reduces temporarily high voltages (transient voltages) which 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.

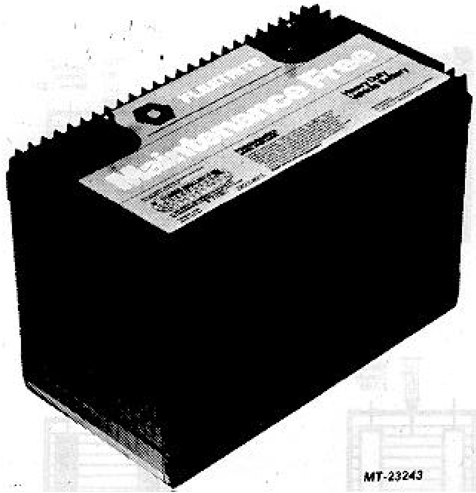


Fig. 2 Maintenance Free Type Battery

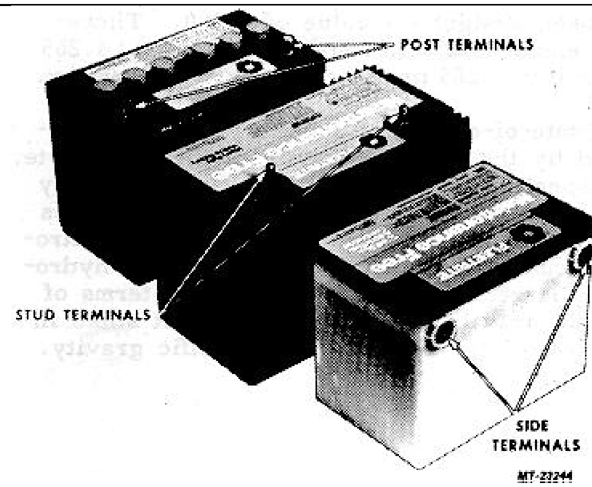


Fig. 3 Types of Battery Terminals

Batteries are provided with side, top stud and top post type terminals (Figure 3) for various vehicle applications.

LOW MAINTENANCE BATTERIES

These are conventional 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" 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.

<u>Maintenance free batteries are not sealed</u>. 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. The corrosive sulfuric acid mixture will escape if 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 combine's with the active materials of the positive and negative plates forming lead sulfate and releasing electrical energy. Electrons flow from the negative terminal to the load (such as headlamps), and back to the positive terminal.

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 arbitrarily 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.

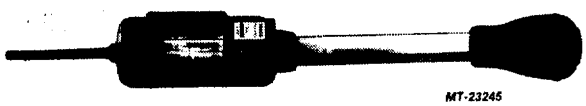


Fig. 4 Battery Hydrometer

Figure 5 graphically illustrates the relationship between specific 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.

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 26.7° C (80° F) 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

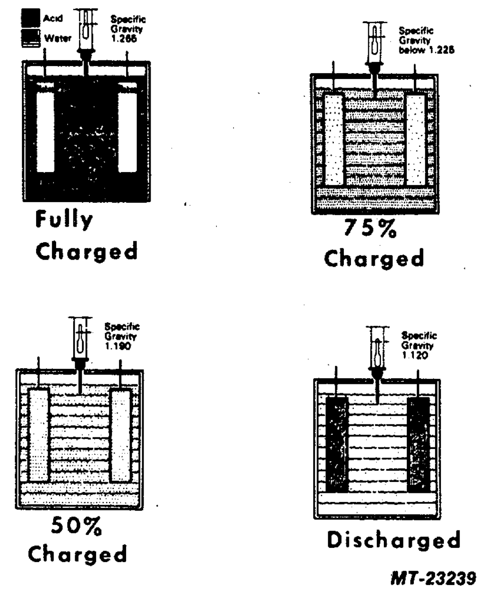


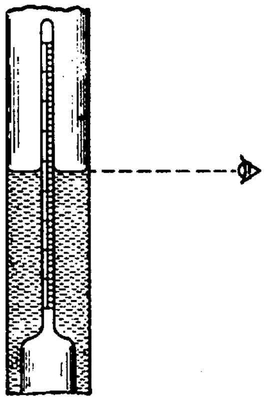
Fig. 5 Relationship of Specific Gravity To Transfer of Sulfate From Electrolyte To Plates.

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 of it. 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 or 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.



MT-23240

Fig. 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 5.5° C (10° F) increment above 26.7° C (80° F) and four points are subtracted for each 5.5° C (10° F) increment below 26.7° C (80° F). 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 (110° F) 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 1.247 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.

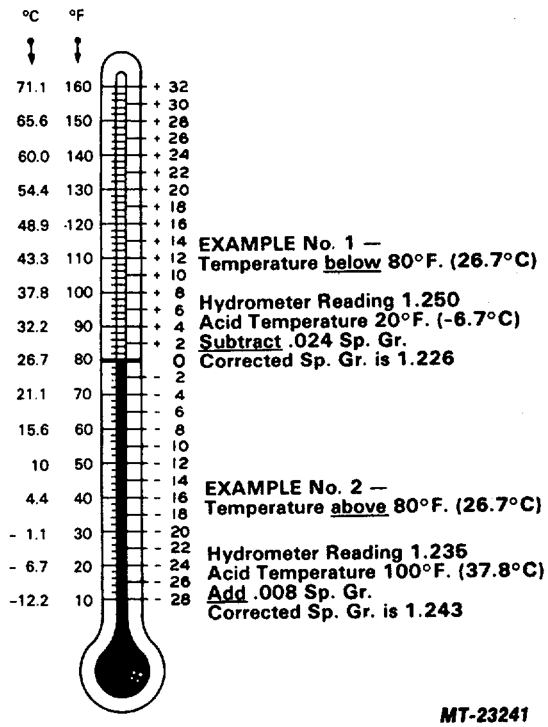


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Fig. 7 Specific Gravity Temperature Correction Values

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 Gravity	State of Charge	Freezing Point
1.265	100%	-59.50 C (-75° F)
1.225	75%	-37.2° C (-35° F)
1.190	50%	-26.10 C (-15° F)
1.155	25%	-15.00 C (+5° F)
1.120	Discharged	-9.40 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 (80° F).

TABLE 3

Temperature	Percentage of Battery Capacity (Fully Charged)
26.7° C (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 for defective cables, loose connections, loose or damaged hold down parts, damaged terminal posts or studs, clogged vents, cracked, or distorted battery case or cover, and accumulations of dirt, moisture and corrosion (Figure 8). Replace any damaged parts.

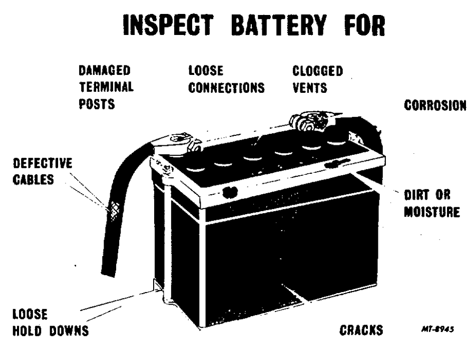

Fig. 8 Battery Maintenance Inspection

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 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 wetted with baking soda and water. Then wipe with a cloth 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 472141C1) and connect cables to battery terminals. Connect ground cable last.

3. On low maintenance (conventional) batteries check the electrolyte level. If necessary, add odorless drinking 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 overcharged. 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 SAFETY PRECAUTIONS.

Wear safety glasses or 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 terminal 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 or 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 cable between negative (-) battery terminals.

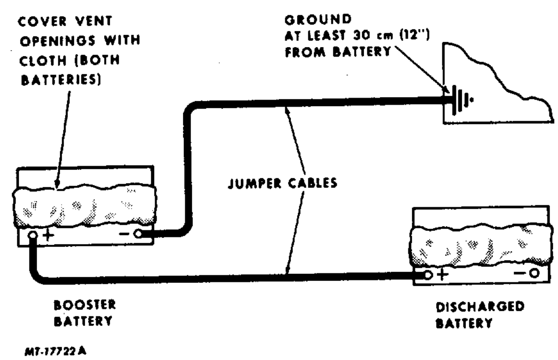

Fig. 9 Proper Jumper Cable Connections (Negative Ground Vehicles Shown

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 electrical conductivity and current carrying capacity.

On positive ground vehicles, connect jumper cable between positive (+) terminal of booster battery and ground on the stalled vehicle.

CAUTION

Take care the clamps from one cable do not inadvertently touch the clamps on the other cable.

<u>DO NOT lean over the battery when making connections.</u>

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 for cause of failure to start.

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) Specific Gravity (Hydrometer) Test
3) Battery Capacity (Load) Test

CAUTION

When performing battery test, observe rules of safety. Refer to SAFETY 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:

<u>Side Terminal Batteries:</u>

Use a knife blade to cut through top plaque center section. (Cut on dotted lines.) Pry up ends of vent manifold with a screwdriver. Remove manifold 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.

<u>Top Terminal Batteries</u>

Use a knife blade to cut through the top plaque center section on the dotted lines (Figure 11). After removal of the

Fig. 10 Removing Vent Manifold to Gain Access to Cells (Side Terminal Maintenance Free Battery)

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.

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 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 mixing electrolyte, proceed to Step 2.

STEP 2. SPECIFIC GRAVITY (HYDROMETER) TEST

Perform specific gravity (hydrometer) test on all cells. (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 4 to determine battery's state of charge.

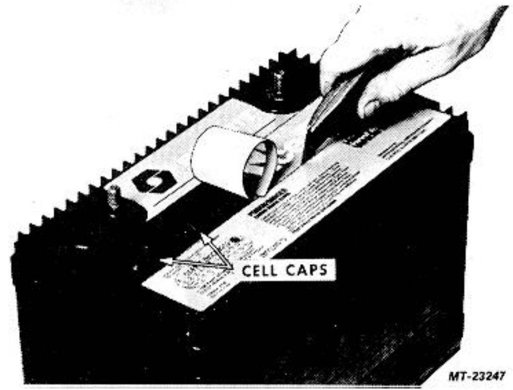

Fig. 11 Removing Section of Top Plaque to Gain Access to Cell Caps (Top Terminal Maintenance Free Battery)

TABLE 4

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

b. If specific gravity readings of all cells are 1.225 or higher when, corrected to 26.7° C (80° F), proceed to Step 3.

c. If specific gravity readings are low (below 1.225) but are within 50 points (.050 specific gravity) between highest and lowest cells, recharge battery as instructed under CHARGING and inspect vehicle's electrical system to determine cause for low charge. After charging battery, proceed to Step 3.

d. If specific gravity readings vary more than 50 points (.050 specific gravity) between cells, replace the battery.

Fig. 12 Testing Specific Gravity

STEP 3. BATTERY CAPACITY (LOAD) TEST

Perform battery capacity (load) test using battery test equipment available commercially.

IMPORTANT

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 26.7° C (80° F).

a. Disconnect battery cables from battery. (Disconnect ground cable first.)

b. Connect tester leads to battery terminals following tester manufacturer's instructions.

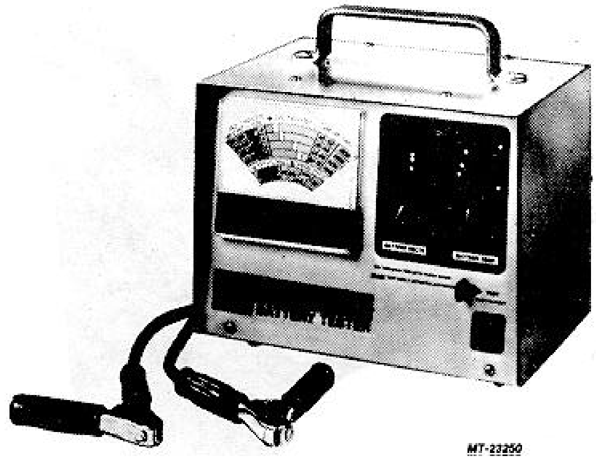

Fig. 13 Battery Tester

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 @ -18° C (0° 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.

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)	-7° 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

CHARGING

CAUTION

Before attempting to charge a battery, be aware of all safety precautions to be followed during the charging operation. Refer to Battery Charging Precautions under SAFETY 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).

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 (125°F). 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.

IMPORTANT

DO NOT OVERCHARGE batteries, particularly maintenance free type batteries. Overcharging causes excessive and needless loss of water from the electrolyte.

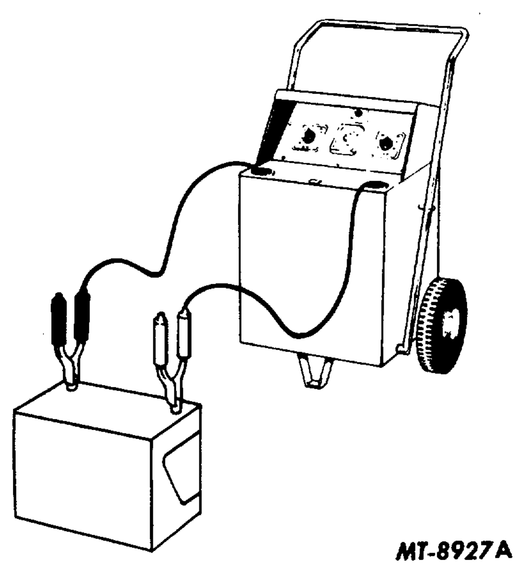

Fig. 14 Charging Battery

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 Hours @ 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 2-1/4 Hours @ 45 Amperes
Above 170 to 250 Minutes	30 Hours @ 5 Amperes 15 Hours @ 10 Amperes	7-1/2 Hours @ 20 Amperes 5 Hours @ 30 Amperes 2-1/2 Hours @ 45 Amperes
Above 250 Minutes	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.

SLOW CHARGING

The Slow Charge method uses a low charging rate for a relatively long period of time. The recommended rate for 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 a 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 can not 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 minutes) 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 it will receive 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 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 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, connect charger to battery.

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.

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IMPORTANT

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 wit. 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 pre-mature 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 subfreezing 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 a 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.)

IMPORTANT

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 INSTRUCTIONS

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.

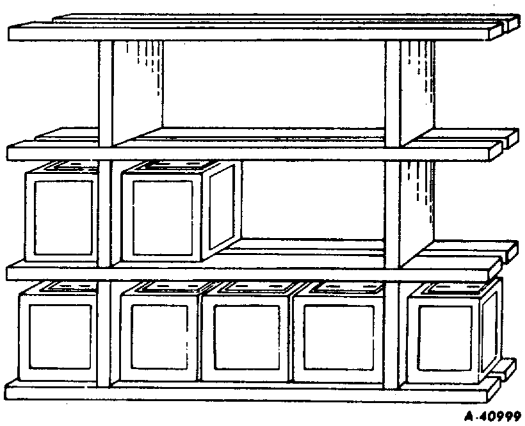


Fig. 15 Battery Storage Rack

Batteries will slowly discharge while standing and will discharge much faster when warm than when cold. On wet type conventional batteries, selfdischarge 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 0°C (32°F) and 26°C (80°F). Storage in ambient temperatures above 26°C (80°F) is not recommended as this increases the rate of self-discharge. Temperatures below 0°C (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.

IMPORTANT

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.

IMPORTANT

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. <u>Using higher or lower specific gravity electrolyte than recommended can impair battery performance.</u> 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 15.5°C (60°F) are reached.

   If the ambient temperature is 0°C (32°F) 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.

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 4° to 5.6°C (7° to 10°F) 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 approved 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 IHPP4	6	21	275	700	570	350
4H	ZBDCH4 IHCH4	6	33	420	975	775	485
4H	ZBDPH4 IHPH4	6	25	340	830	675	415
24	ZBDSP24	12	11	93	345	280	180
27H	ZBDPR27H IHPR27H	12	13	125	435	340	215
30H	ZBDPL30	12	15	165	520	430	260
31	ZBDCF31S IHCF31S	12	13	160	455	375	230
31	ZBDCL31S IHCL31S	12	17	170	600	455	300
72	ZBDPH72	12	9	63	300	240	150
74	ZBDPH74 IHPH74	12	11	100	390	315	195
4D	ZBDCM4DA IHCM4DA	12	21	275	700	570	450
8D	ZBDCM8DA IHCM8DA	12	29	440	900	700	440

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	ZBDCLM31 IHCLM31	12	17	170	625	470	310
31	ZBDCLM31S IHCLM31S	12	17	170	625	470	310
74	ZBDMF74 IHMF74	12	13	115	500	360	250

ELECTRICAL
CIRCUIT DIAGRAMS 1980
S-SERIES TRUCKS

PRINTED IN UNITED STATES OF AMERICA

BULB CHART

BULB APPLICATION	WATTS OR CANDLEPOWER	TRADE NO.
HEADLIGHT:		7002 RH DR 6014
UPPER BEAM	60 WATTS	
LOWER BEAM	45 WATTS RH DR 50 WATTS LH DR	
FRONT TURN	32	1156
SIDE MARKER	2	1895
PARK	3	181
STOP-TURN/TAIL-LICENSE	32/3	1157
BACK-UP	32	1156
IDENTIFICATION-CLEARANCE	3	168
FLOOD LIGHT	12	561
MIRROR LIGHT	2	1895
CLUSTER:		
ILLUMINATION	2	194
INDICATOR	2	194
WARNING	2	194
INFORMATION	2	194
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
INSTR PANEL CONTROLS	0.50	**
ASHTRAY	0.50	**
DOME	12	211-2
RADIO	0.75	1892
HEATER & A/C CONTROLS	3	168
AUTOMATIC XMSN COTROLS	1	53

** PURCHASED LIGHT ASSEMBLY (REF G.E. BULB NO. 2162D)

DESCRIPTION	SIZE	TYPE	LOCATION
TRAILER AUX	——	——	FUSE BLOCK
TRAILER MARKER	15A	FUSE *	AT REAR
TRAILER STOP	20A	FUSE *	CAB
TRAILER TAIL	15A	FUSE *	JUNCTION
TRAILER RT TURN	10 A	FUSE *	BLOCKS
TRAILER L TURN	10 A	FUSE *	
LIGHT SWITCH FBC/BUS	18GA	GN FUSE LINK	LIGHT SWITCH
KEY SWITCH IGN BUS BAR	14GA	BN FUSE LINK	AMMETER
FUSE BLOCK BAT BUS BAR	14 GA	BN FUSE LINK	AMMETER
IGNITION FBC/BUS	20GA	OR FUSE LINK	KEY SWITCH
INSTRUMENT FBC/BUS	20 GA	OR FUSE LINK	KEY SWITCH

FUSE, CIRCUIT BREAKER & FUSIBLE LINK CHART

* CIRCUIT BREAKER OPTIONAL

DESCRIPTION	SIZE	TYPE	LOCATION
HOURMETER	4A	FUSE	GAUGES BUS &
ETHER START	4A	FUSE *	FUEL/ETHER FBC
HAZARD LIGHTS	20A	FUSE	TURN/HAZARD
TURN LIGHTS	20A	FUSE	
DOME LIGHTS	15 A	FUSE *	
CIGAR LTR (FBC/BUS)	15 A	FUSE *	HORN/DOME
HORN	15A	FUSE *	
STOP LIGHTS	30A	FUSE *	
TRAILER MARKER	30A	FUSE *	STOP/TRL MKR
FLOOD LIGHTS	30A	FUSE *	
TAIL LIGHTS	20A	FUSE *	(15A FBC/BUS)
CL/ID LIGHTS	20A	FUSE *	TAIL/CAB MKR
PARK MARKER LTS	20A	FUSE *	
MIRROR LIGHTS	20A	FUSE *	
MKR LIGHTS (FBC/BUS)	15A	FUSE *	MARKER
TRL MKR LIGHT REL	15A	FUSE *	MARKER
INSTR PANEL LIGHTS	4A	FUSE *	
CLUSTER PANEL LTS	4A	FUSE *	
ASHTRAY LIGHTS	4A	FUSE *	PANEL
HTR & A/C CONT ILLUM	4A	FUSE *	
XMSN & ENG OIL TEMP GAUGE ILLUM	4A	FUSE *	
RADIO	4A	FUSE *	RADIO
HEATER ONLY	20A	FUSE *	HEATER & A/C
HTR & A/C-EXCEPT HIGH POSITION	20A	FUSE *	
2 SPEED AXLE	20A	FUSE *	2 SPEED
SUBMERGED FUEL PUMP	4A	FUSE *	FUEL/ETHER-BUS FUEL PUMP-TRUCK
BACK-UP LIGHTS	15A	FUSE *	BACK-UP/ ANTILOCK
ANTILOCK SYSTEMS	15A	FUSE *	
HTR & A/C HIGH POSITION	30A	CIRCUIT BKR	HEATER & A/C
KYSOR ENGINE SHUTDOWN	10A	IN-LINE FUSE	ABOVE KYSOR SW, LWR FRT LT
2 FUSES	6A	IN-LINE FUSE	SIDE OF CAB
HEADLIGHTS	15A	CIR BKR	INSIDE LIGHT SW
WINDSHEILD WIPER & WASHER	6A	CIR BKR	REAR OF WIPER SWITCH
HI-POWER PUMP (CONVENTIONAL ONLY)	50A	CIR BKR	RELAY MTG BRKT
HIGH POWER PUMP FBC/BUS	50A	CIR BKR	DASH PANEL (ENG SIDE)
CIGAR LIGHTER (CONVENTIONAL ONLY)	18 GA	GN FUSE LINK	LIGHT SWITCH
HEADLIGHT FEED	16 GA	BK FUSE LINK	AT START MOTOR SOL
CAB FEED (CONVENTIONAL ONLY)	12 GA	DK BL FUSE LINK	AT START MOTOR SOL
GENERATOR FBC/BUS	20 GA	OR FUSE LINK	KEY SWITCH
HOURMETER	5A	IN-LINE FUSE	UNDER FUSE BLOCK - TRUCK
ETHER START	5A	IN-LINE FUSE	LWR EDGE INST PNL - TRUCK

FUSE IDENT SHOWN AS ON FUSE BLOCK
FUSE BLOCK MTG ON INSIDE CAB-UPPER LEFT SIDE OF DASH-CONVENTIONAL-LH DR
FUSE BLOCK MTG ON INSIDE COWL-CENTER OF INSTR PANEL - FBC/BUS
FUSE BLOCK MTG ON INSIDE CAB-UPPER RIGHT SIDE OF DASH-CONVENTIONAL-RH DR

MT-23712

Bulb And Fuse Chart

SYMBOLS

- —11-16— TYPICAL WIRING
- —1 GA— BATTERY CABLE
- REFERENCE WIRING
- --11-16--ALTERNATE WIRING
- RESISTANCE OR RESISTOR
- RESISTANCE OR RESISTOR-VARIABLE
- FUSIBLE LINK
- SPLICE
- —• OR • FIXED CONTACT OR COMPONENT INTERNAL CONNECTION
- OPEN SWITCH
- CLOSED SWITCH
- 15 CIRCUIT BREAKER W/AMP IDENTIFIER
- 15 INLINE FUSE W/AMP IDENTIFIER
- 15 FUSE PANEL CLIP W/MALE BLADE TERMINALS & FUSE W/ AMP IDENTIFIER
- MALE TERMINAL
- FEMALE TERMINAL
- SINGLE BODY INLINE CONNECTOR
- MULTIPLE TERMINAL INLINE CONNECTOR
- —11-16— EXTERNAL GROUND
- CASE GROUND
- TERMINAL OR CONNECTOR CAVITY
- INCANDESCENT LAMP
- ELECTROMAGNETIC COIL
- THERMAL CUTOUT (FLASHER)
- DIODE

WIRE COLOR CODES

BK-BLACK	RD-RED
BN-BROWN	GN-GREEN
YL-YELLOW	WH-WHITE
BL-BLUE	OR-ORANGE

KEY

11A-16 BK

- CABLE COLOR
- CABLE GAUGE
- CIRCUIT NUMBER

NOTES

1-MULTIPLE CONNECTORS AT ELECTRICAL EQUIPMENT VIEWED FROM CABLE INSERTION END UNLESS OTHERWISE SPECIFIED.

MT-23713

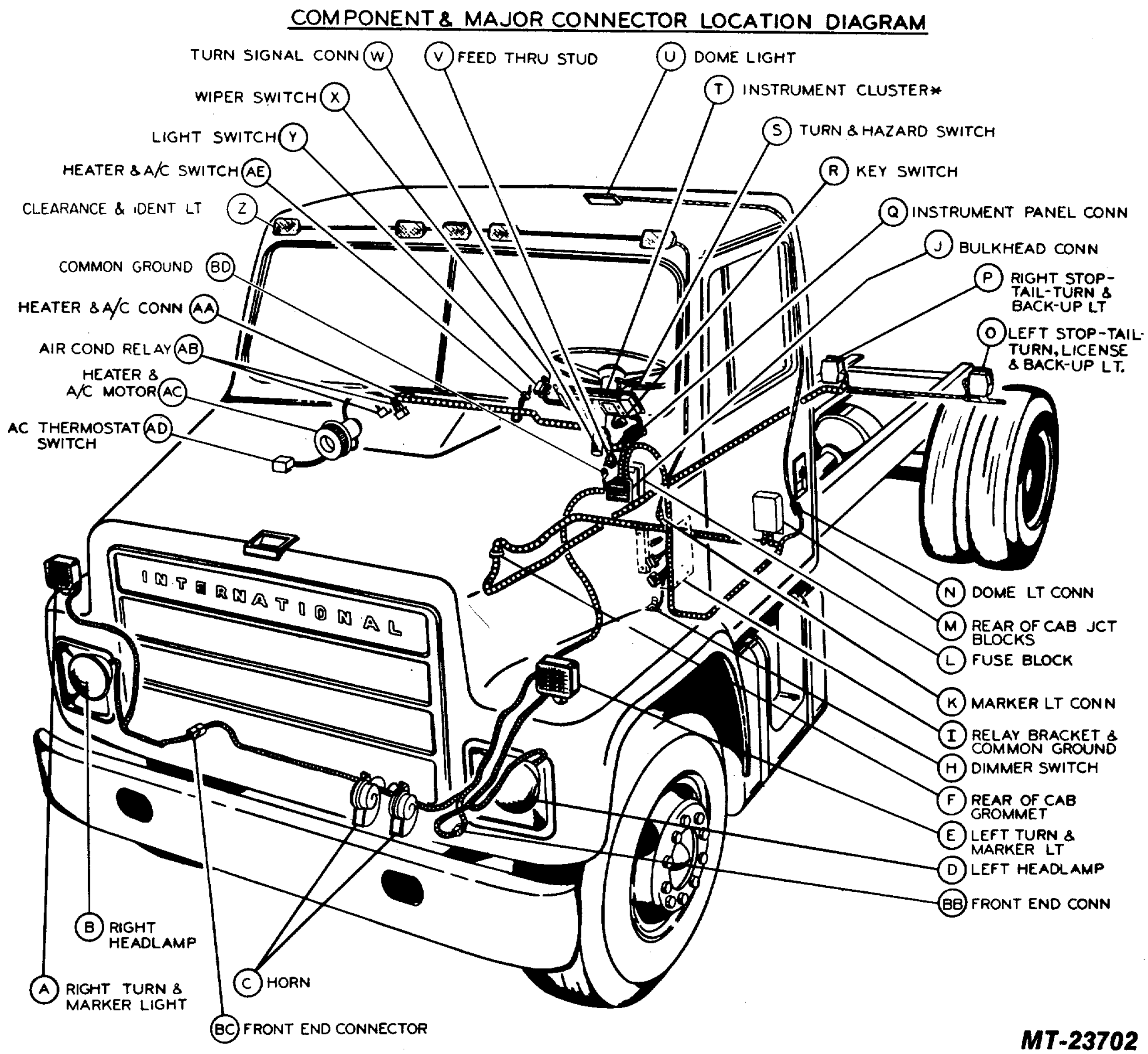
Definition Of Symbols (All Models)

CIRCUIT NUMBERS & DESCRIPTION

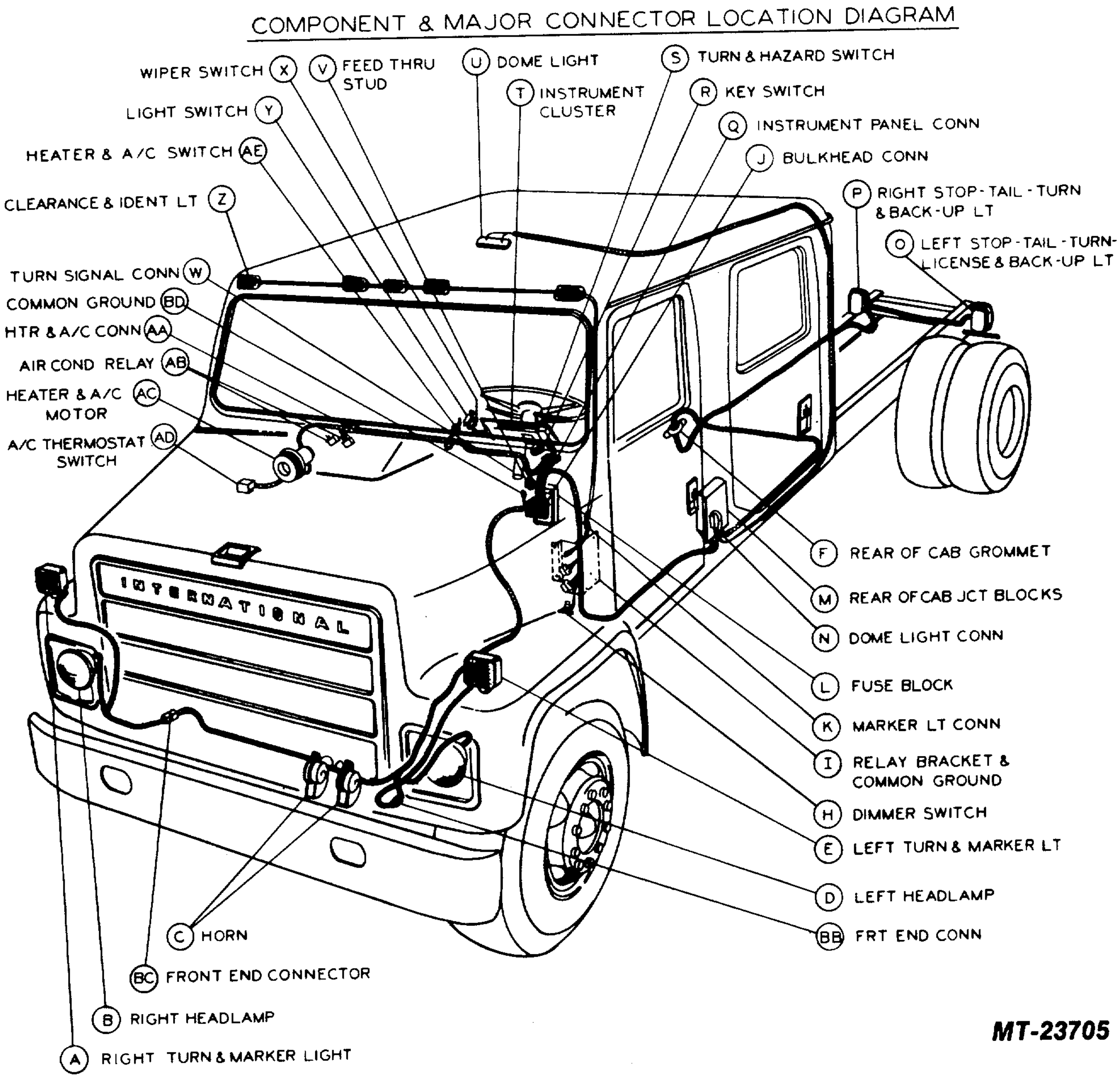
1	GENERATOR (FIELD)
2	GENERATOR (CHARGE)
6	REGULATOR,VOLT (FIELD RELAY)
7	REGULATOR, VOLT (CHARGE)
11	GROUND
14	MAIN FEELD
15	KEY SWITCH
16	IGNITION
17	STARTING CONTROI
18	GLOW PLUG,PRE HEATER
19	FUEL SHUT-OFF
21	ET HER
23	MAGNETIC FAN
24	EXHAUST BRAKE
28	,NSTRUMENT
29	ENG WATER TEMP
50	ENG OIL TEMP
31	TRANS OIL TEMP
32	AXLE OIL TEMP
33	ENG OIL LEVEL
34	WATER LEVEL
35	ENG OIL PRESSURE
36	FUEL LEVEL
37	FUEL PUMP
42	FRT AXLE WARNING
43	P.D. LOCK WARNING
44	,RAKE SYSTEM WARNING
48	TACHOMETER
50	LIGHT SWITCH
51	DIMMER SWITCH
52	HEAD LIGHT-HI-BEAM
53	HEAD LIGHT-LO-BEAM
54	PARKING LIGHTS
55	DIR. SIGNAL SWITCH
56	DIR. SIGNAL LIGHTS-LEFT
57	DIR. SIGNAL LIGHTS-RIGHT
58	CLEAR., IDENT., & MARKER LIGHTS
60	HAZARD SWITCH
62	PANEL LIGHTS
63	DOME &/OR COURTESY LIGHTS
69	TAIL LIGHT
70	STOP LIGHT
71	BACK-UP LIGHT
72	TRAILER
75	HEATER
76	LEFROSTER
77	AIR f)NDITIONER
78	HEAETO MIRROR
80	ACCESSORY FEED
82	WINDSHIELD WIPER
84	'IGAR LIGHTER
85	HORN
86	RADIO
87	WINSHIELD WASHER
88	HOURMETER
90	HY-POWER BRAKES
92	TRANSMISSION
93	AXLE SHIFT
94	WHEELLOCK (ANTI SKID BRAKES)
95	EXHAUST EMISSION

MT-23714 CIRCUIT NUMBERS MAY REQUIRE SUFFIX LETTER IDENTIFICATIUN WHEREVER BRANCHES OF THE MAIN CIRCUIT ARE ENCOUNTERED.

Circuit Numbers And Description (All Models)

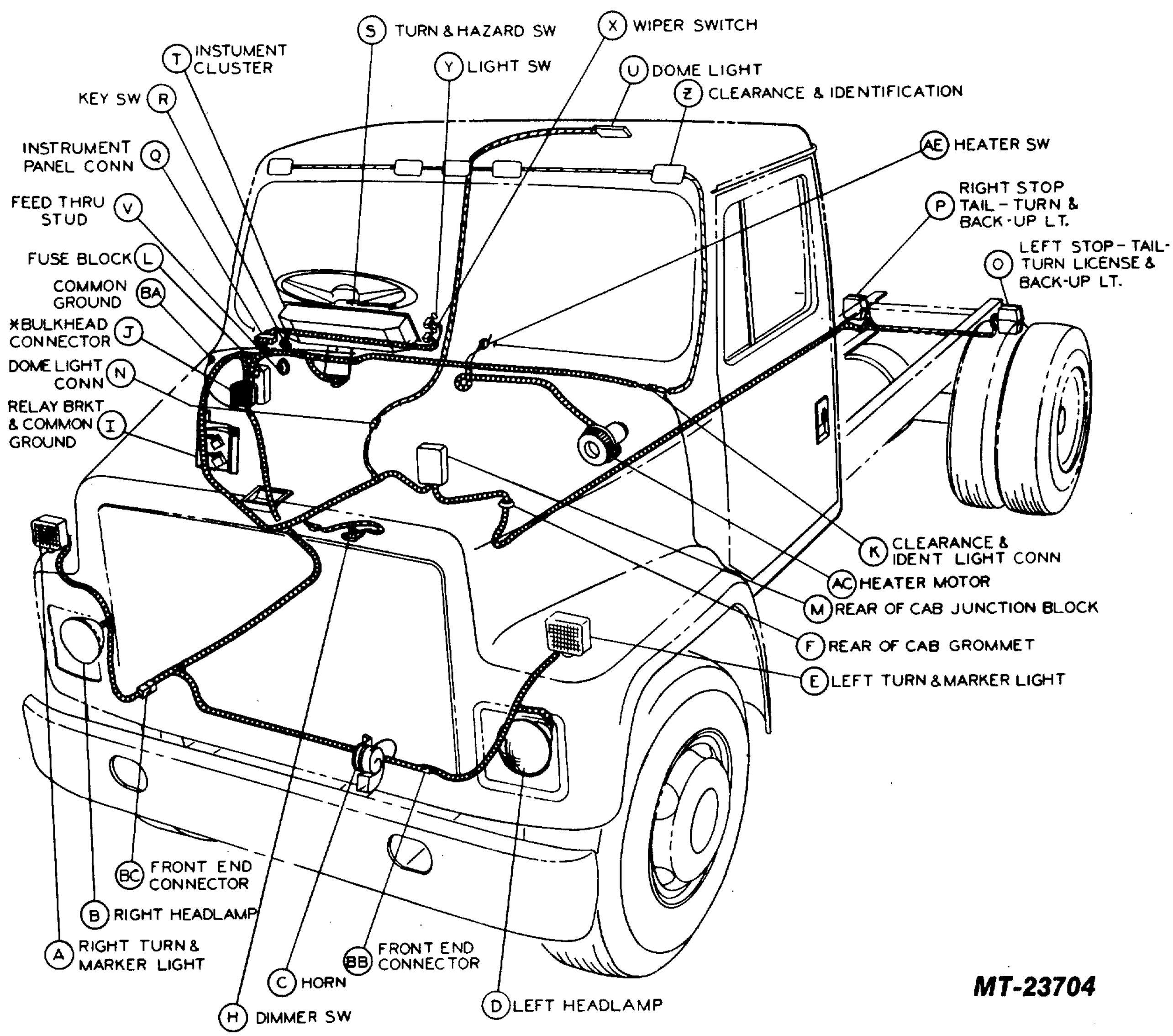


Component And Major Connector Location (On Chassis)
1600 thru 1900 Models

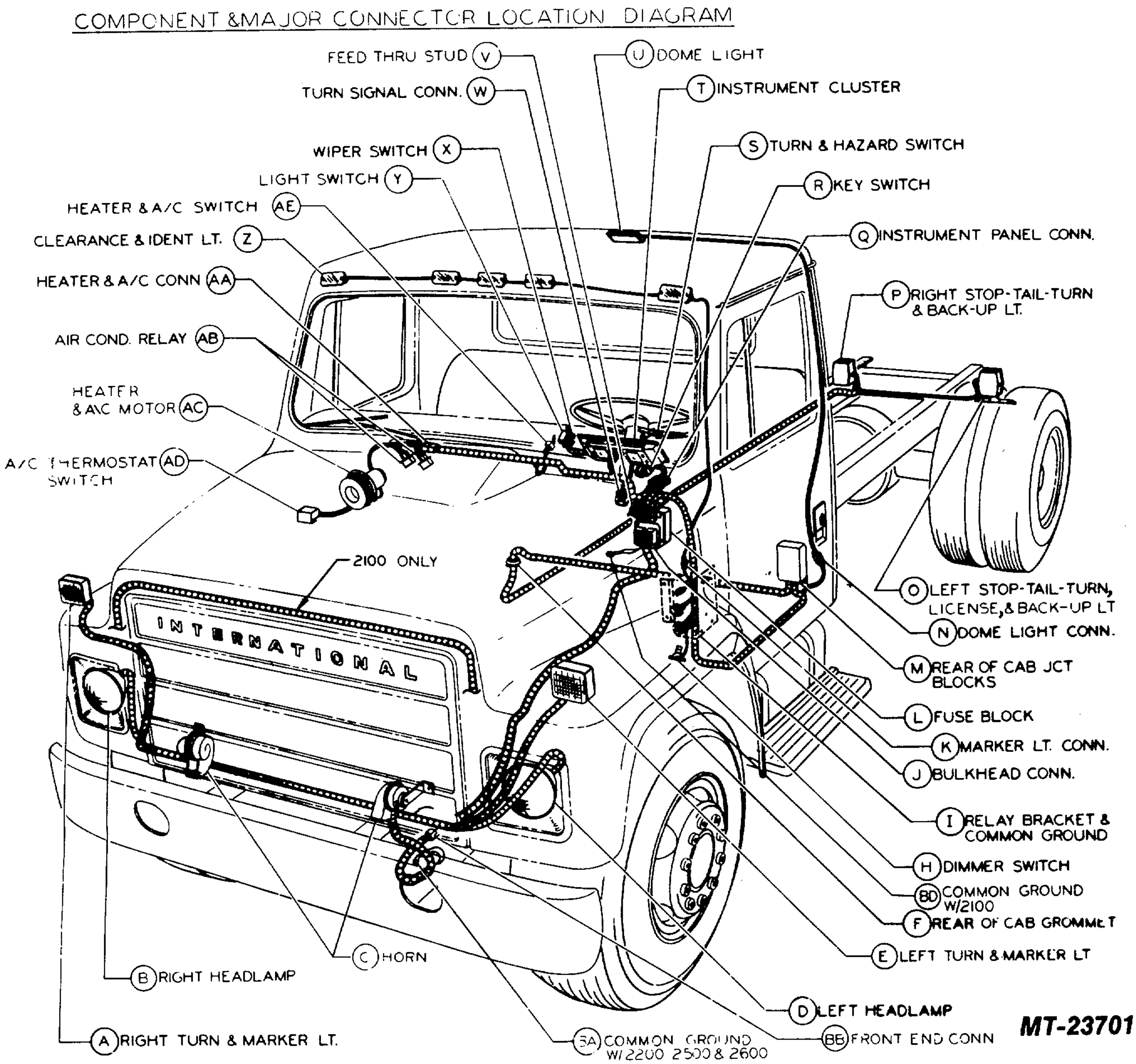


Component And Major Connector Location (On Chassis)
1700 thru 1900 Models

COMPONENT & MAJOR CONNECTOR LOCATION DIAGRAM

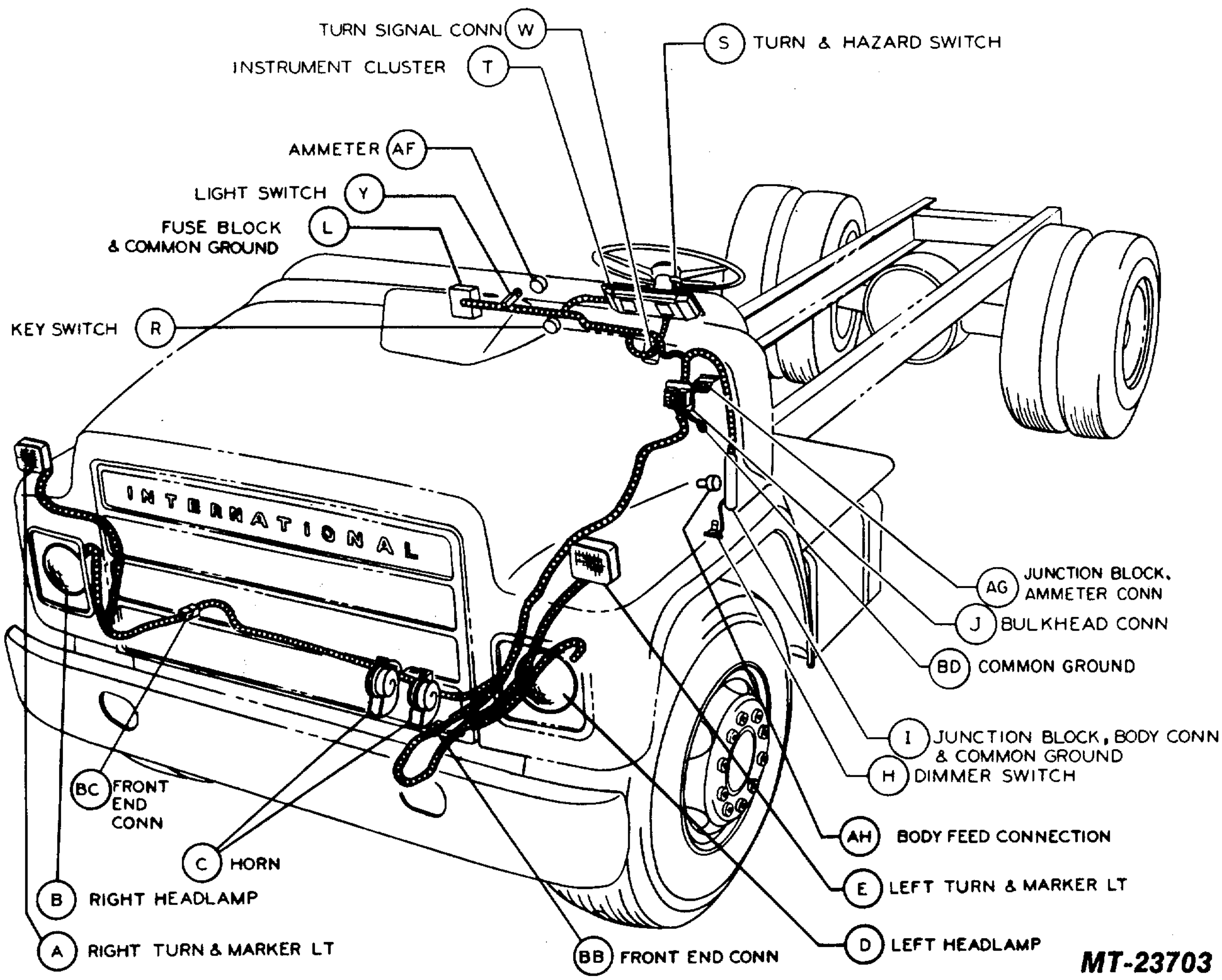


Component And Major Connector Location (On Chassis)
1700 thru 1900 Right Hand Drive Models

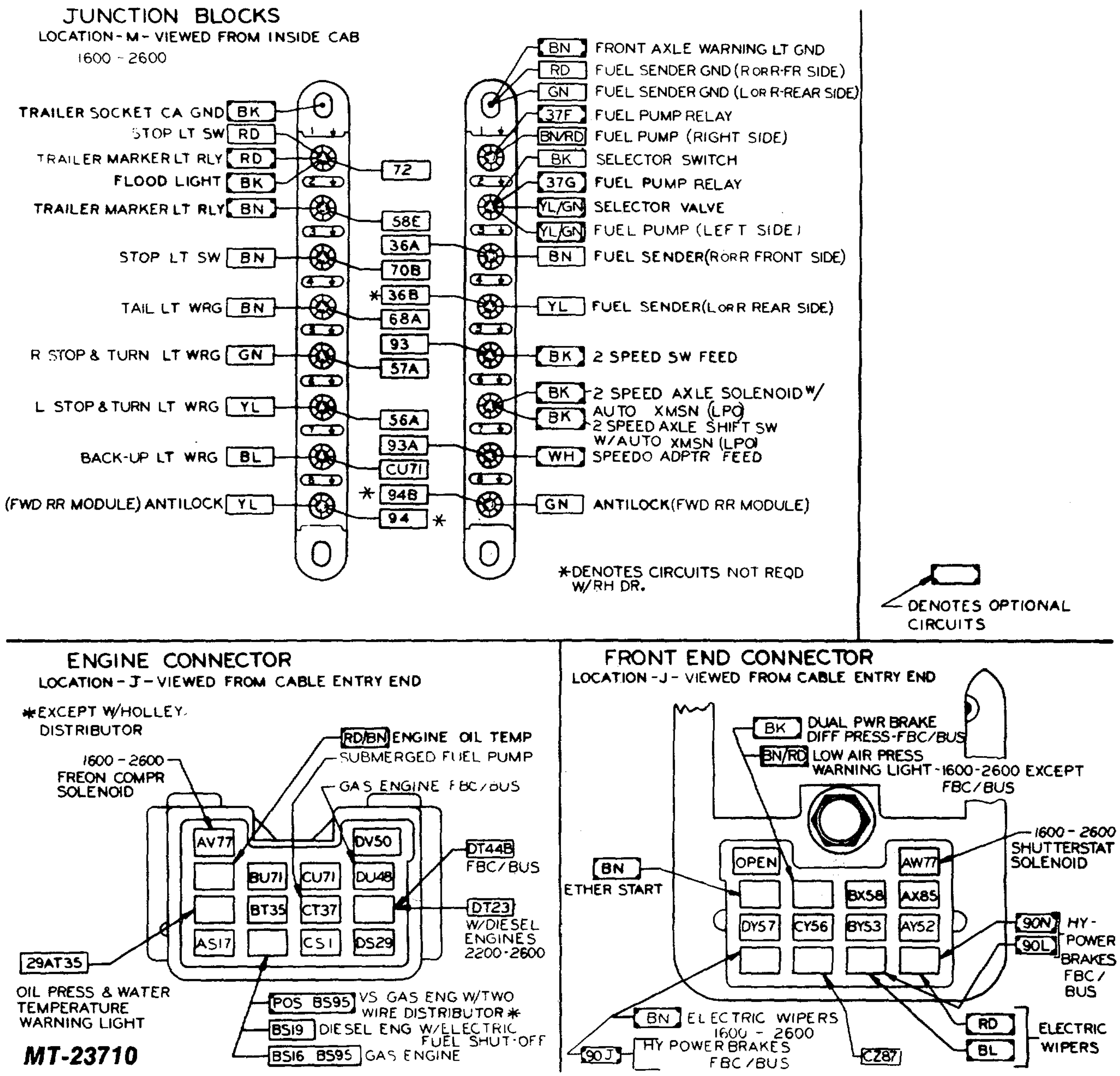


Component And Major Connector Location (On Chassis)
2100 thru 2600 Models

COMPONENT & MAJOR CONNECTOR LOCATION DIAGRAM

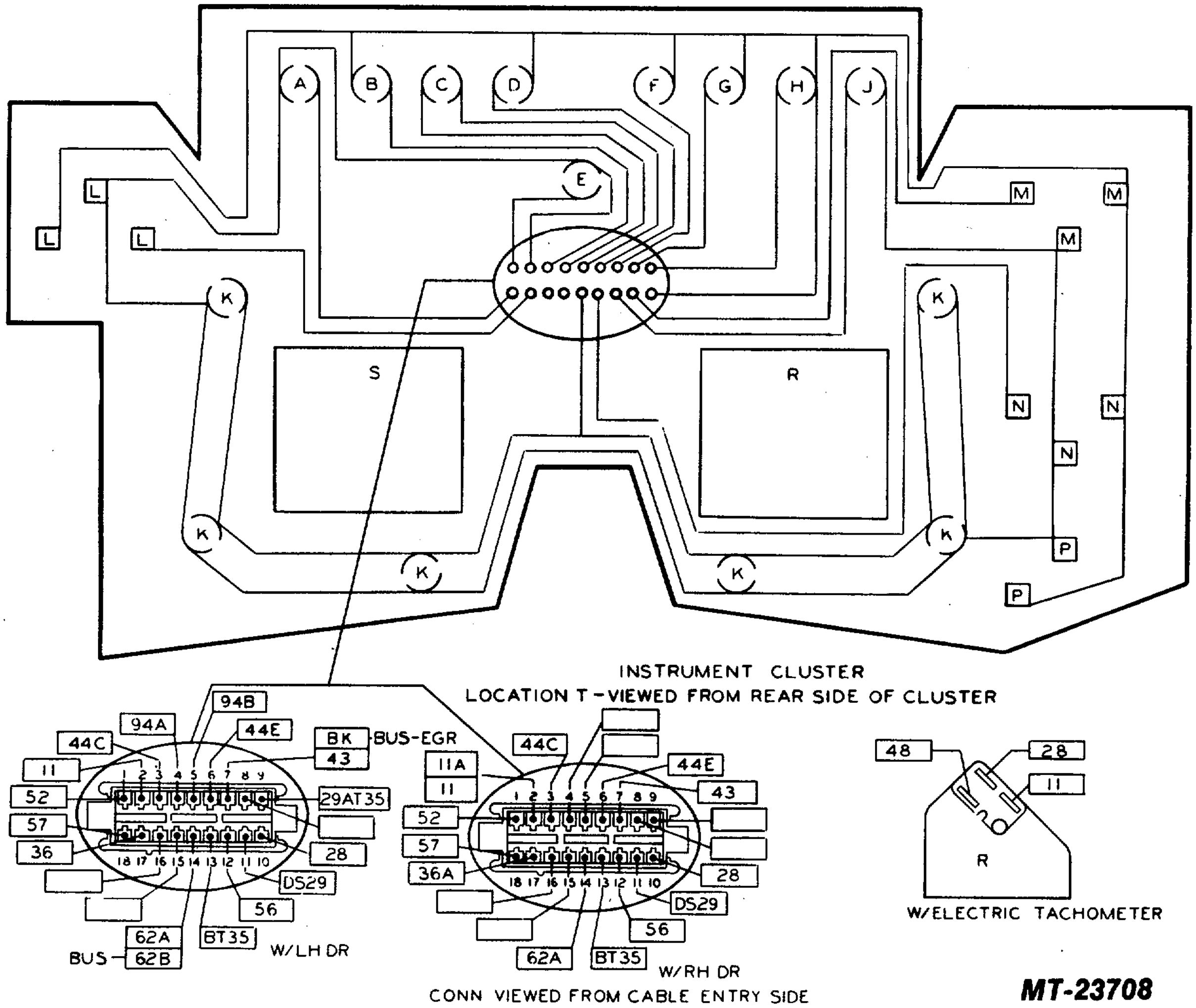


Component And Major Connector Location (On Chassis)
FBC/Bus

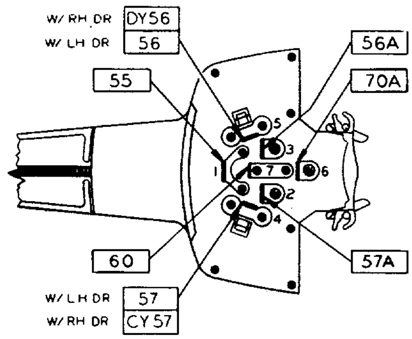


Component And Major Connectors
Junction Blocks - Engine Connector - Front End Connector

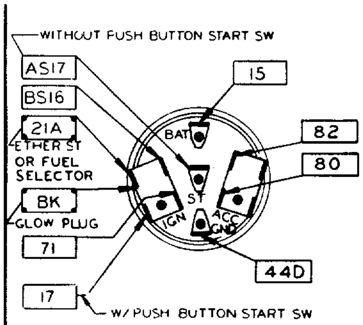
A RT TURN INDICATOR
B BRAKE PRESSURE
C ANTILOCK WARNING
D PARK BRAKE
E HI BEAM INDICATOR
F POWER DIVIDER LOCK WARN OR SERVICE EGR
G ANTILOCK WARNING
H LOW OIL PRESS & HIGH WATER TEMPERTURE WARNING
J LEFT TURN INDICATOR
K PANEL LIGHT
L FUEL GAUGE
M WATER TEMP GAUGE
N OIL PRESS GAUGE
P VOLTMETER
R TACHOMETER
S SPEEDOMETER



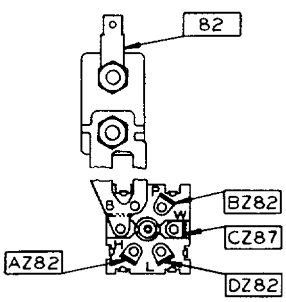
Component And Major Connectors
Instrument Cluster



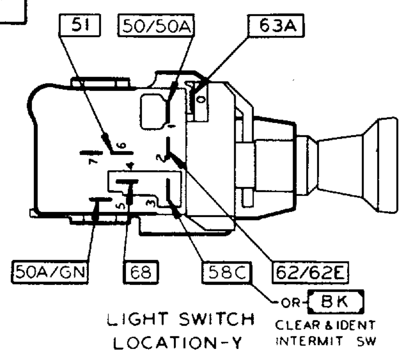
TURN SIGNAL SWITCH
LOCATION-S
VIEWED FROM TERMINAL SIDE



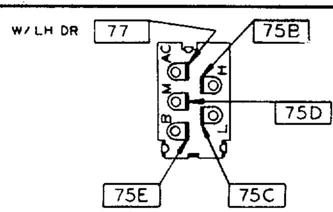
KEY SWITCH LOCATION-R
VIEWED FROM TERMINAL SIDE



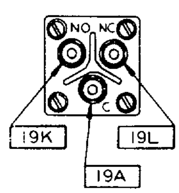
WIPER/WASHER SWITCH
LOCATION-X
VIEWED FROM TERMINAL SIDE



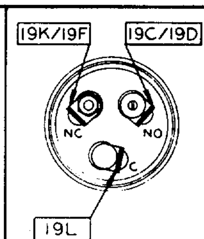
LIGHT SWITCH
LOCATION-Y
VIEWED FROM TERMINAL SIDE



HEATER/A-C SWITCH
LOCATION-AE
VIEWED FROM TERMINAL SIDE



SHT-DN TEMP SW



SHT-DN PRESS SW

SWITCH CONTACT CHART

SWITCH	POSITION	CONTACTS CLOSED	CONTACTS OPEN
TURN SIGNAL & HAZARD	OFF (NORMAL)	2,3 & 6	1,4,5 & 7
	LEFT TURN & LANE CHANGE	1,3 & 5 2 & 6	4 & 7
	RIGHT TURN & LANE CHANGE	1,2 & 4 3 & 6	5 & 7
	HAZARD	2,3,4,5 & 7	1 & 6
HEAD LIGHT	OFF-(KNOB IN & TURNED C.W.)	2,3 & 4	0,1,5,6 & 7
	PARK LIGHTS (KNOB IN 1ST POS.)	1 & 7 2,3,4 & 5	0 & 6
	HEAD LIGHTS (KNOB IN 2ND POS.)	1 & 6 2,3,4 & 5	0 & 7
	DOME-(KNOB IN & TURN C.C.W.)	0 TO GND 3,4 & 2	1,5,6 & 7
	PANEL-(2ND POS. TURN C.C.W. TO LOCK)	0 TO GND 1 & 6 2,3,4 & 5	7
KEY	OFF	NONE	ALL
	START	BAT-ST-IGN GND-CASE	ACC
	IGNITION	BAT-IGN-ACC	ST-GND
	ACCESSORY	BAT-ACC	ST-IGN-GND
HEATER & A/C	OFF	NONE	ALL
	LOW	BAT-L-A/C	M-H
	MED	BAT-M-A/C	L-H
	HIGH	BAT-H-A/C	L-M
WIPER/ WASHER	PARK	BAT-P	W-L-H
	LOW	BAT-L	W-P-H
	HIGH	BAT-H	W-P-L
	WASHER (KNOB IN)	BAT-W	L-M-H
SHT-DN TEMP	NORMAL (BELOW 204°)	C-NC	C-NO
	ALARM (204°-210°)	C-NC C-NO	NONE
	SHUT-DOWN (ABOVE 210°)	C-NO	C-NC
SHT-DN PRESS	ENG OFF	C-NC	C-NO
	NORMAL	C-NO	C-NC
	ALARM (7 OR 11 P.S.I.)	C-NO C-NC	NONE
	SHUT-DOWN (3 OR 6 P.S.I.)	C-NC	C-NO

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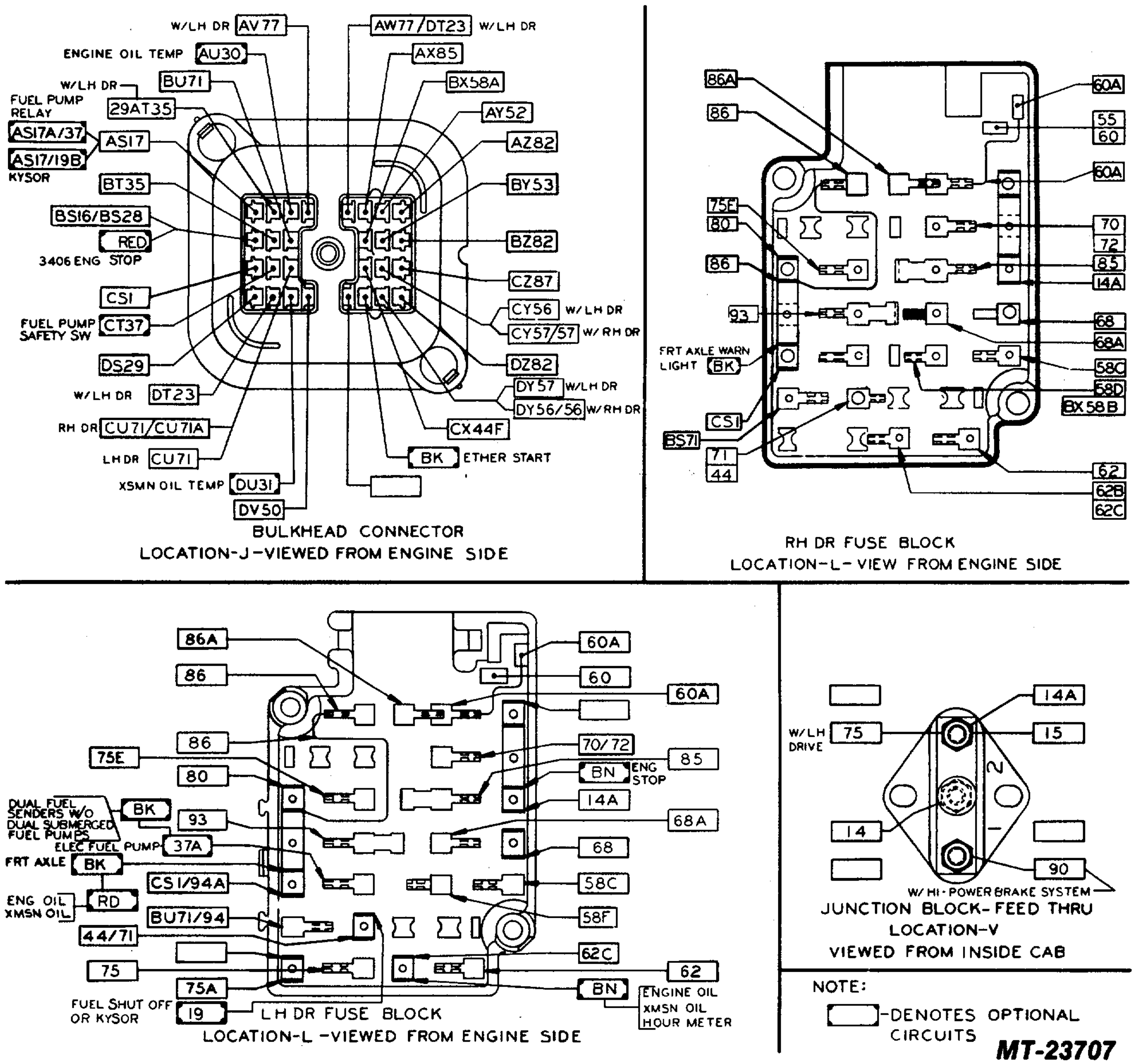
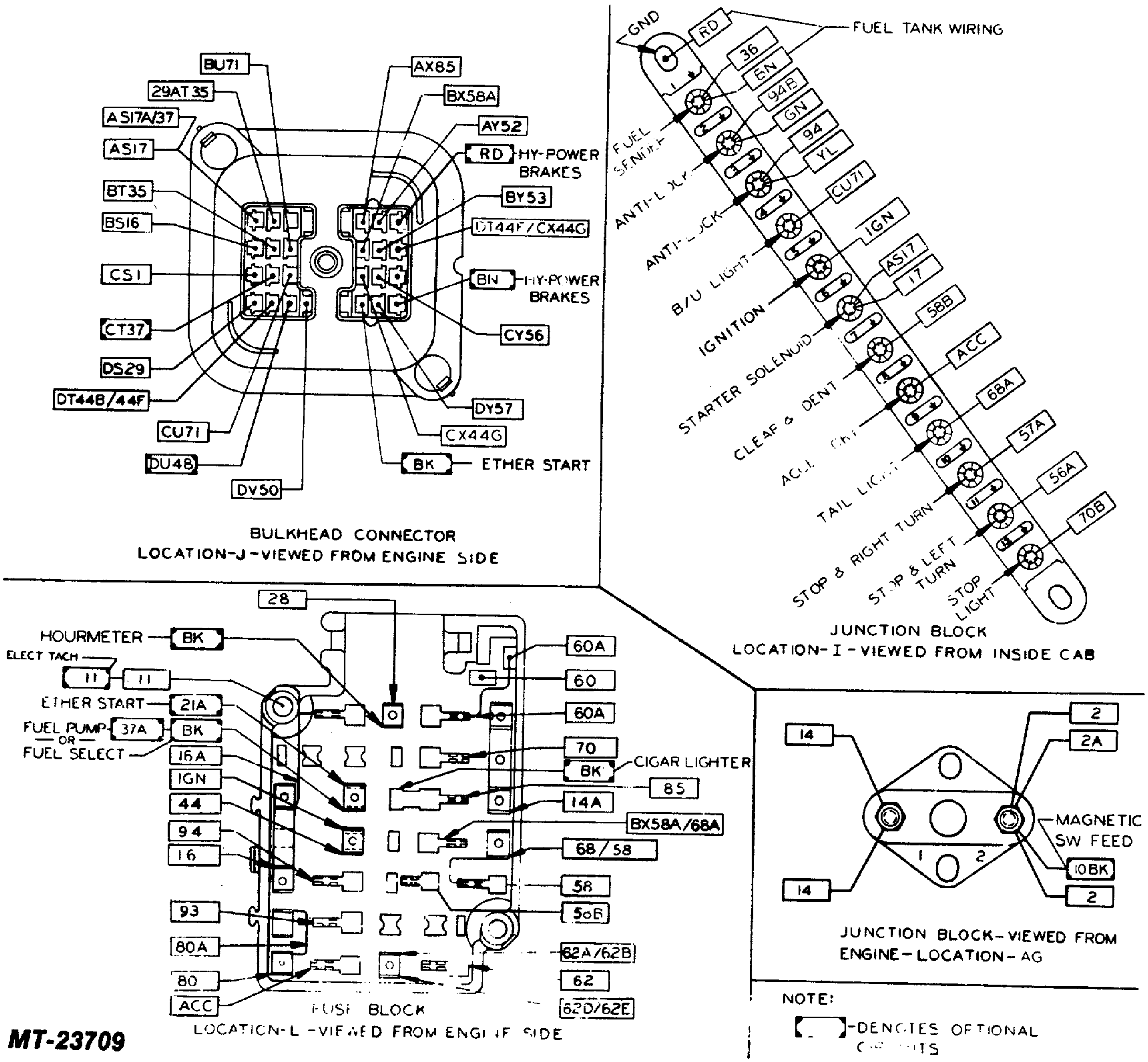
NOTE: [ ] DENOTES OPTIONAL CIRCUITS

Component And Major Connectors (Not Schoolbus)
Turn Signal Switch - Key Switch - Windshield Wiper/Washer Switch
Light Switch - Heater/Air Conditioner Switch - Shut Down Temperature Switch
Shutdown Pressure Switch



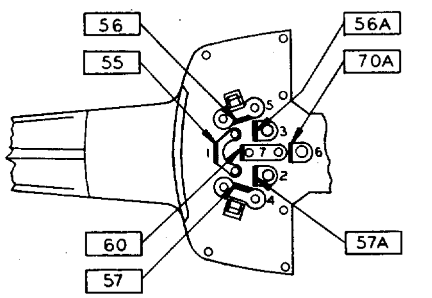
Component And Major Connectors (Not Schoolbus)

Bulkhead Connector - Fuse Blocks - Junction Block

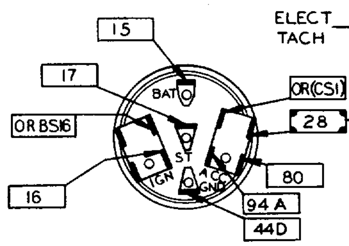


Component And Major Connector (Schoolbus)

Bulkhead Connector - Fuse Block - Junction Block

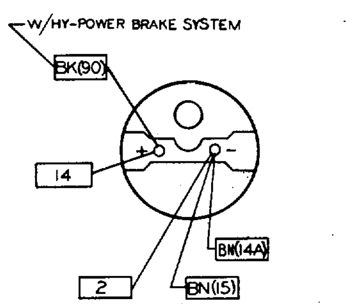


TURN SIGNAL SWITCH
LOCATION-S
VIEWED FROM TERMINAL SIDE

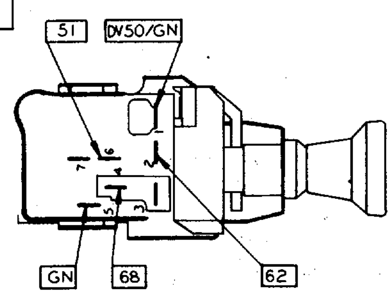


KEY SWITCH
LOCATION-R
VIEWED FROM TERMINAL SIDE

SWITCH	POSITION	CONTACTS CLOSED	CONTACTS OPEN
TURN SIGNAL & HAZARD	OFF (NORMAL)	2,3 & 6	1,4,5 & 7
	LEFT TURN & LANE CHANGE	1,3 & 5 / 2 & 6	4 & 7
	RIGHT TURN & LANE CHANGE	1,2 & 4 / 3 & 6	5 & 7
	HAZARD	2,3,4,5 & 7	1 & 6
HEAD LIGHT	OFF-(KNOB IN- & TURNED C.W.)	2,3&4	0,1,5,6 & 7
	PARK LIGHTS (KNOB IN- 1 ST POS.)	1 & 7 / 2,3,4&5	0 & 6
	HEAD LIGHTS (KNOB IN- 2 ND POS.)	1 & 6 / 2,3,4&5	0 & 7
	DOME-(KNOB IN & TURN C.C.W.)	0 TO GND / 3,4 & 2	1,5,6 & 7
	PANEL-(2 ND- POS. TURN- C.C.W. TO LOCK)	0 TO GND / 1 & 6 / 2 3 4&5	7
KEY	OFF	NONE	ALL
	START	BAT-ST-IGN / GND-CASE	ACC
	IGNITION	BAT-IGN-ACC	ST-GND
	ACCESSORY	BAT-ACC	ST-IGN-GND



AMMETER
LOCATION-AF
VIEWED FROM TERMINAL SIDE

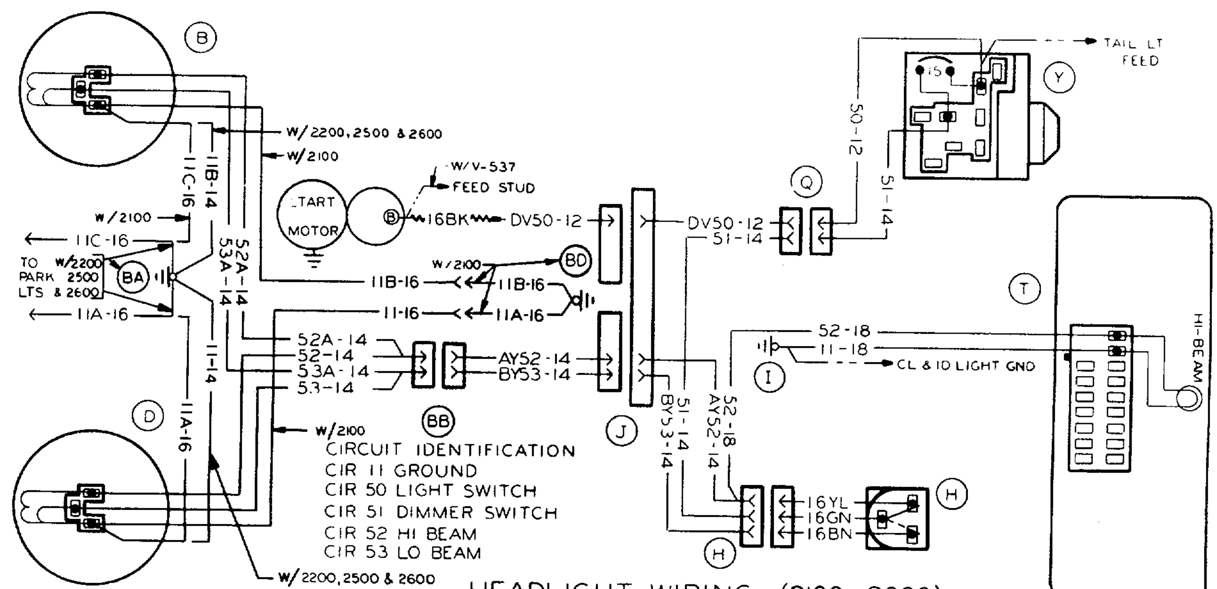


LIGHT SWITCH
LOCATION-Y
VIEWED FROM TERMINAL SIDE

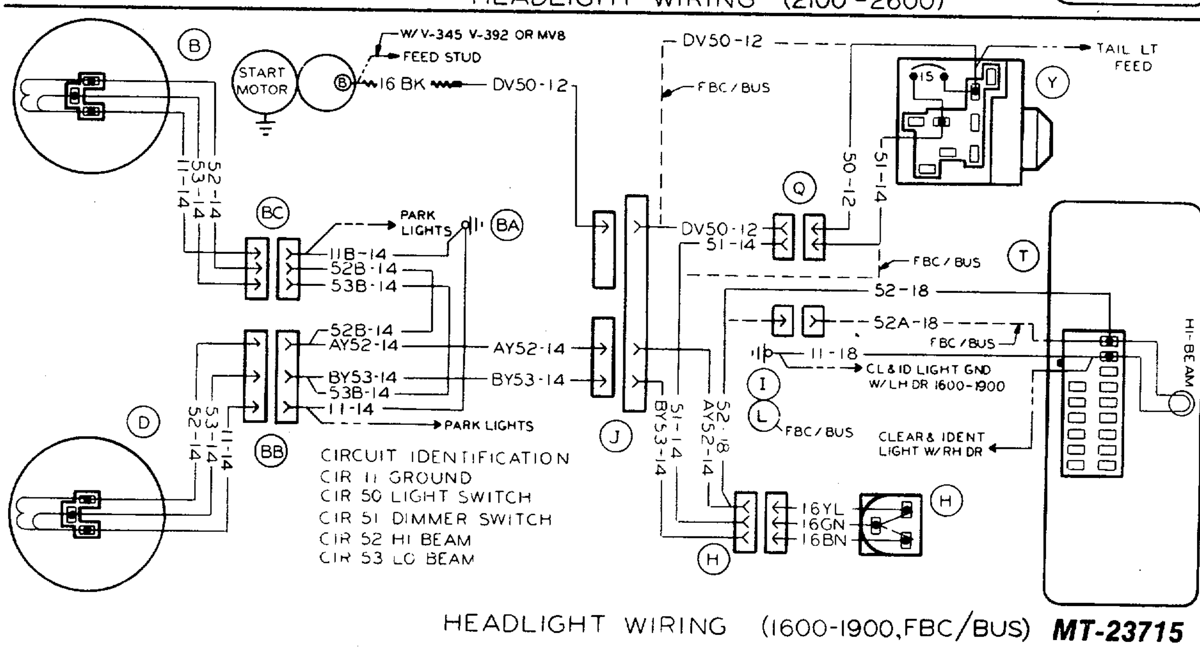
MT-23711

Component And Major Connectors (Schoolbus)

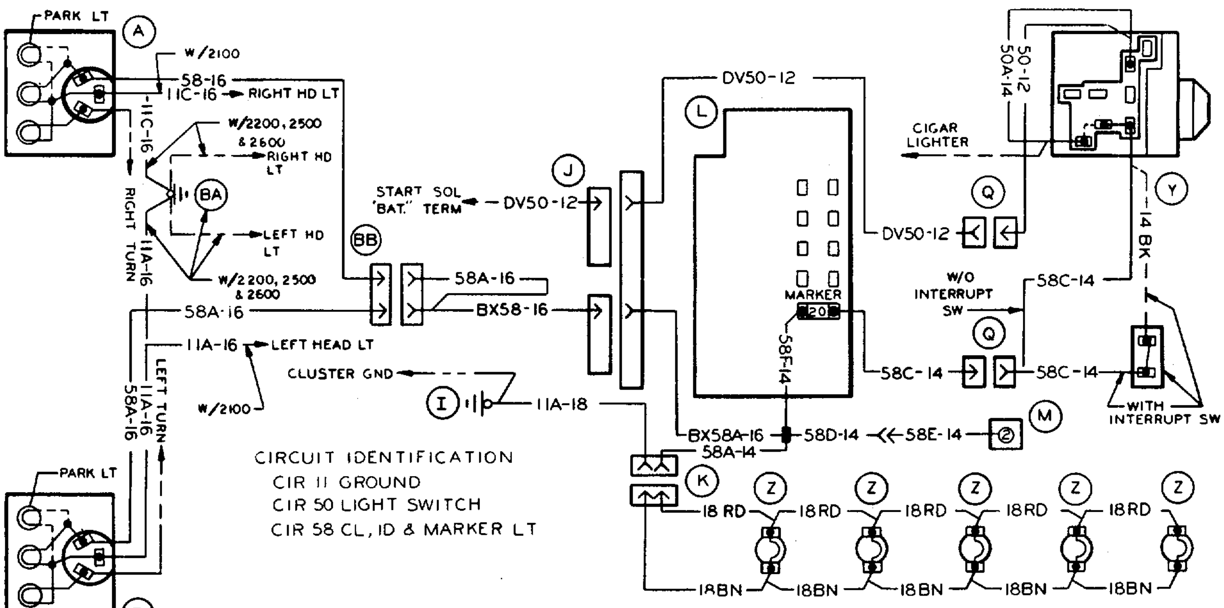
Turn Signal Switch - Key Switch - Ammeter - Light Switch



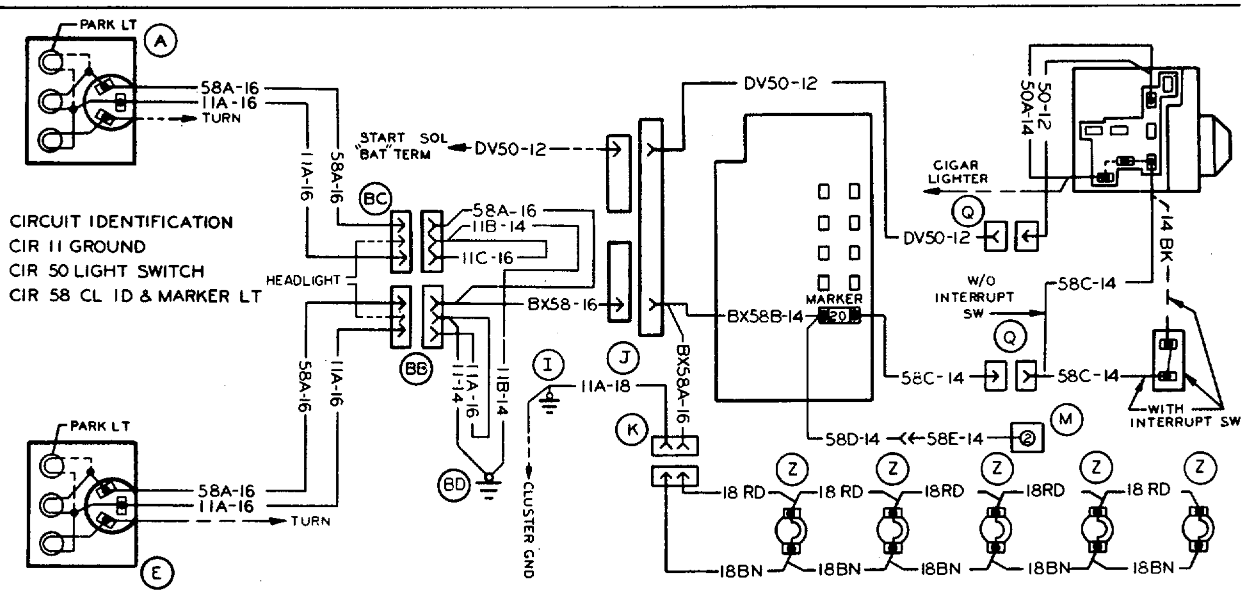
HEADLIGHT WIRING (2100-2600)



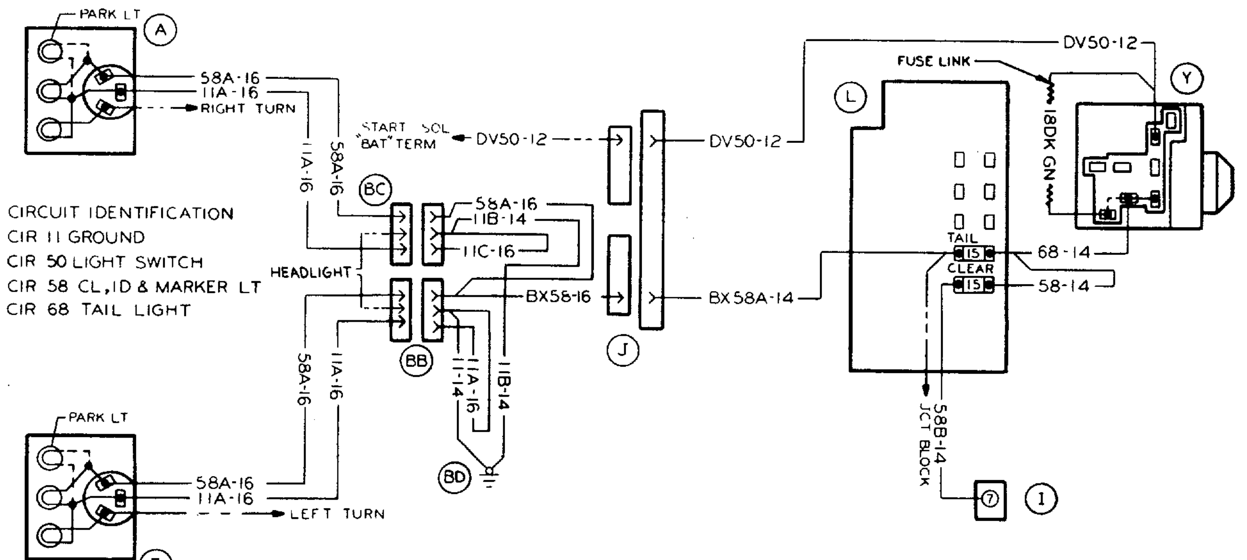
HEADLIGHT WIRING (1600-1900, FBC/BUS) **MT-23715**



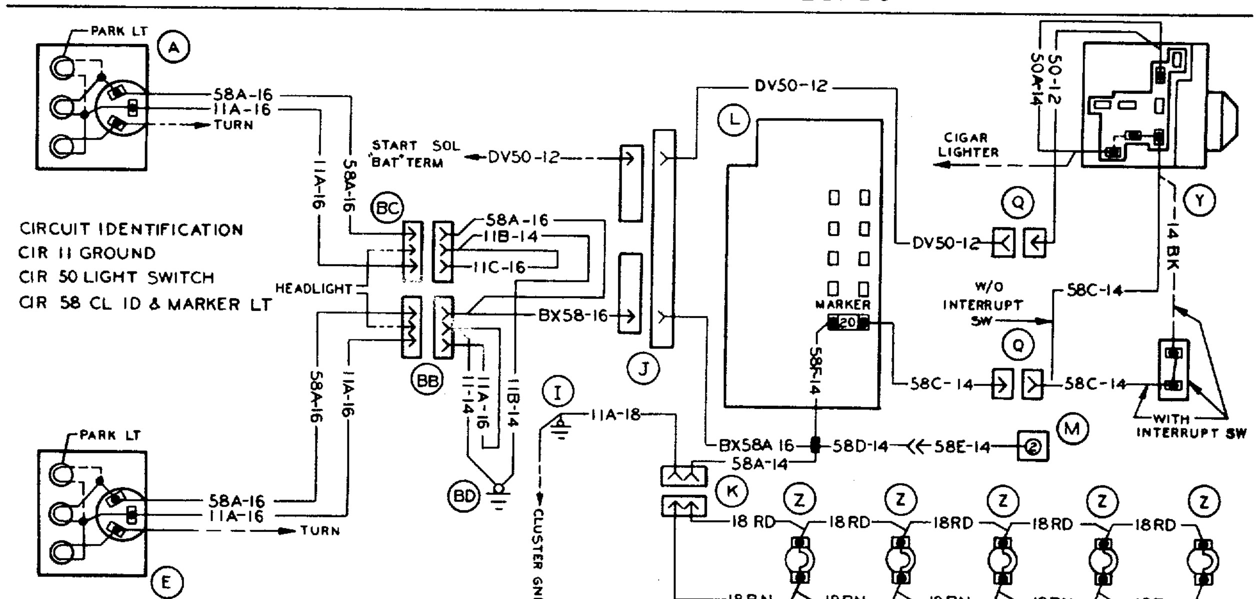
CLEARANCE - IDENTIFICATION - PARK & MARKER LT WIRING 2100 - 2600



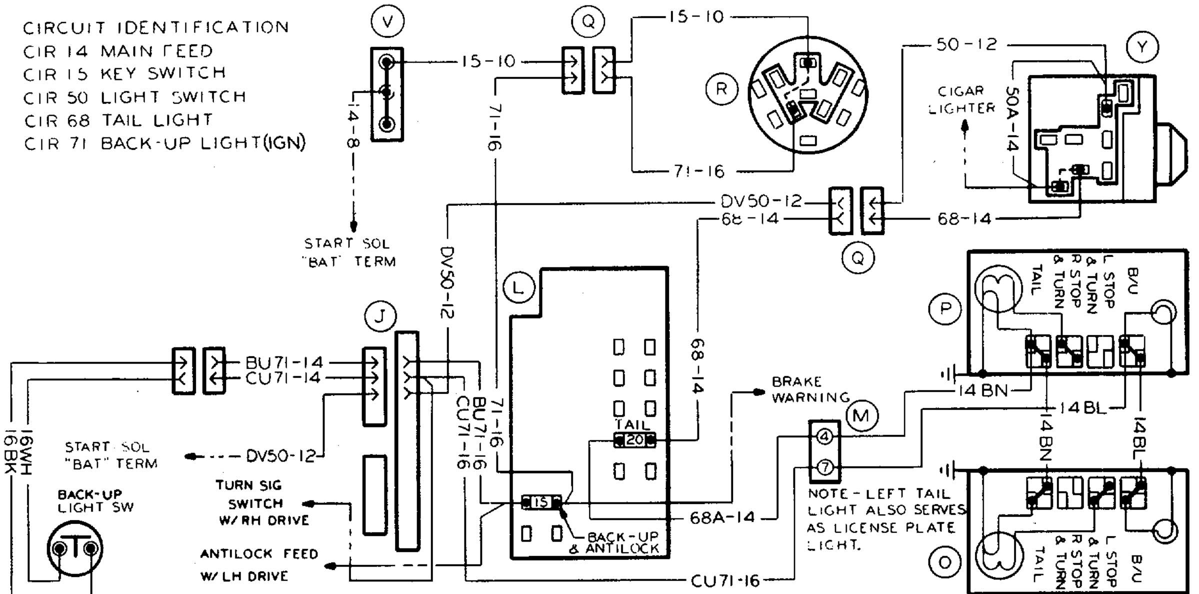
MT-23716 CLEARANCE — IDENTIFICATION — PARK & MARKER LT WIRING 1600 1900 RH DF



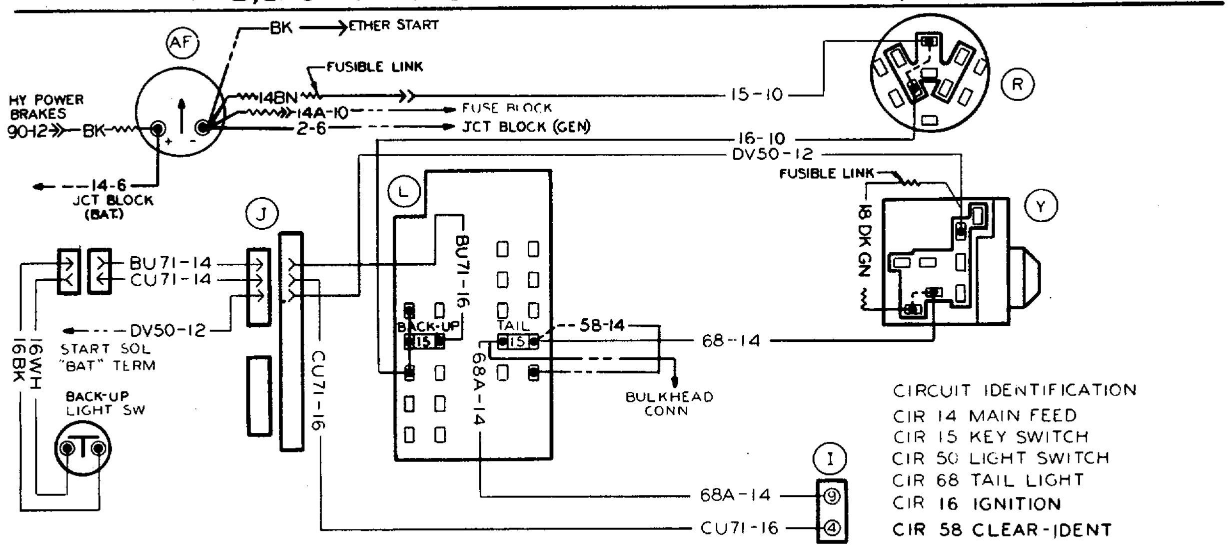
PARK & MARKER LIGHT WIRING FBC/BUS



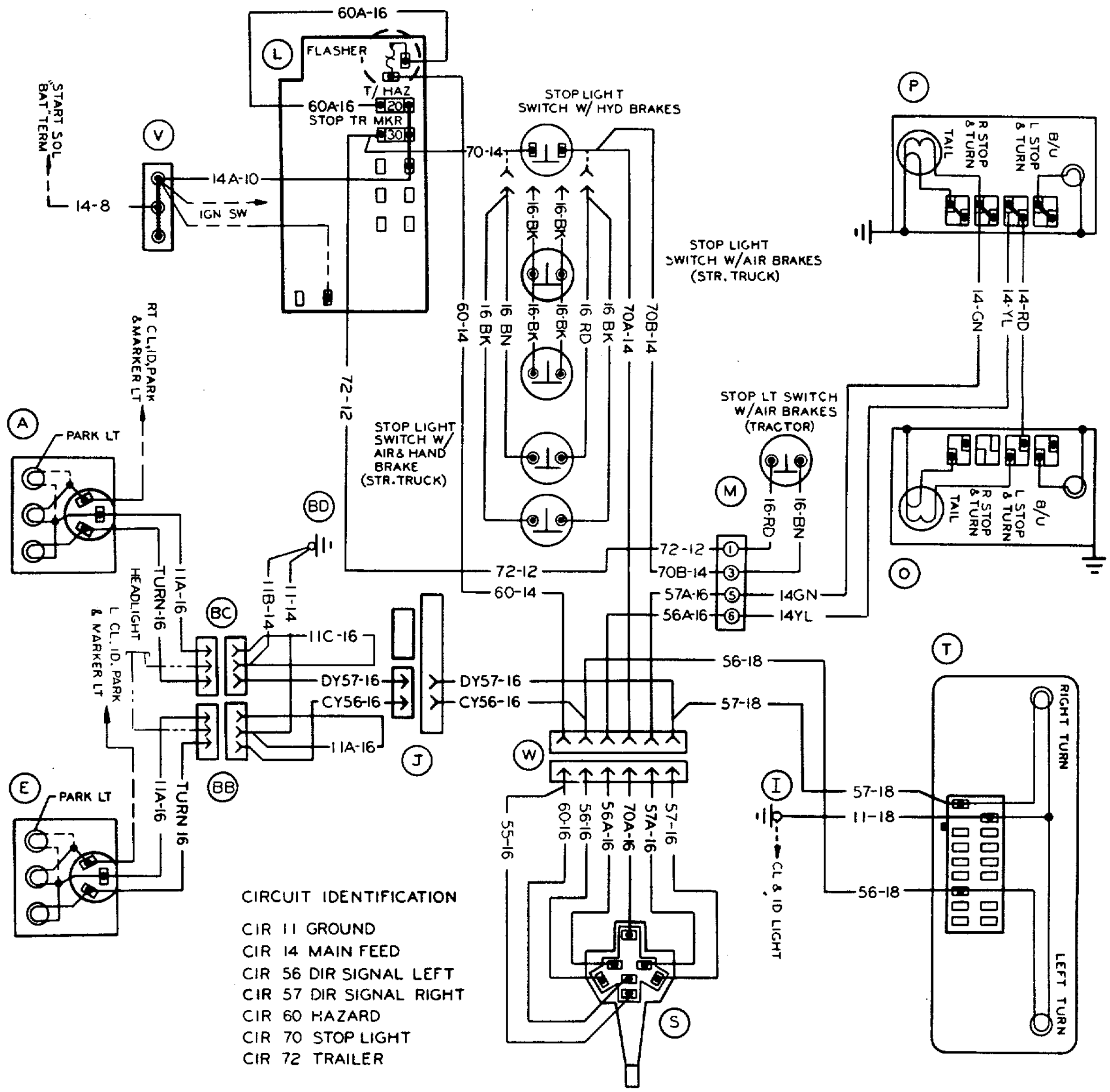
MT-23717 CLEARANCE — IDENTIFICATION — PARK & MARKER LT WIRING 1600-1900 LH DR



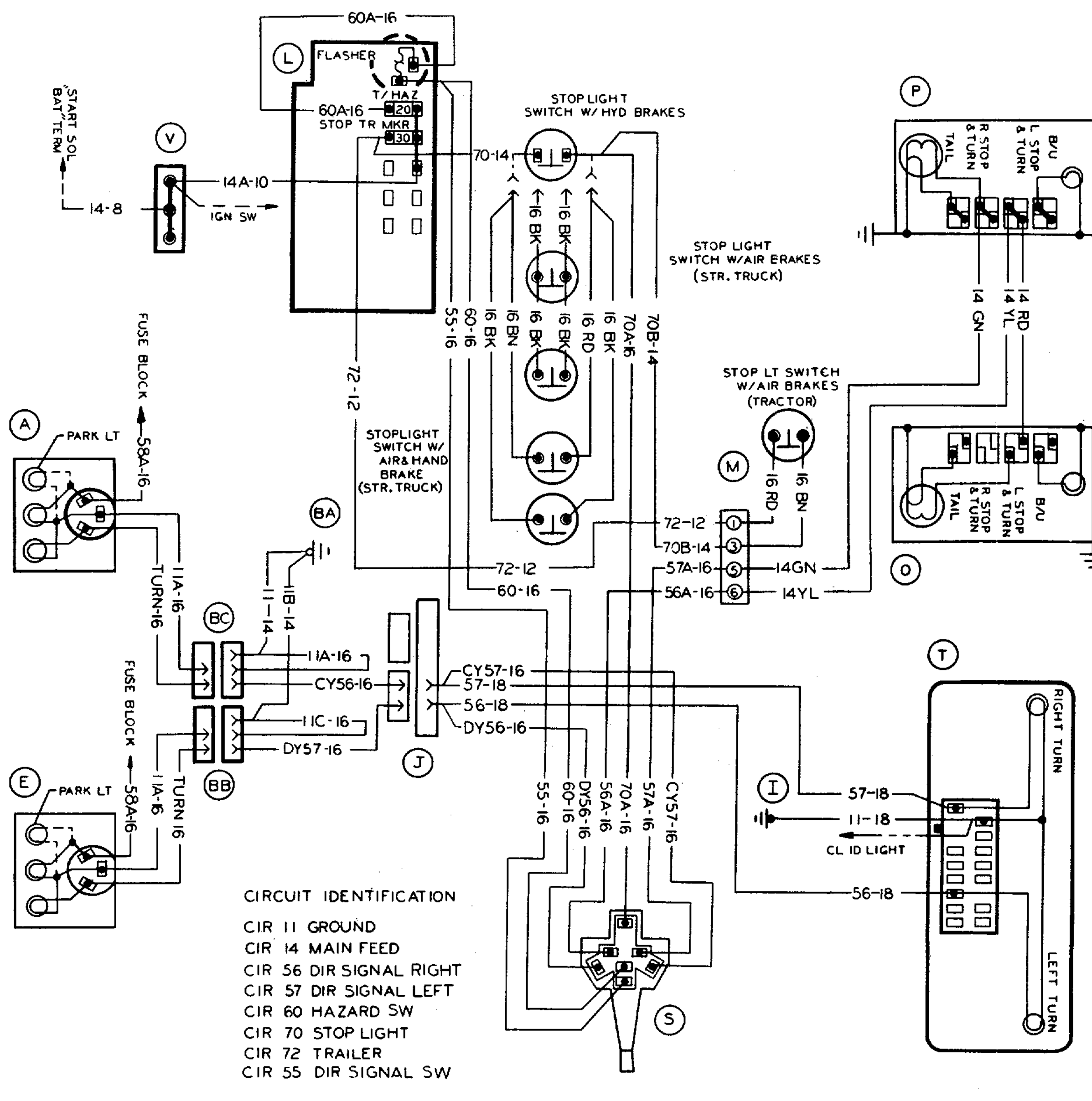
TAIL, BACK-UP & LICENSE PLATE LIGHT WIRING (1600 - 2600)



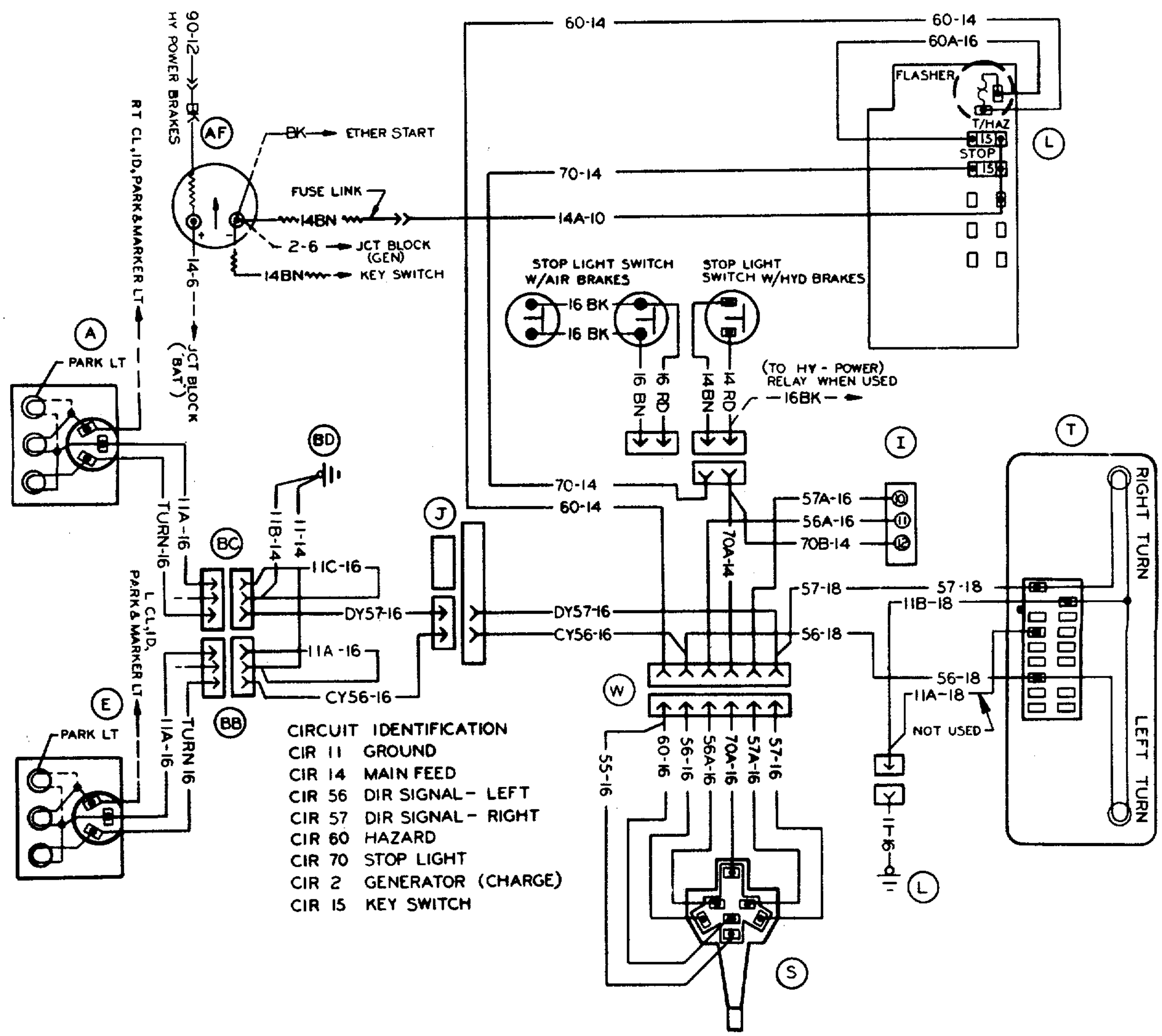
TAIL, BACK-UP & LICENSE PLATE LIGHT WIRING (FBC / BUS) **MT-23718**



MT-23722 TURN HAZARD & STOP LIGHT WIRING LH DR 1600,1700, 1800 & 1900



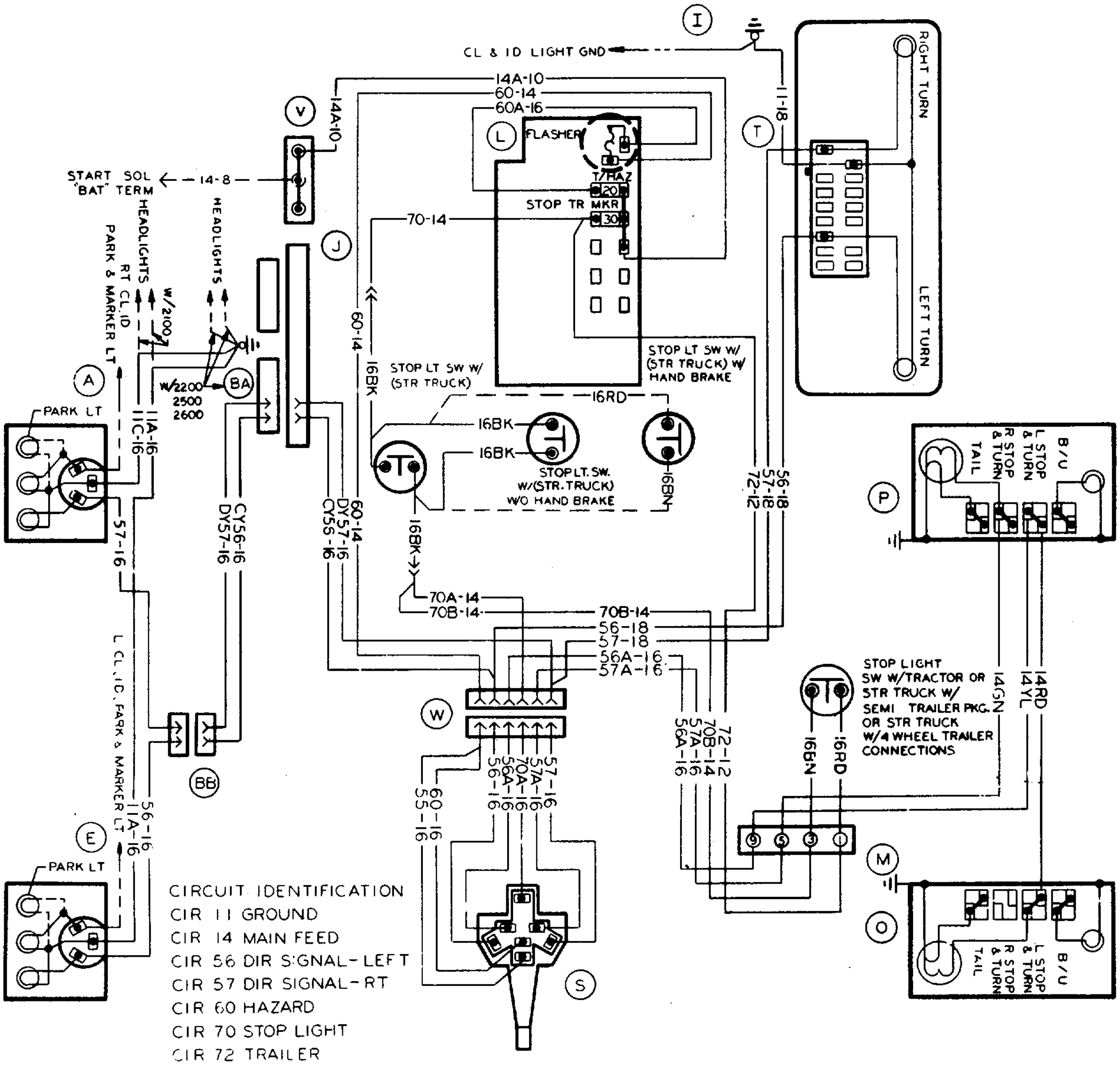
MT-23720 TURN HAZARD & STOP LIGHT WIRING RH DR 1700 1800 & 1900



CIRCUIT IDENTIFICATION
CIR 11 GROUND
CIR 14 MAIN FEED
CIR 56 DIR SIGNAL- LEFT
CIR 57 DIR SIGNAL- RIGHT
CIR 60 HAZARD
CIR 70 STOP LIGHT
CIR 2 GENERATOR (CHARGE)
CIR 15 KEY SWITCH

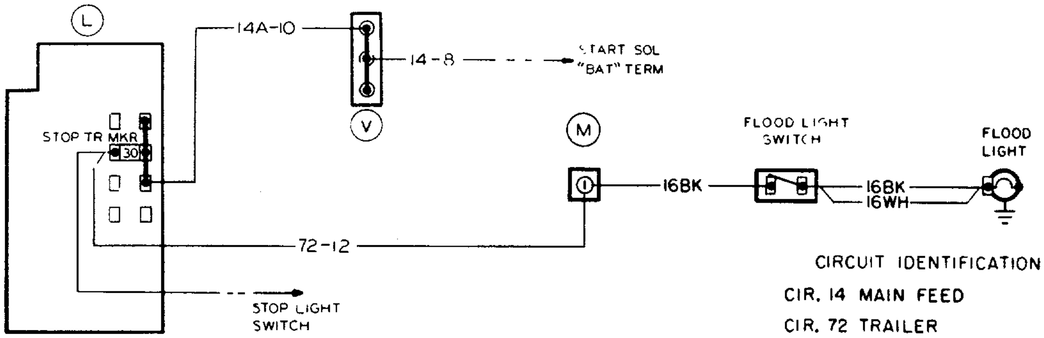
MT-23721

TURN HAZARD & STOP LIGHT WIRING — FBC/BUS

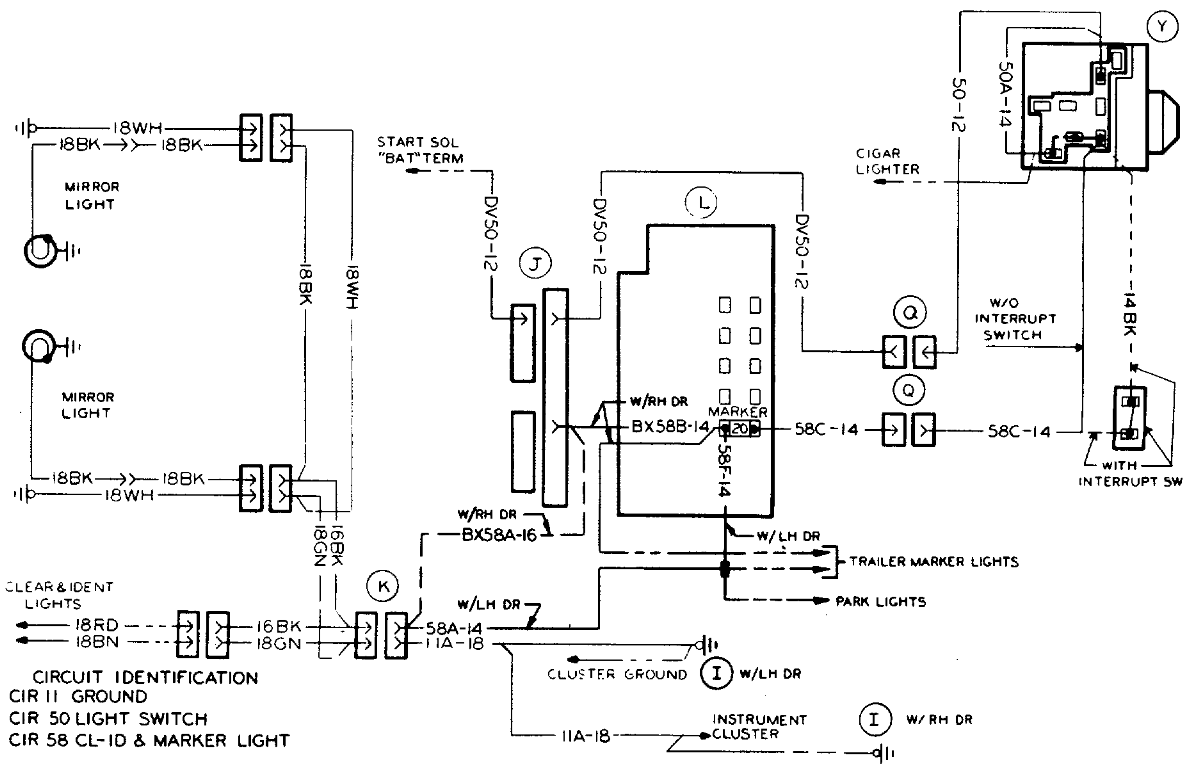


MT-23719

TURN, HAZARD & STOP LIGHT WIRING
2100, 2200, 2500 & 2600

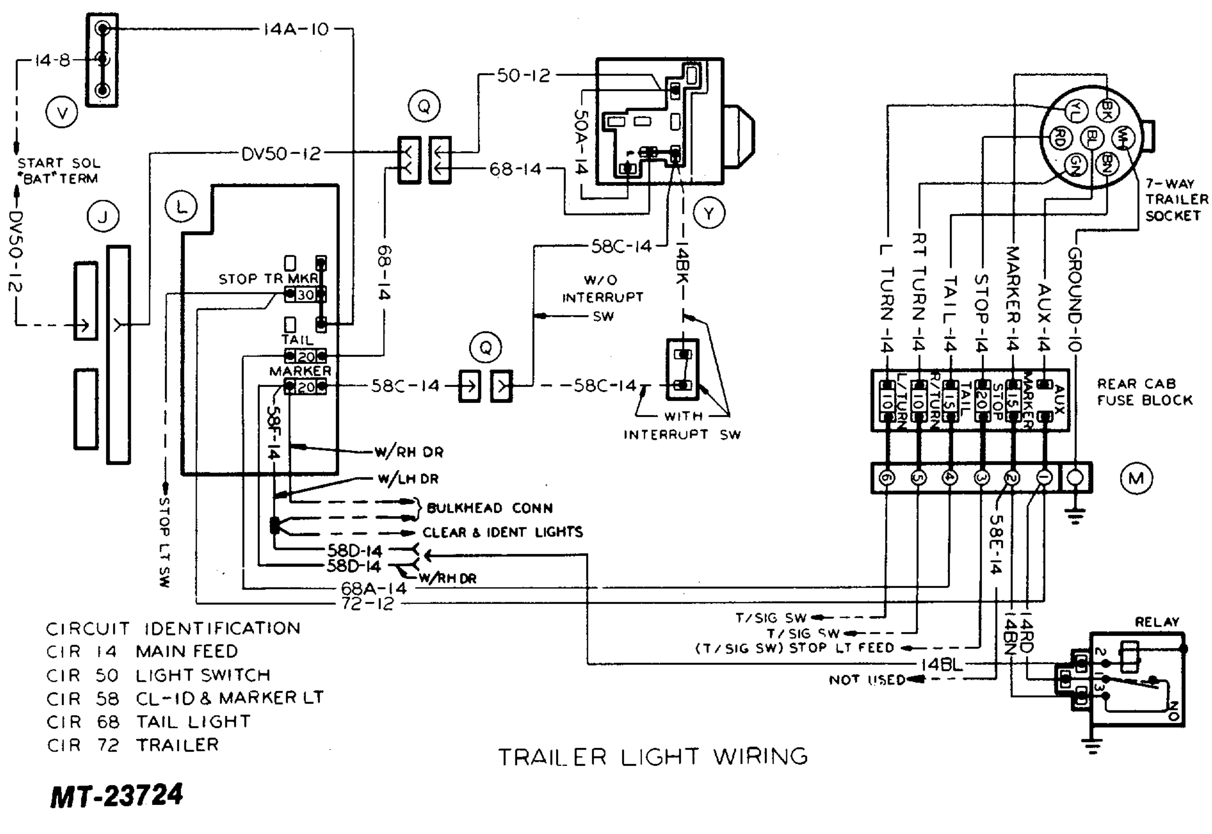


FLOOD LIGHT WIRING



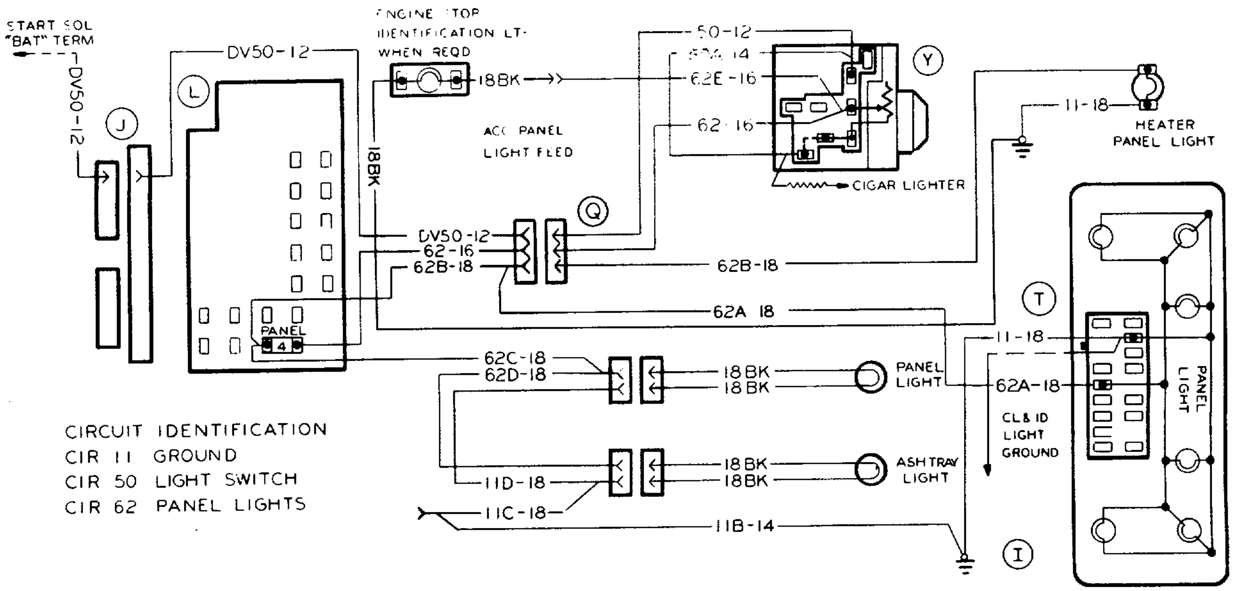
MT-23723

LIGHTED MIRROR WIRING

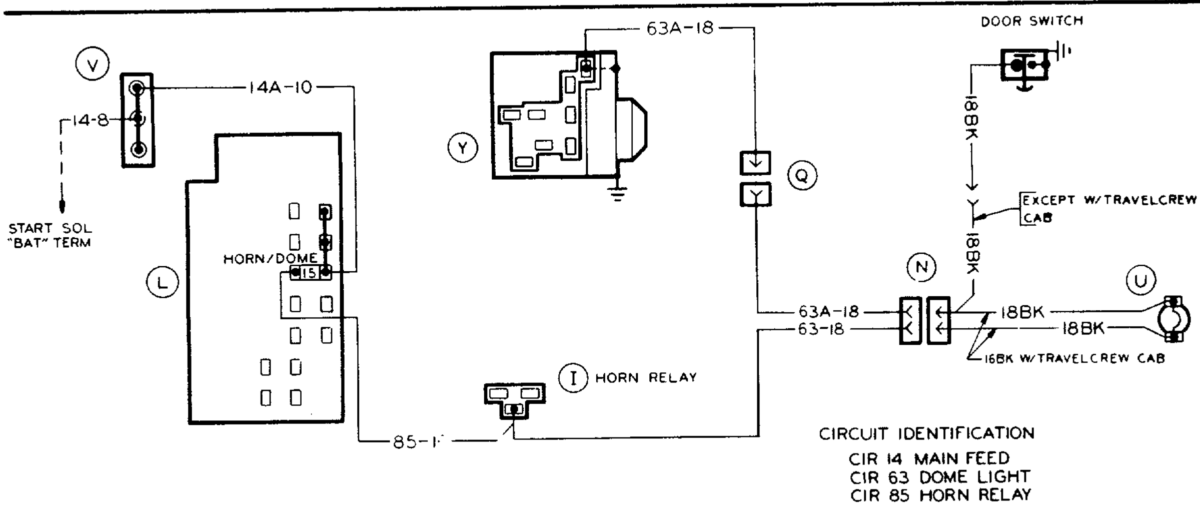


TRAILER LIGHT WIRING

MT-23724

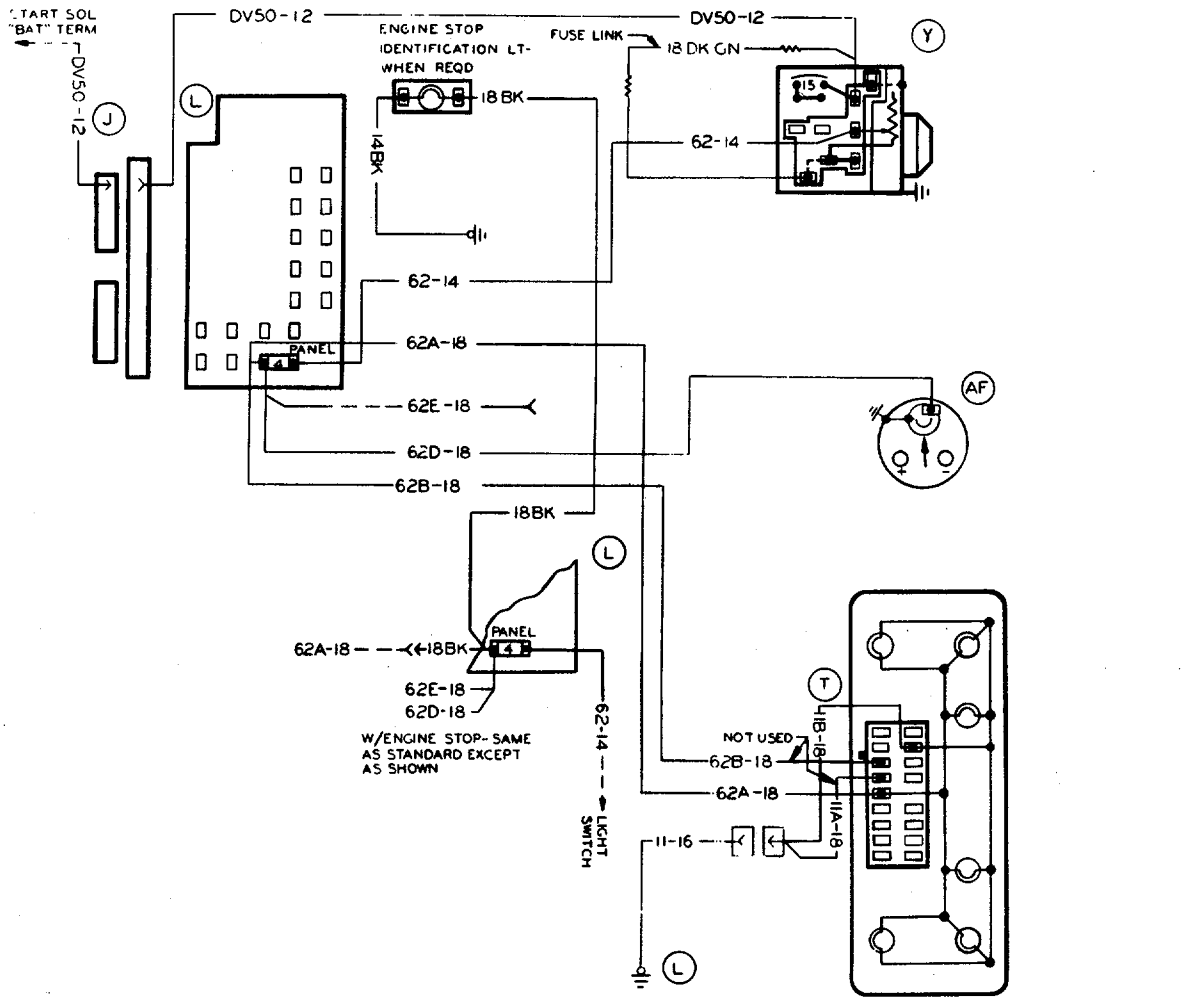


INSTRUMENT PANEL AND CONTROL IDENTIFICATION ILLUMINATION-RH DR



MT-23725

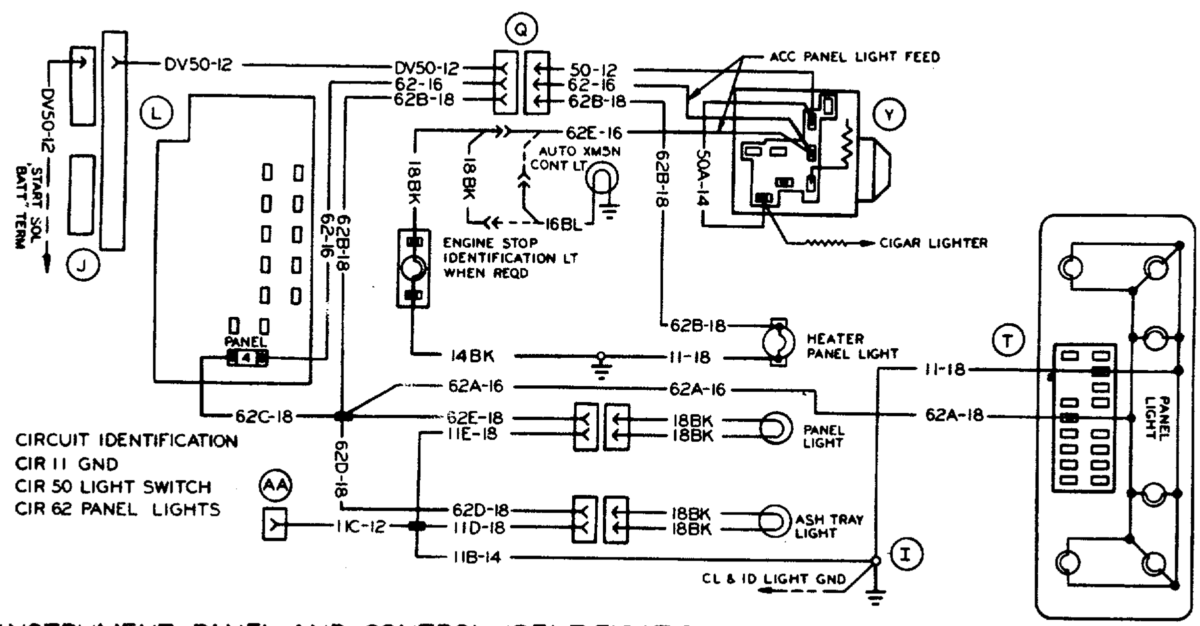
DOME LIGHT WIRING



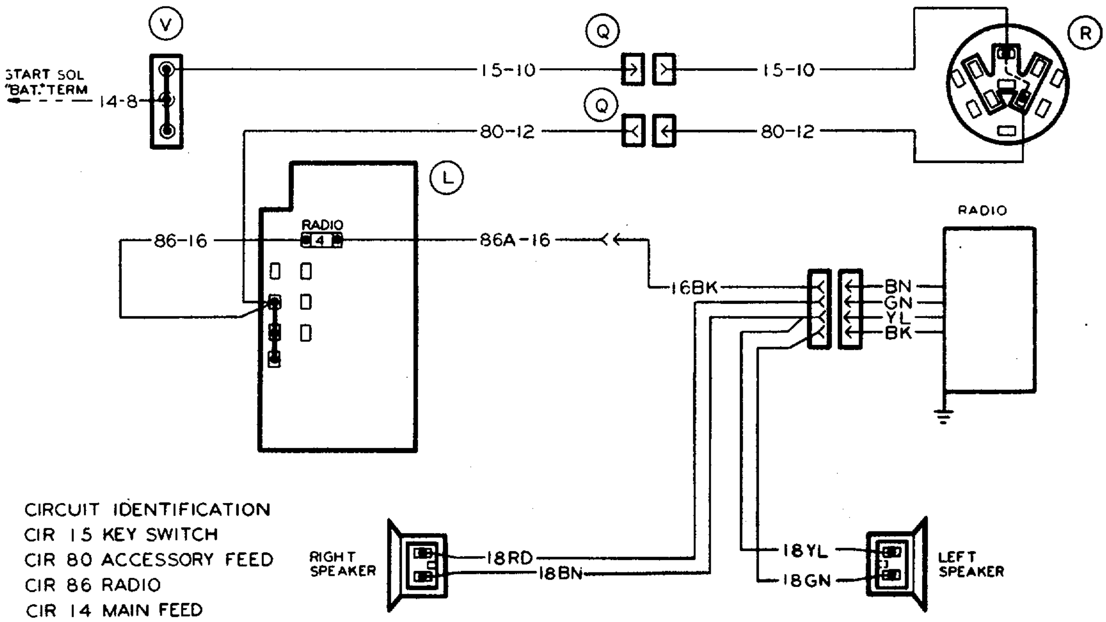
CIRCUIT IDENTIFICATION
CIR 11 GROUND
CIR 50 LIGHT SWITCH
CIR 62 PANEL LIGHTS

MT-23726

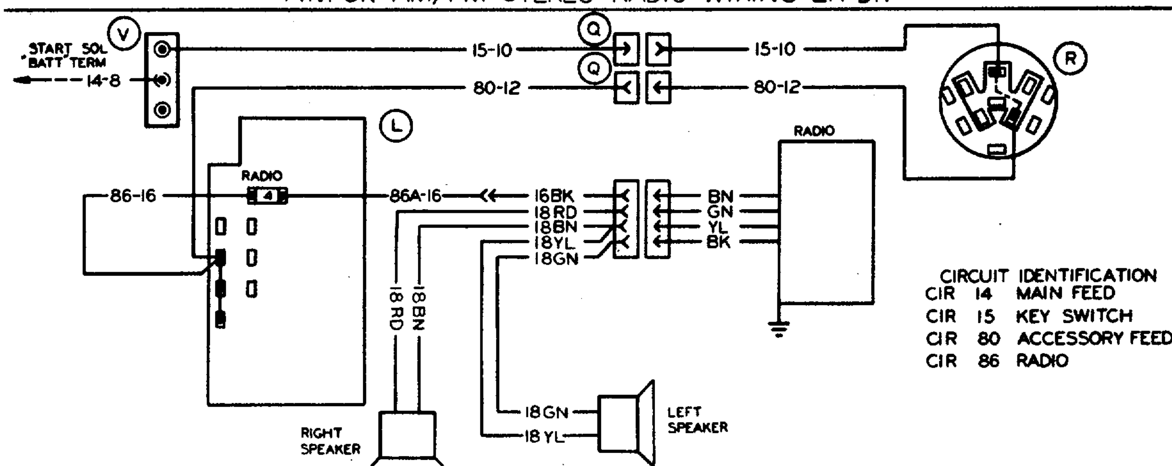
INSTRUMENT PANEL AND CONTROL IDENTIFICATION ILLUMINATION - FBC/BUS



INSTRUMENT PANEL AND CONTROL IDENTIFICATION ILLUMINATION LH DR **MT-23727**

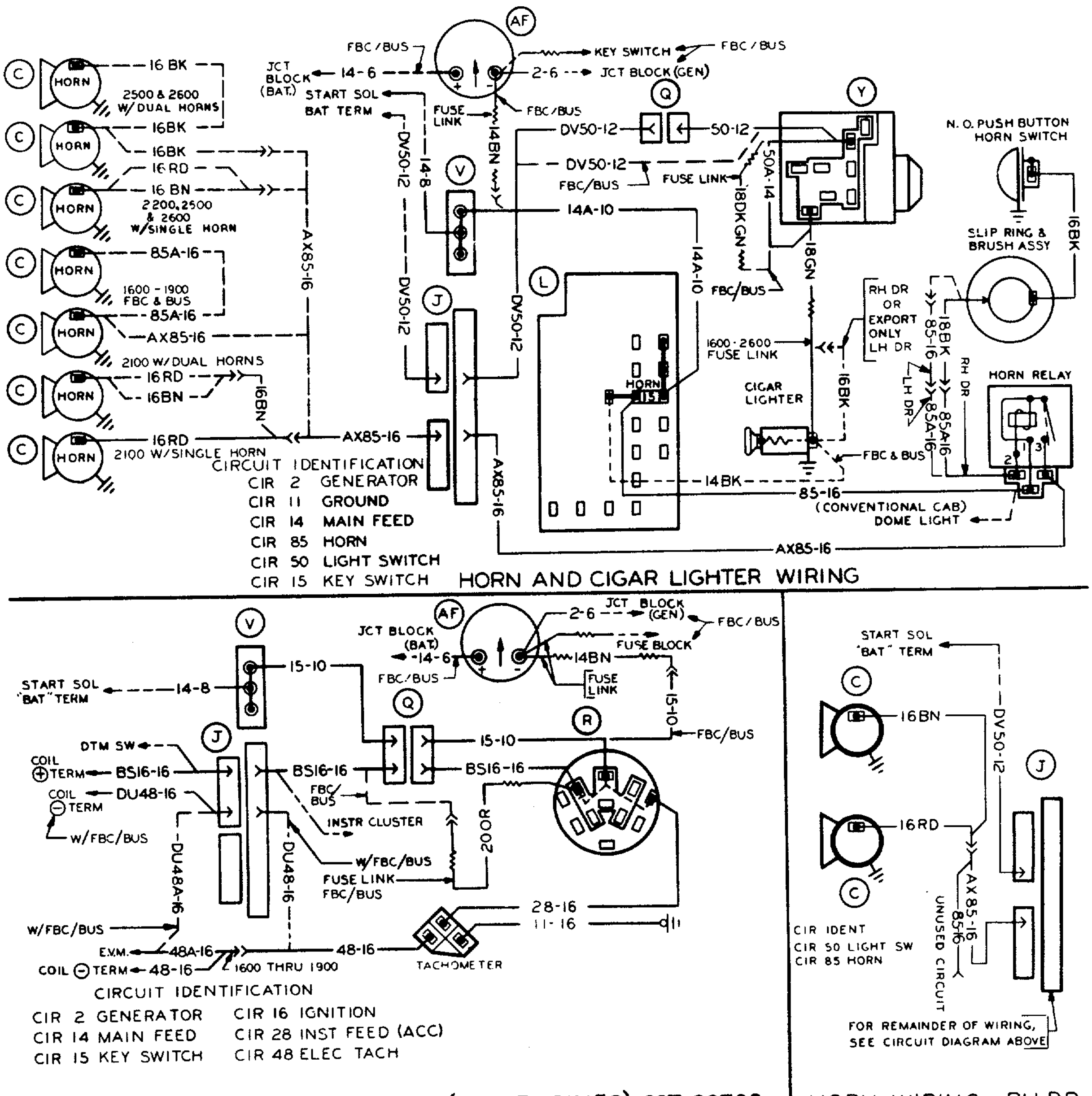


AM OR AM/FM STEREO RADIO WIRING LH DR



AM OR AM/FM STEREO RADIO WIRING RH DR

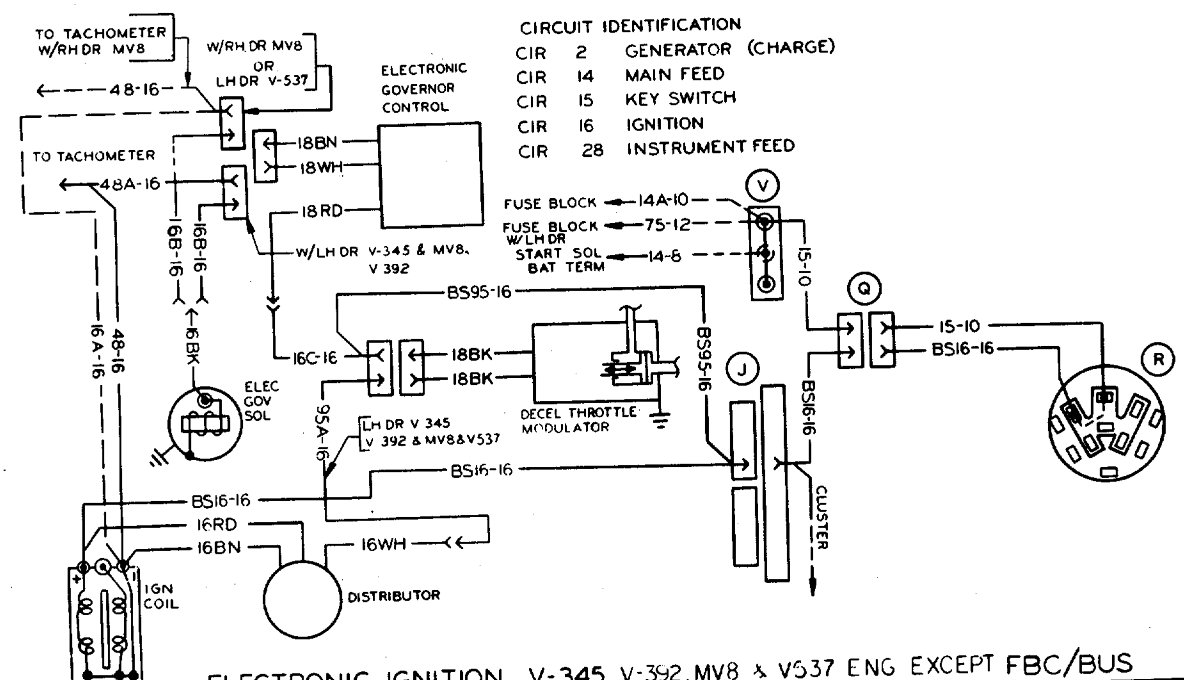
MT-23731



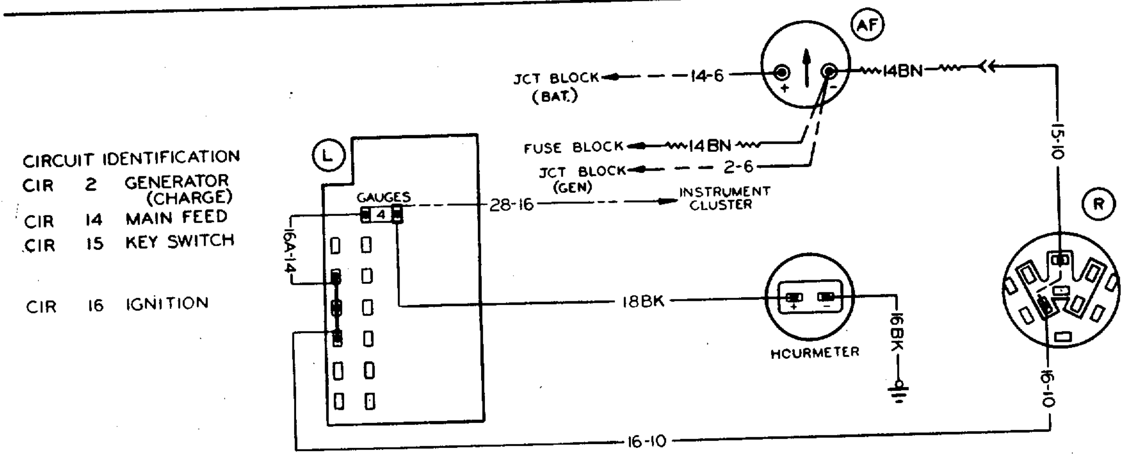
HORN AND CIGAR LIGHTER WIRING

ELECTRIC TACHOMETER WIRING (GAS ENGINES) **MT-23732**

HORN WIRING RH DR

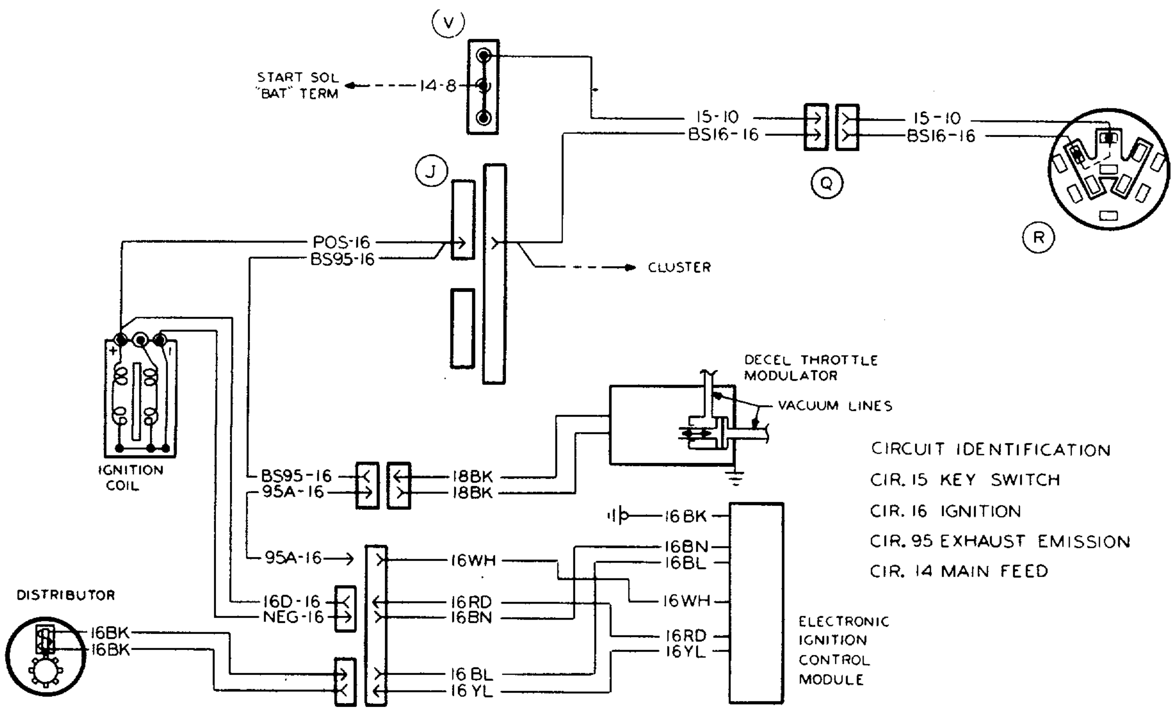


ELECTRONIC IGNITION V-345, V-392, MV8 & V537 ENG EXCEPT FBC/BUS

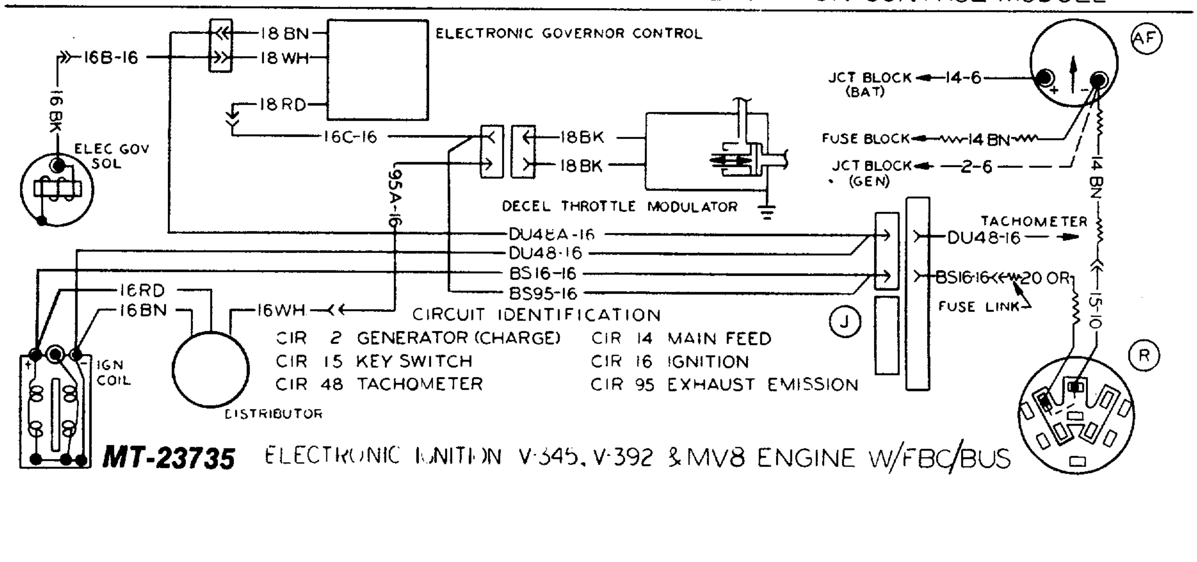


HOURMETER WIRING FBC/BUS

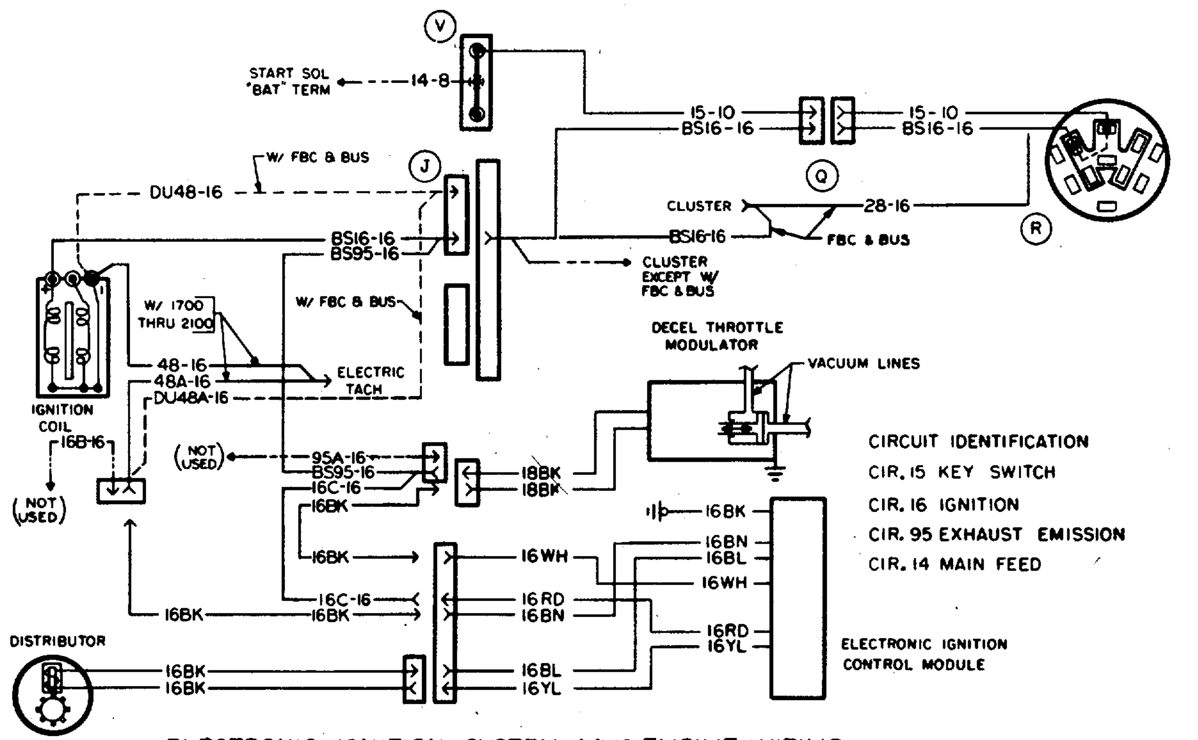
MT-23736



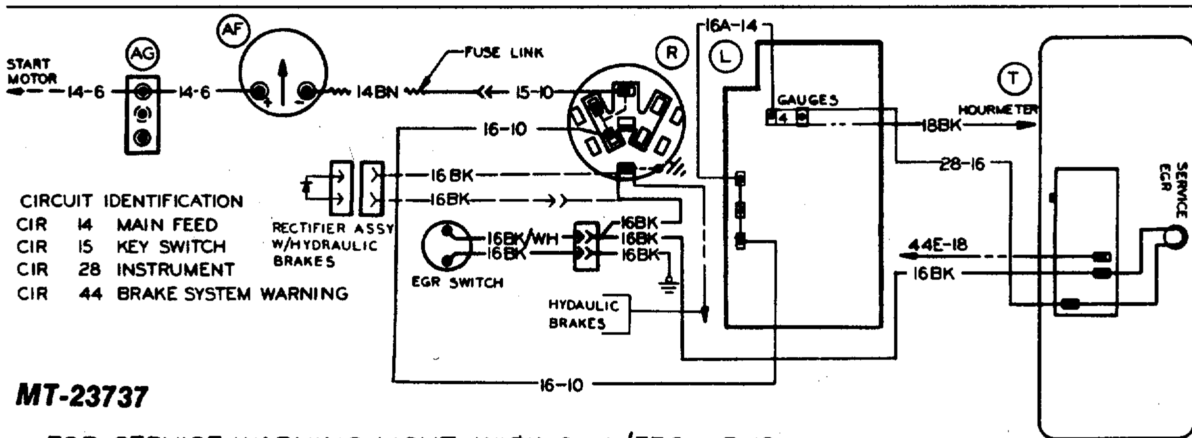
ELECTRONIC IGNITION SYSTEM V-537 ENGINE WIRING 2500 & 2600 W/2 WIRE DISTRIBUTOR & EXTERNAL IGNITION CONTROL MODULE



MT-23735 ELECTRONIC IGNITION V-345, V-392 & MV8 ENGINE W/FBC/BUS

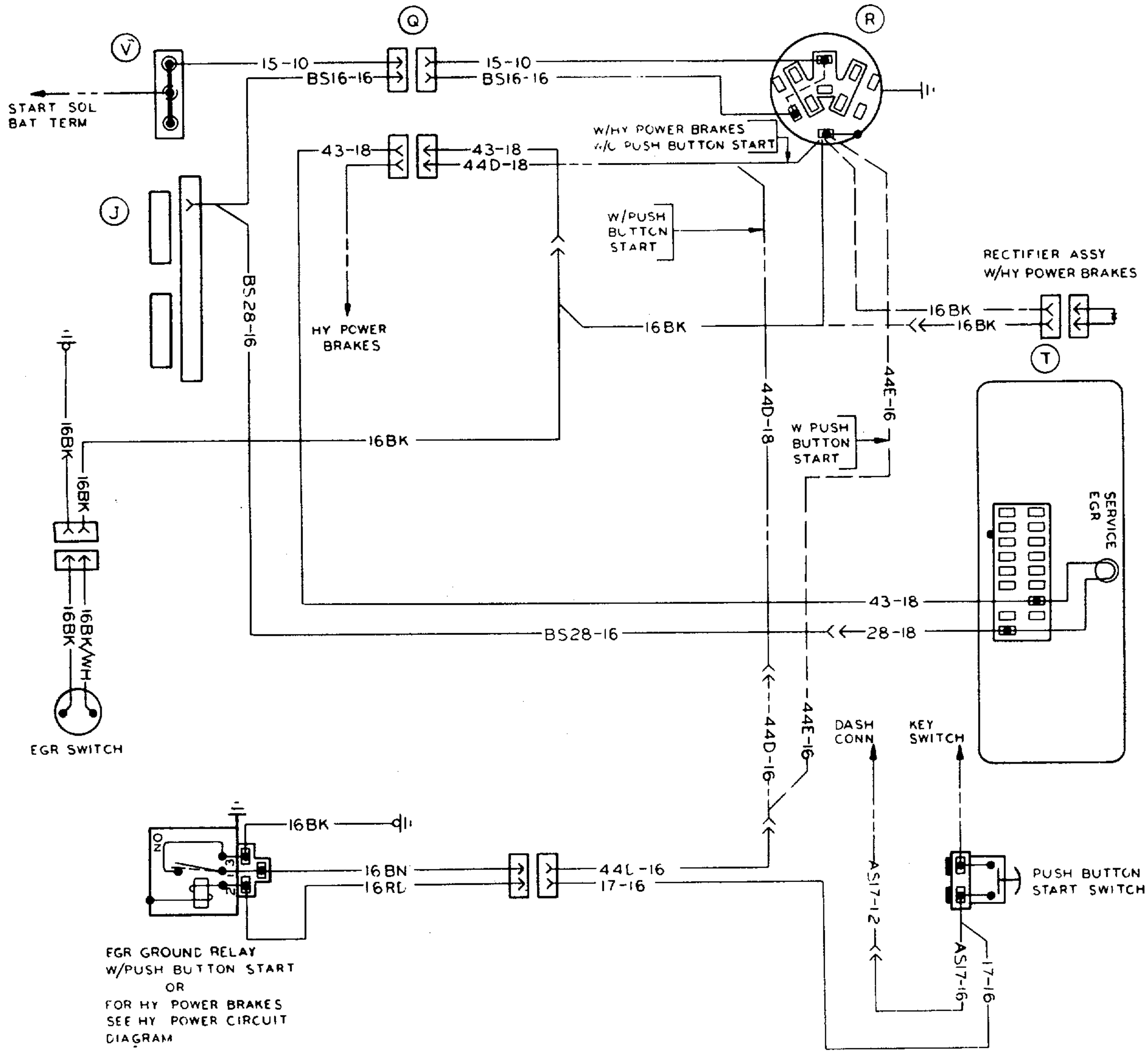


ELECTRONIC IGNITION SYSTEM MV8 ENGINE WIRING W/ HOLLEY DISTRIBUTOR

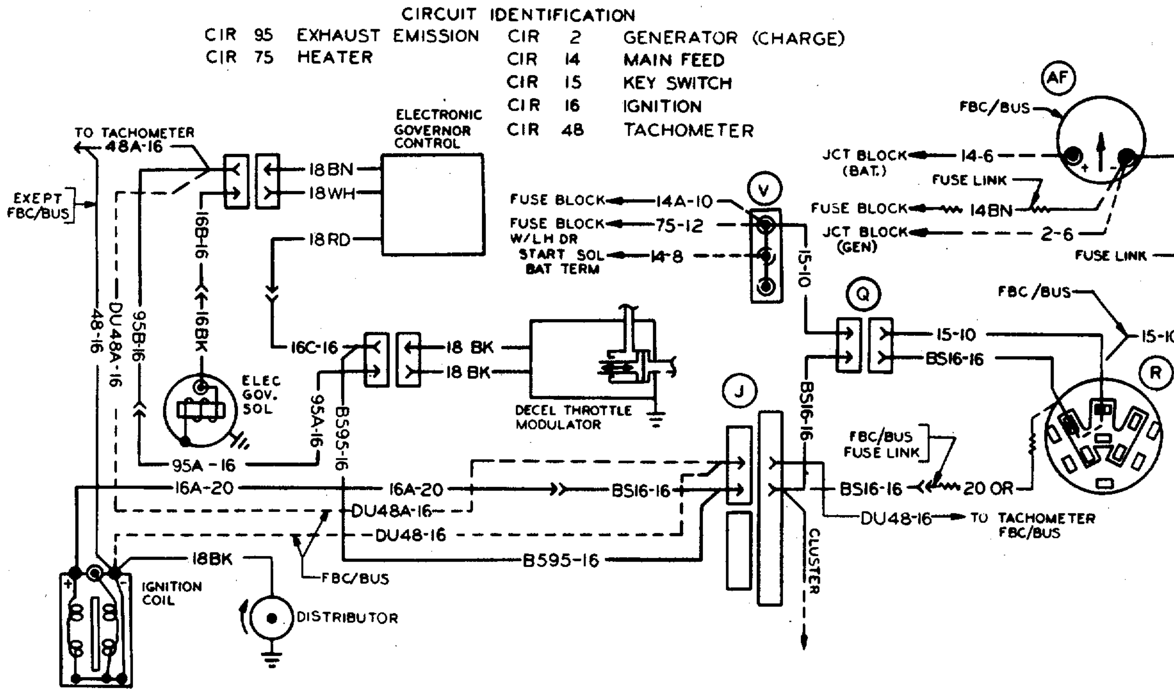


MT-23737

EGR SERVICE WARNING LIGHT WIRING W/FBC & BUS

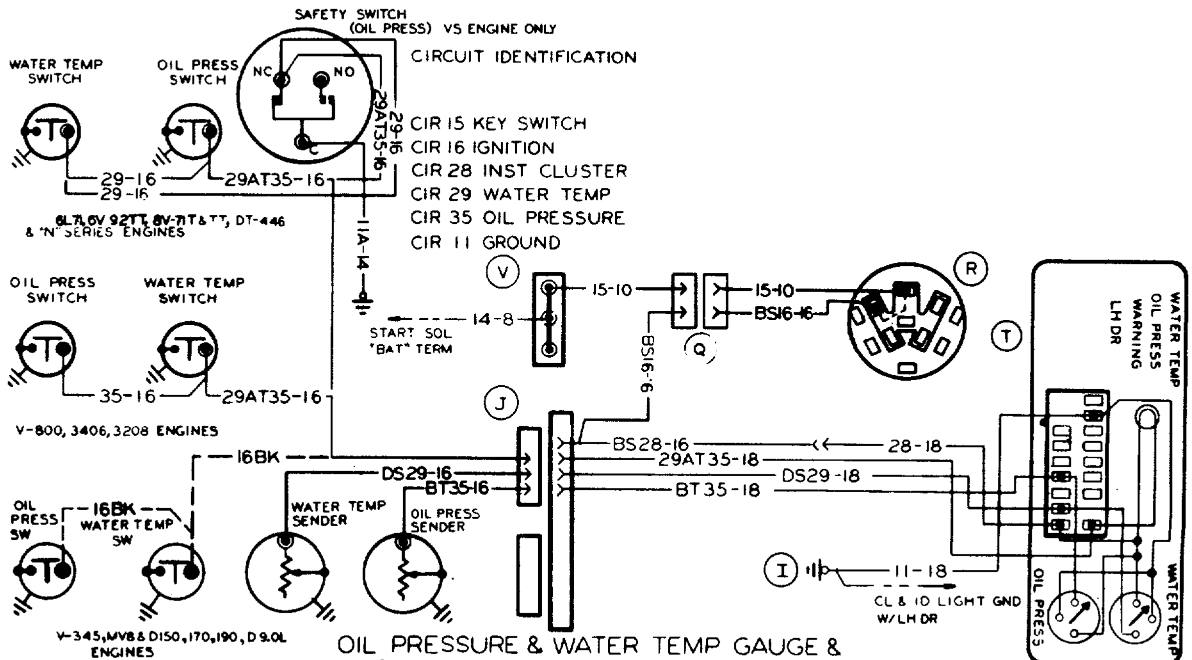


EGR SERVICE WARNING LIGHT WIRING 1600 THRU 1800 **MT-23739**

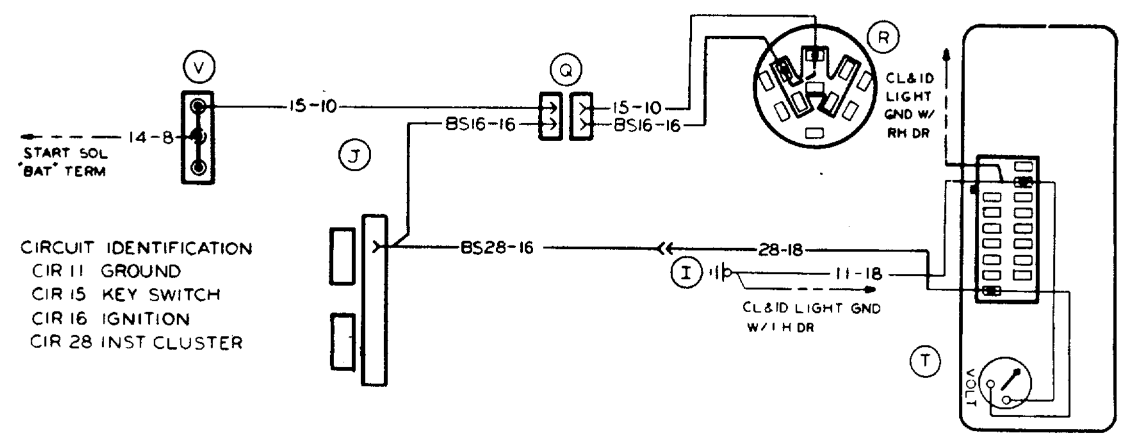


BREAKER POINT IGNITION V-345 ENG

MT-23738

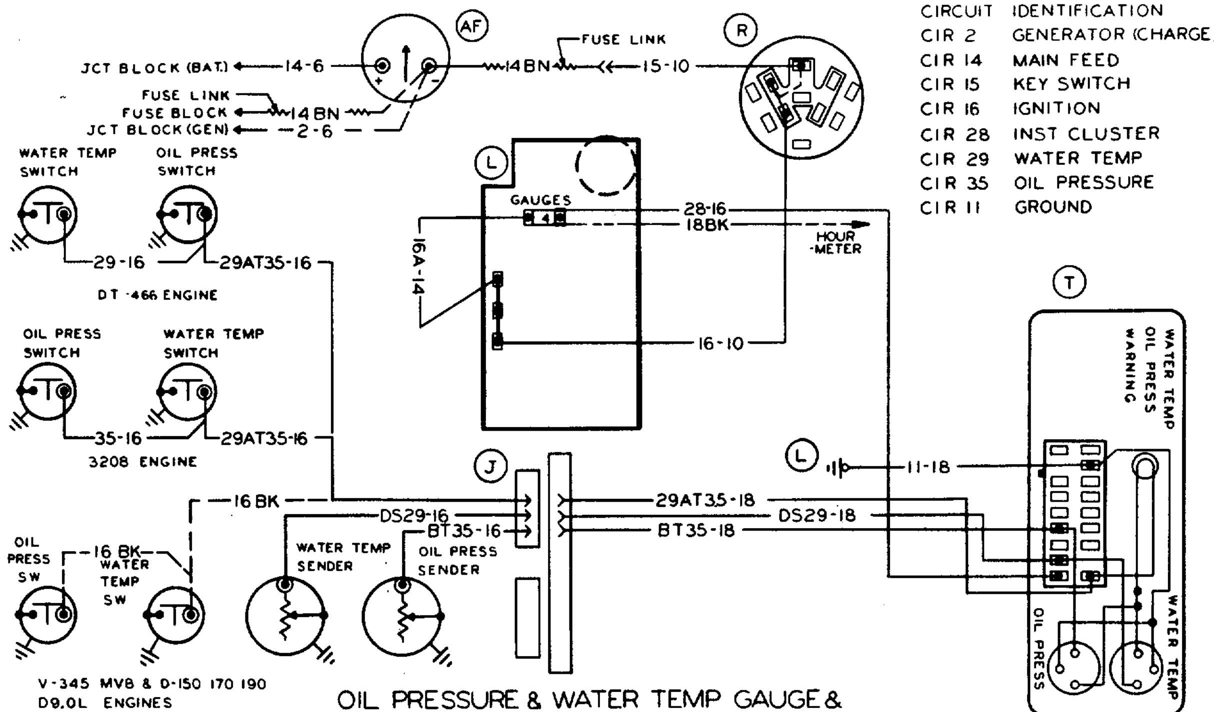


OIL PRESSURE & WATER TEMP GAUGE & OIL/WATER WARNING LIGHT WIRING EXCEPT FBC / BUS

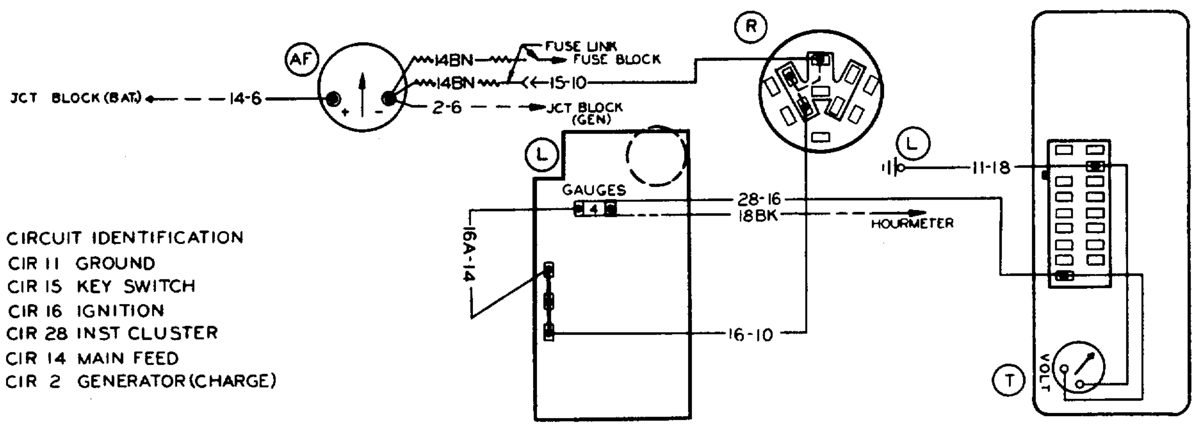


VOLTMETER WIRING EXCEPT FBC / BUS

MT-23745

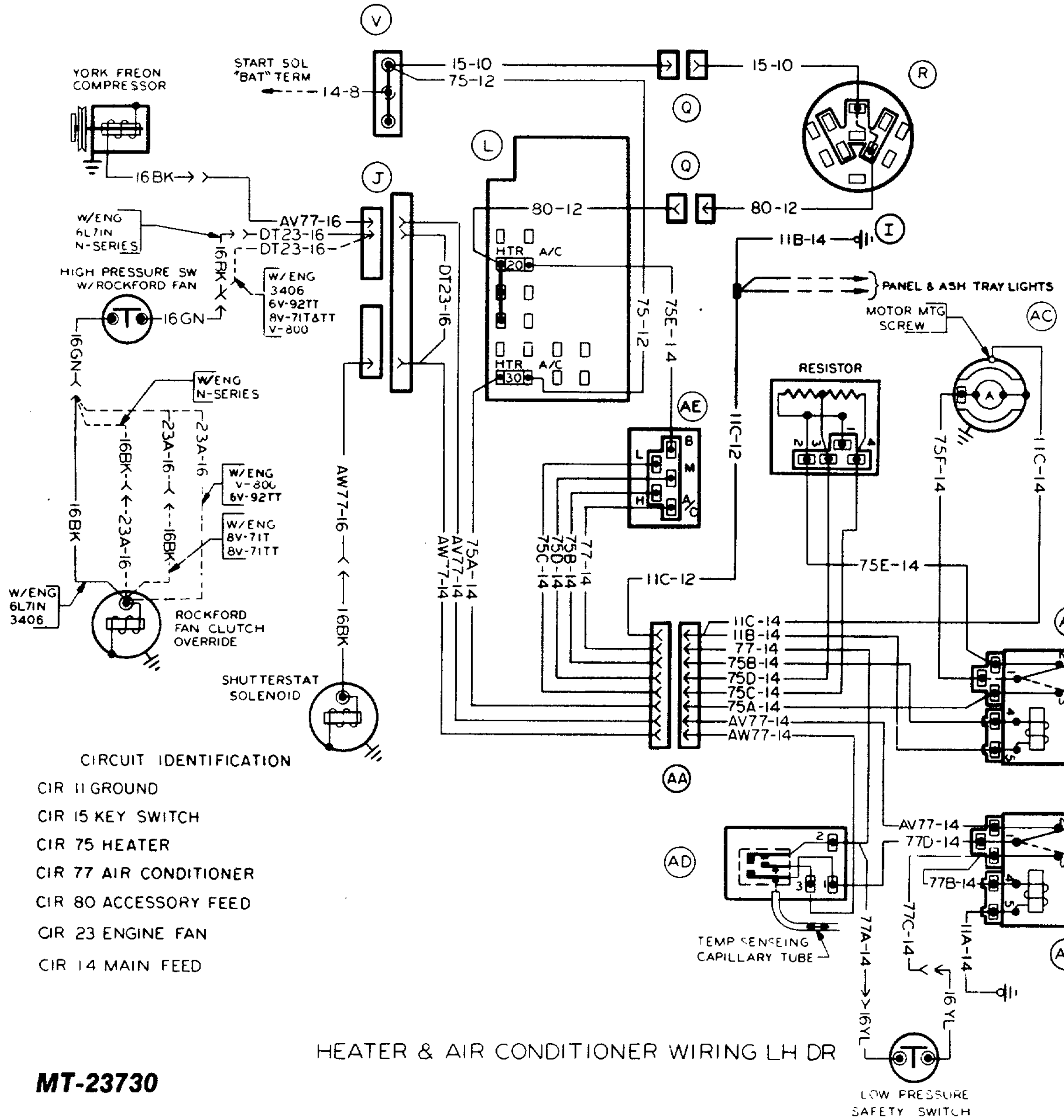


OIL PRESSURE & WATER TEMP GAUGE & OIL/WATER WARNING LIGHT WIRING FBC/BUS



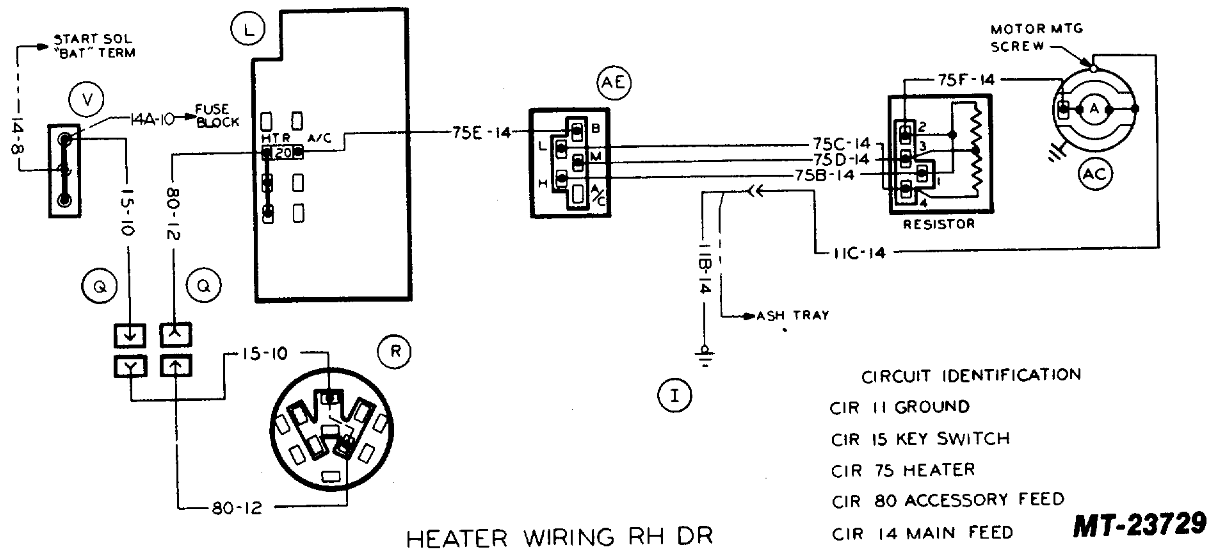
VOLTMETER WIRING FBC/BUS

MT-23746

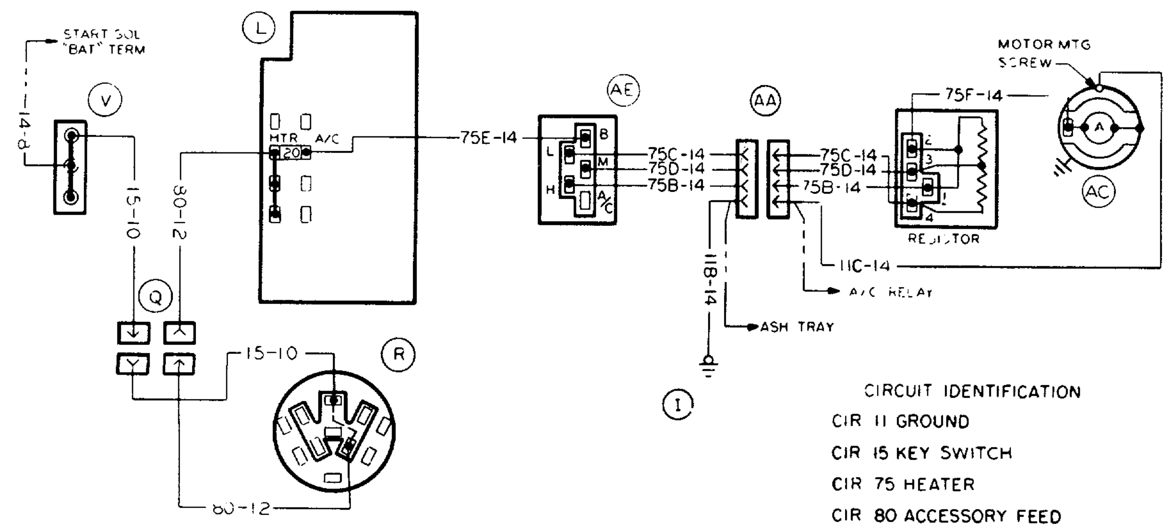


HEATER & AIR CONDITIONER WIRING LH DR

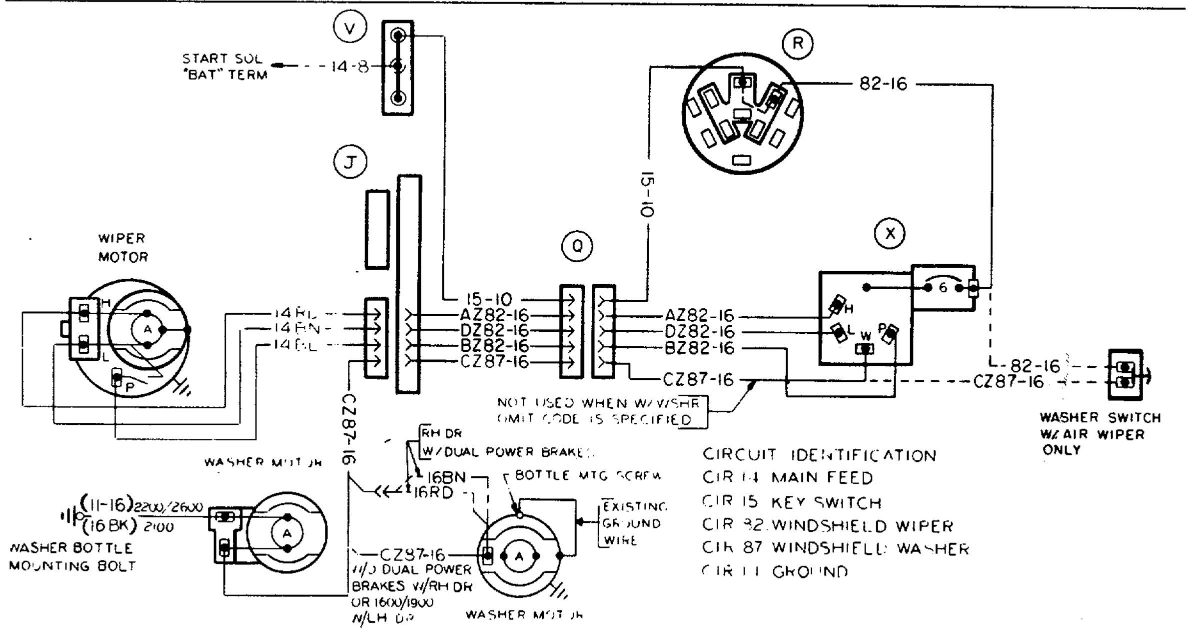
MT-23730



START SOL "BAT" TERM
14-8
V
14A-10
FUSE BLOCK
L
HTR
A/C
20
75E-14
AE
B
L
M
H
A/C
75C-14
75D-14
75B-14
75F-14
MOTOR MTG SCREW
A
AC
RESISTOR
2
3
1
4
11C-14
11B-14
ASH TRAY
I
15-10
80-12
Q
Q
R
15-10
80-12
HEATER WIRING RH DR
CIRCUIT IDENTIFICATION
CIR 11 GROUND
CIR 15 KEY SWITCH
CIR 75 HEATER
CIR 80 ACCESSORY FEED
CIR 14 MAIN FEED
MT-23729

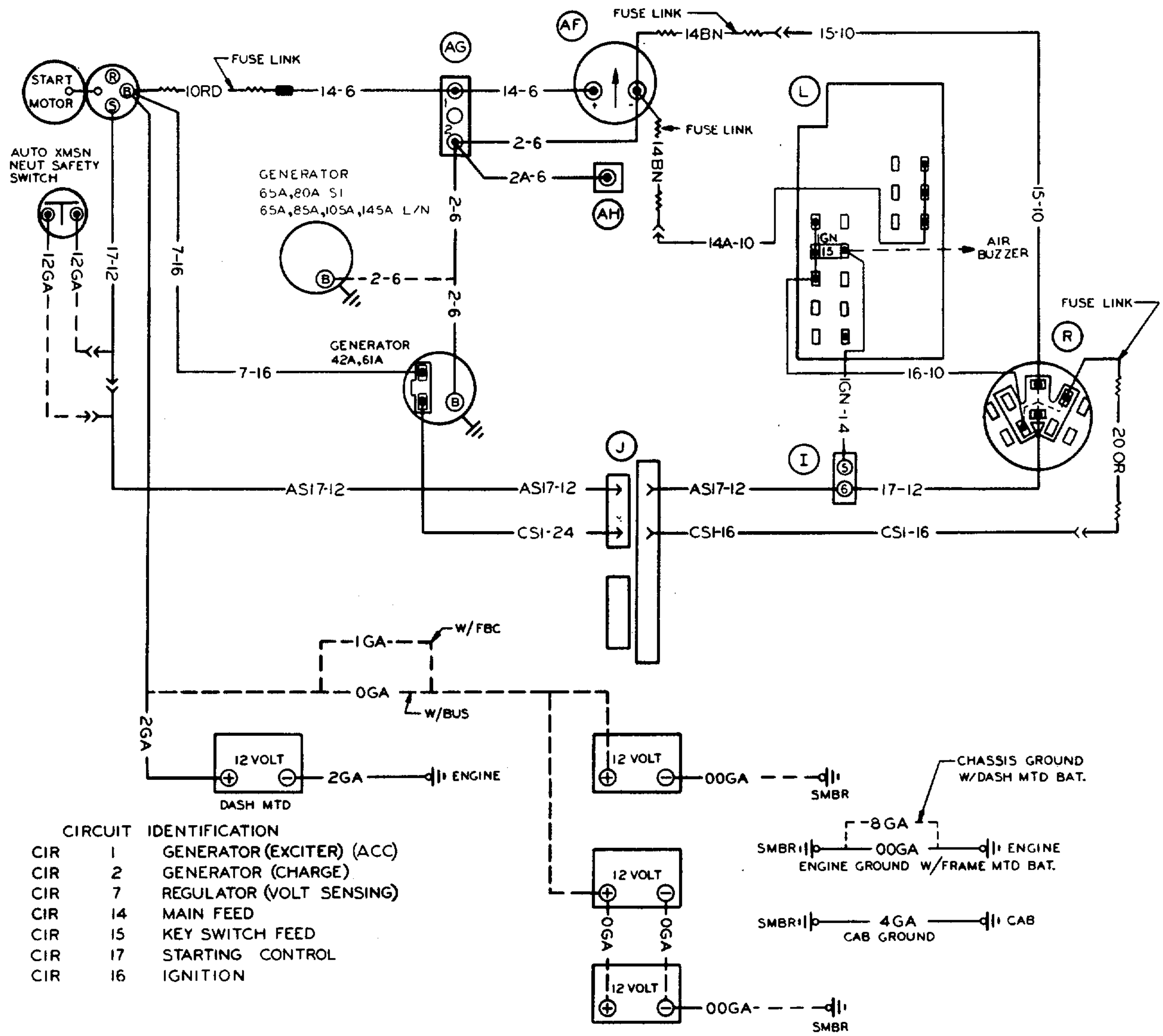


HEATER WIRING-LH DR



WIPER/ WASHER WIRING

MT-23728

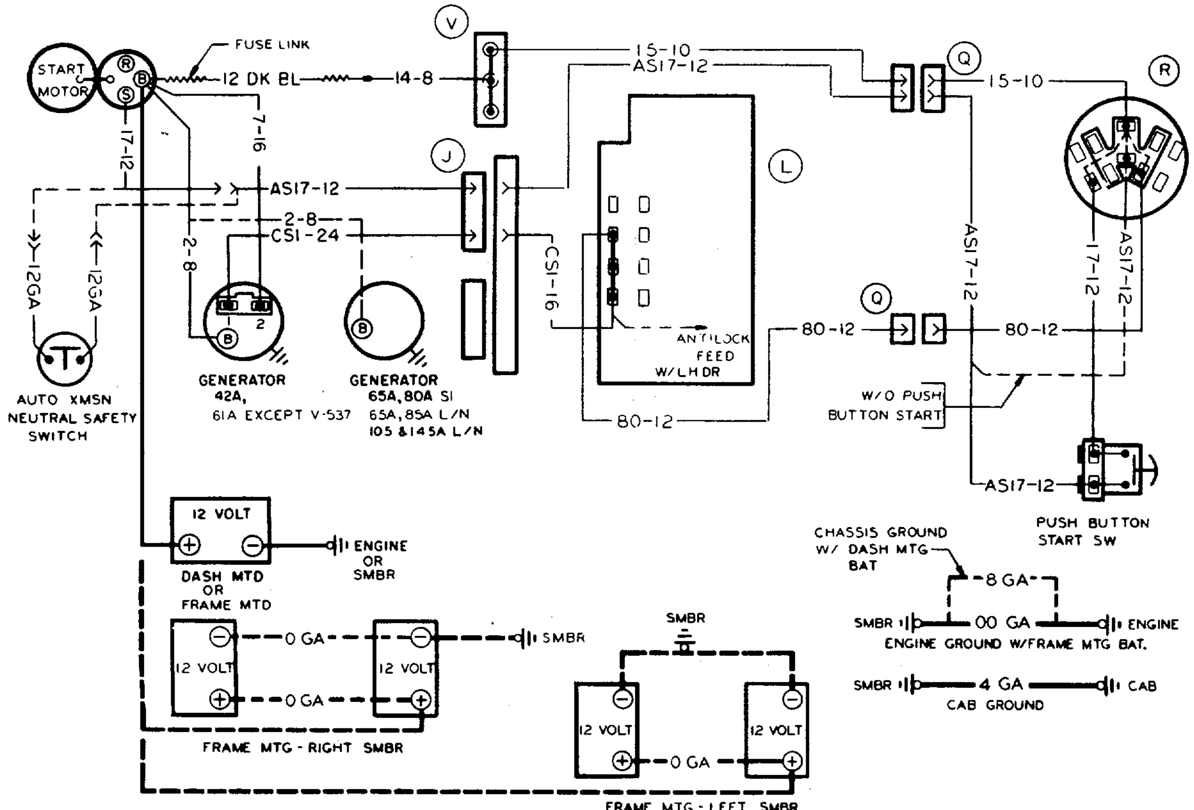


CIRCUIT IDENTIFICATION

CIR	1	GENERATOR (EXCITER) (ACC)
CIR	2	GENERATOR (CHARGE)
CIR	7	REGULATOR (VOLT SENSING)
CIR	14	MAIN FEED
CIR	15	KEY SWITCH FEED
CIR	17	STARTING CONTROL
CIR	16	IGNITION

MT-23733

V-392, MV8 & V-345 STARTING, CHARGING & MAJOR FEED & GROUND WIRING FBC/BUS

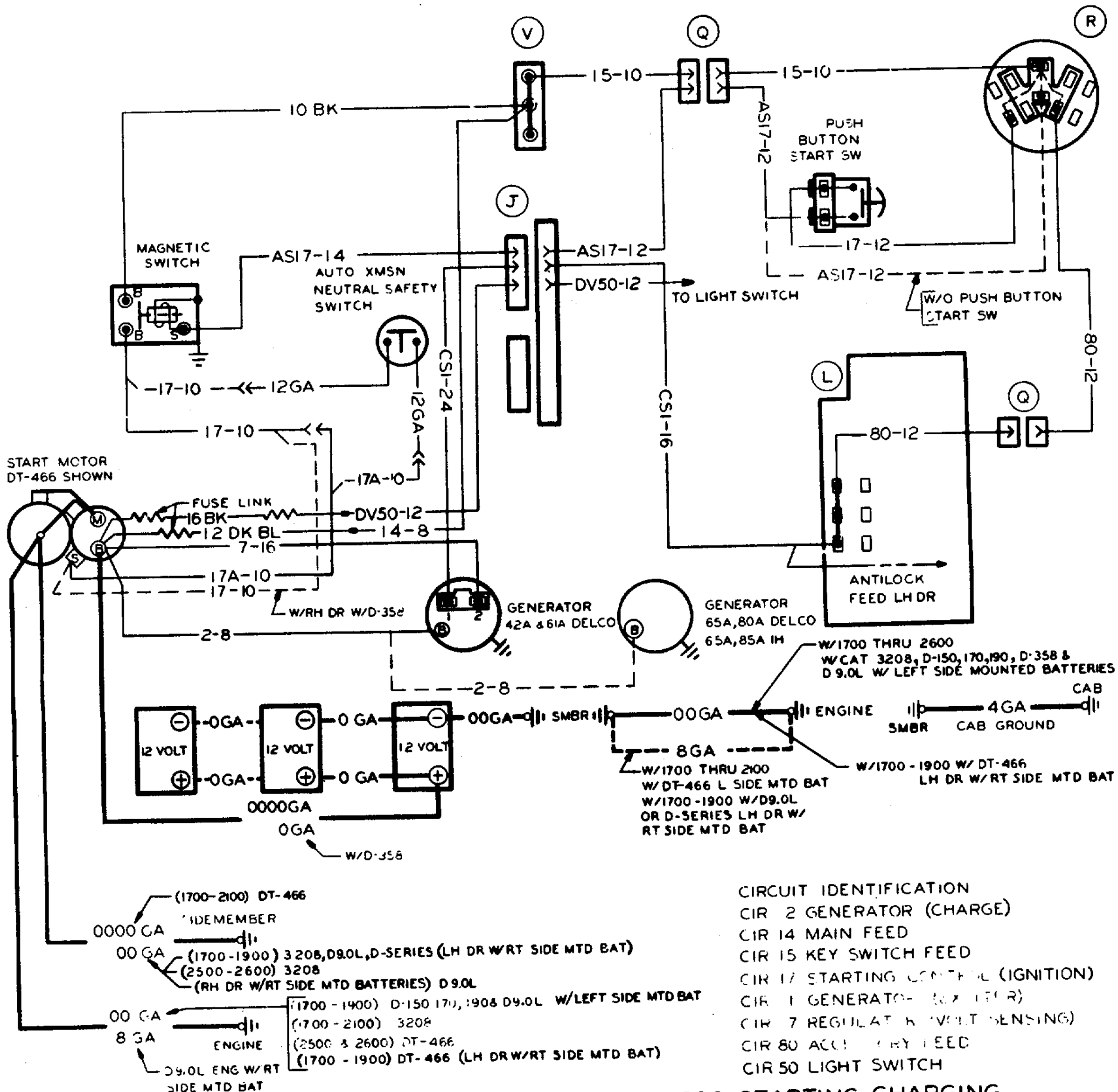


BATTERY		POSITIVE CABLE GAUGE	NEGATIVE CABLE GAUGE	ENGINE	MODEL
LOCATION	COMBINATION				
DASH PANEL	1/ 12 VOLT	2	2	V-345, MV8 & V-392	1600 THRU 1900
LEFT SMBR	2/ 12 VOLT	1	00		
LEFT SMBR	1/ 12 VOLT	1	00		
LEFT SMBR	2/ 12 VOLT	1	00	V-537	2100
LEFT SMBR	1/ 12 VOLT	1	00		
RIGHT SMBR	1/ 12 VOLT	0	00	V-537	2500& 2600-CONSTR
RIGHT SMBR	2/ 12 VOLT	0	00		
RIGHT SMBR	2/ 12 VOLT	2	00	V-345 V-392 & MV8	1700 THRU 1900

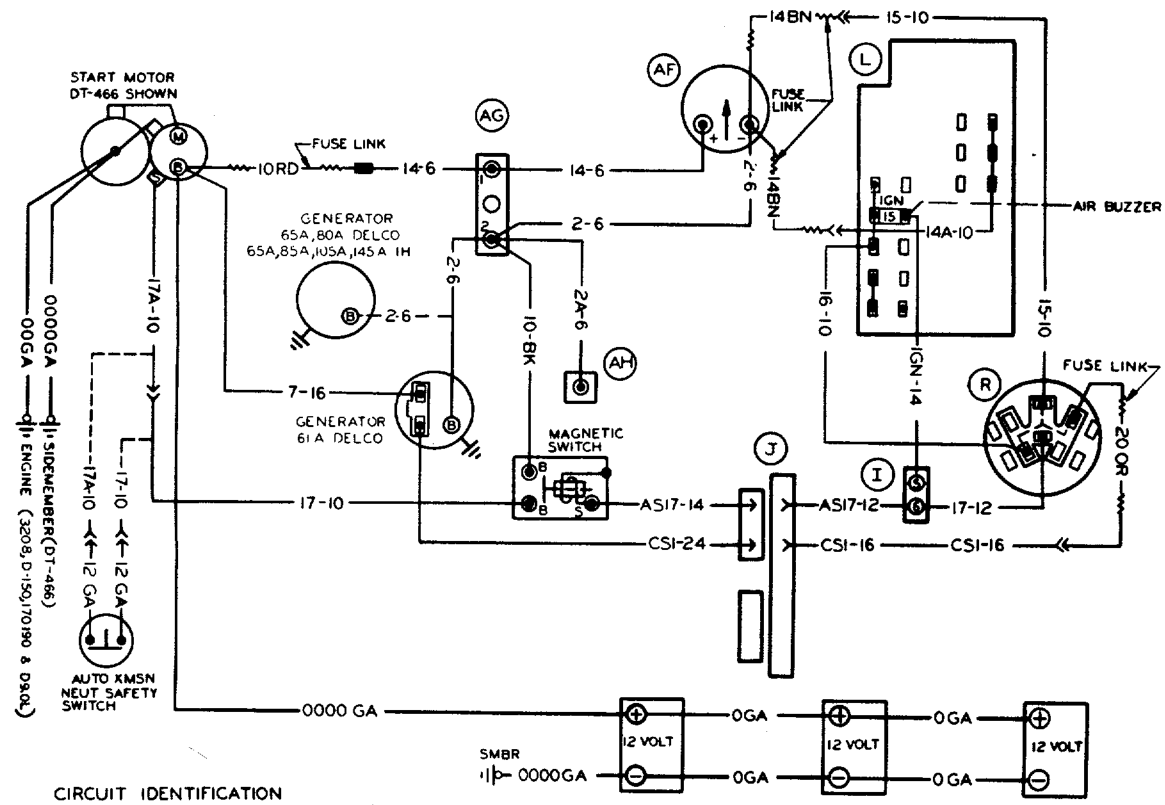
CIRCUIT IDENTIFICATION
CIR 1 GENERATOR (EXCITER)
CIR 2 GENERATOR (CHARGE)
CIR 7 REGULATOR (VOLT SENSING)
CIR 14 MAIN FEED
CIR 15 KEY SWITCH FEED
CIR 17 STARTING CONTROL
CIR 80 ACCESSORY FEED

MT-23734

V-392, V-345, MV8 & V-537 STARTING, CHARGING & MAJOR FEED & GROUND WIRING

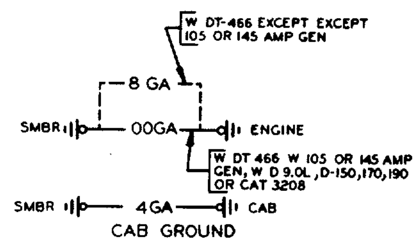


MT-23741 D-358, D9.0L. D-150,170,190, DT-466 & 3208 STARTING CHARGING MAJOR FEED & GROUND WIRING 1600-2100, 2500-2600 CONSTRUCTOR



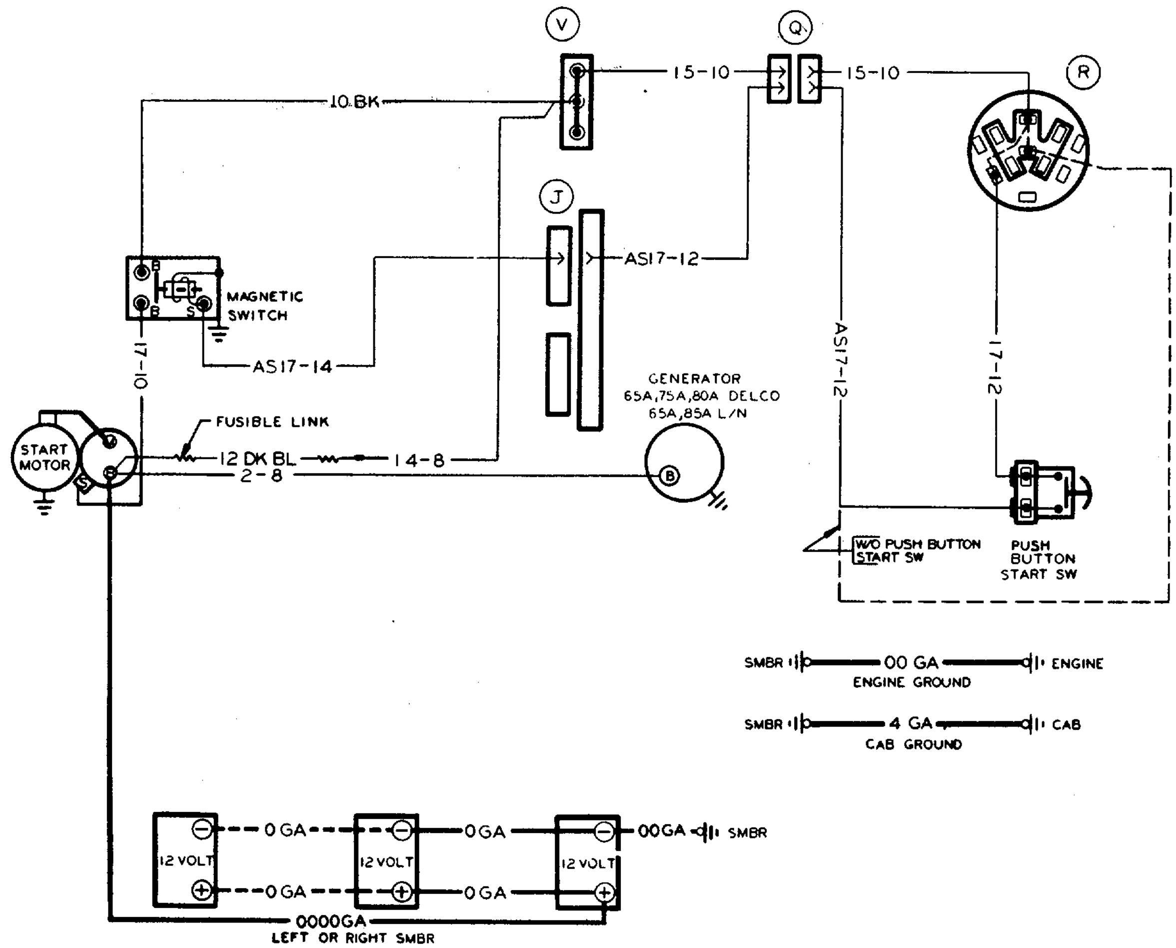
CIRCUIT IDENTIFICATION

CIR	2	GENERATOR (CHARGE)
CIR	14	MAIN FEED
CIR	15	KEY SWITCH
CIR	17	STARTING CONTROL (IGN)
CIR	1	GENERATOR (EXCITER)(ACC)
CIR	7	REGULATOR (VOLT SENSING)
CIR	16	IGNITION



D 9.0L, D-150, 170, 190, DT-466 OR 3208 STARTING, CHARGING, MAJOR FEED & GROUND WIRING FBC/BUS

MT-23742



CIRCUIT IDENTIFICATION

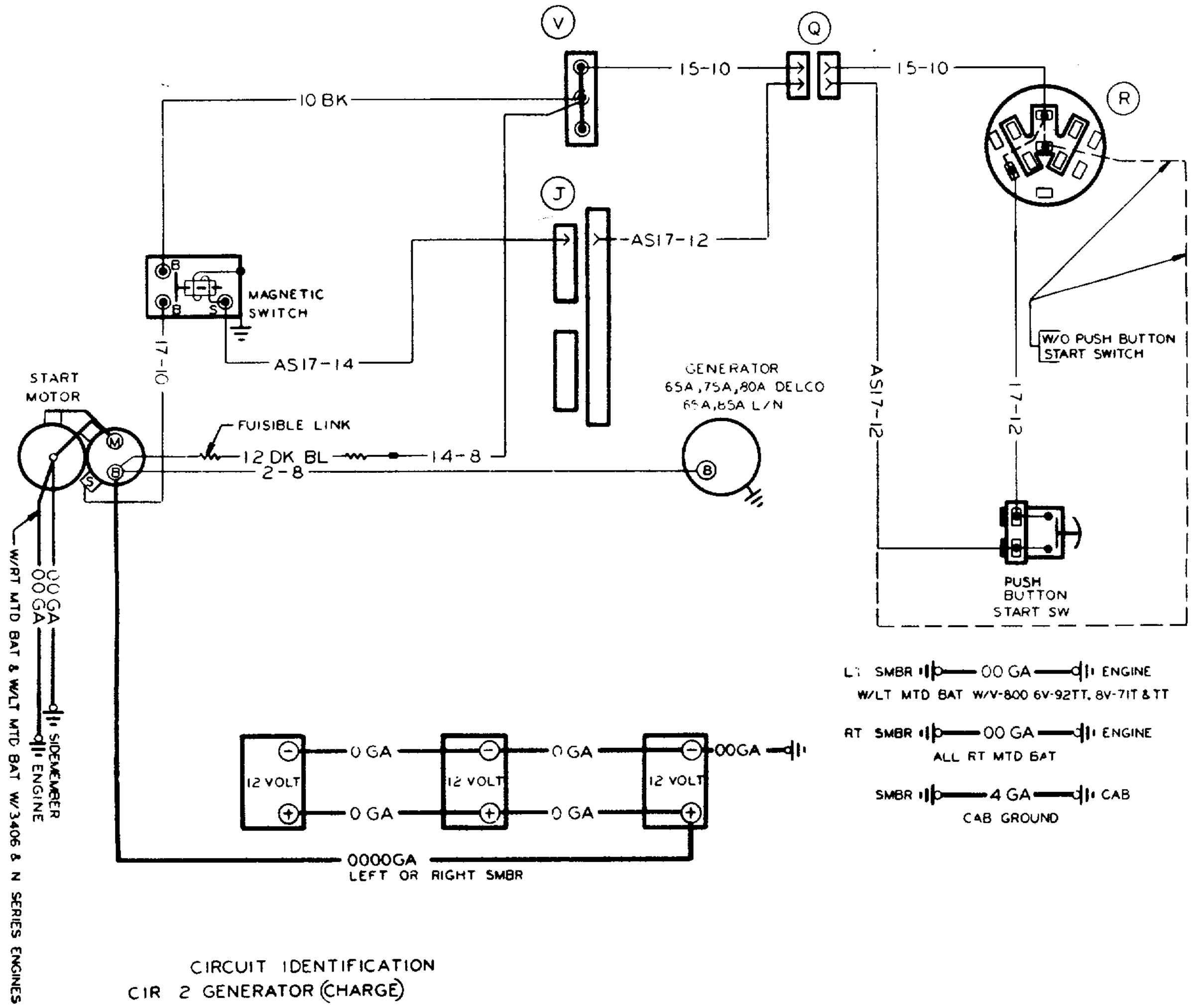
CIR 2 GENERATOR (CHARGE)

CIR 14 MAIN FEED

CIR 15 KEY SWITCH FEED

CIR 17 STARTING CONTROL

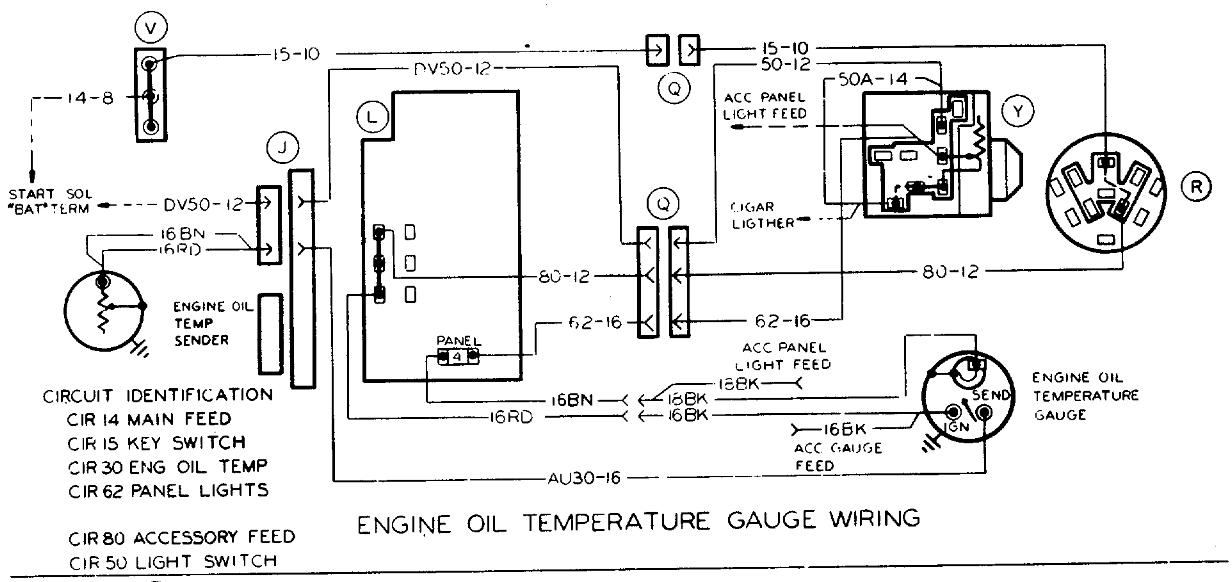
6-71 STARTING, CHARGING, & MAJOR FEED & GROUND WIRING **MT-23743**



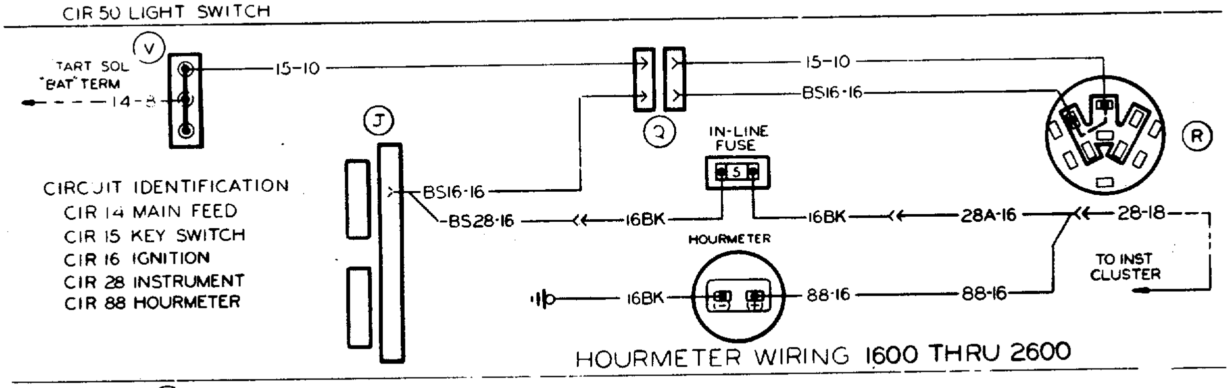
CIRCUIT IDENTIFICATION
CIR 2 GENERATOR (CHARGE)
CIR 14 MAIN FEED
CIR 15 KEY SWITCH FEED
CIR 17 STARTING CONTROL

6V-92TT,8V-71T&TT,800,3406 &N-SERIES STARTING,CHARGING & MAJOR FEED & GROUND WIRING

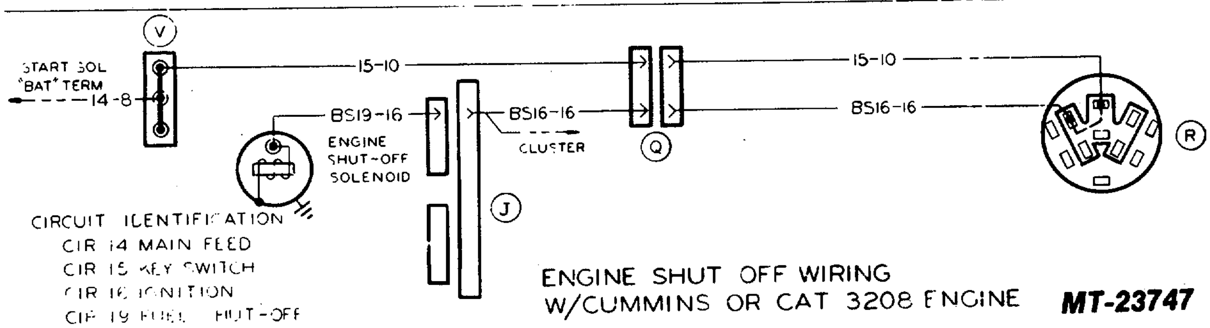
MT-23744



ENGINE OIL TEMPERATURE GAUGE WIRING

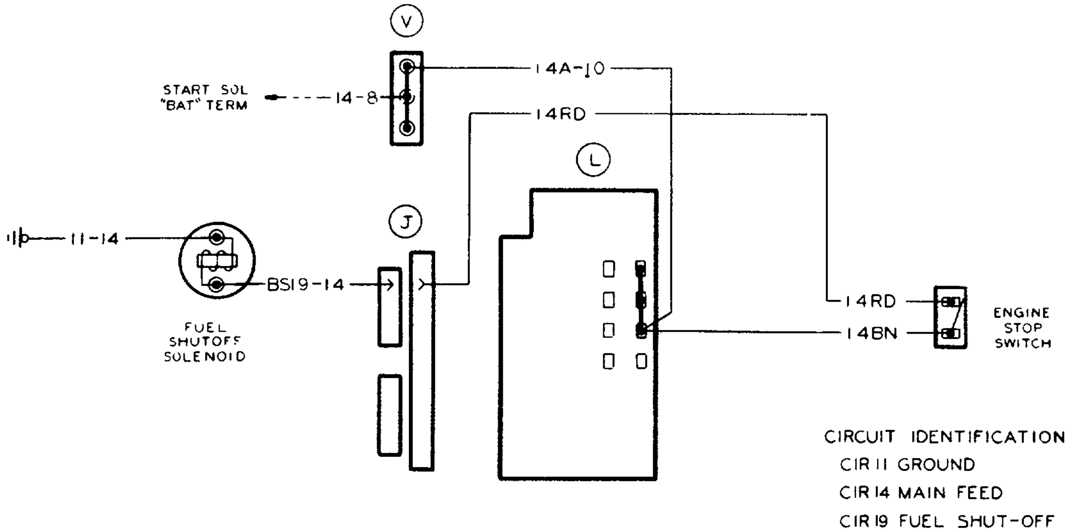


HOURMETER WIRING 1600 THRU 2600

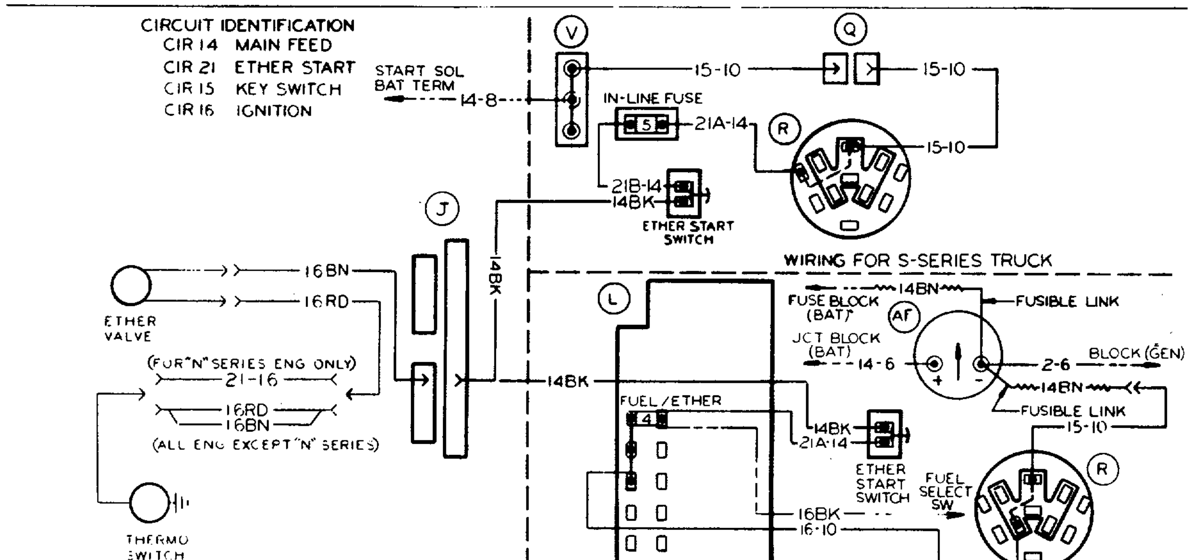


ENGINE SHUT OFF WIRING W/CUMMINS OR CAT 3208 ENGINE

MT-23747

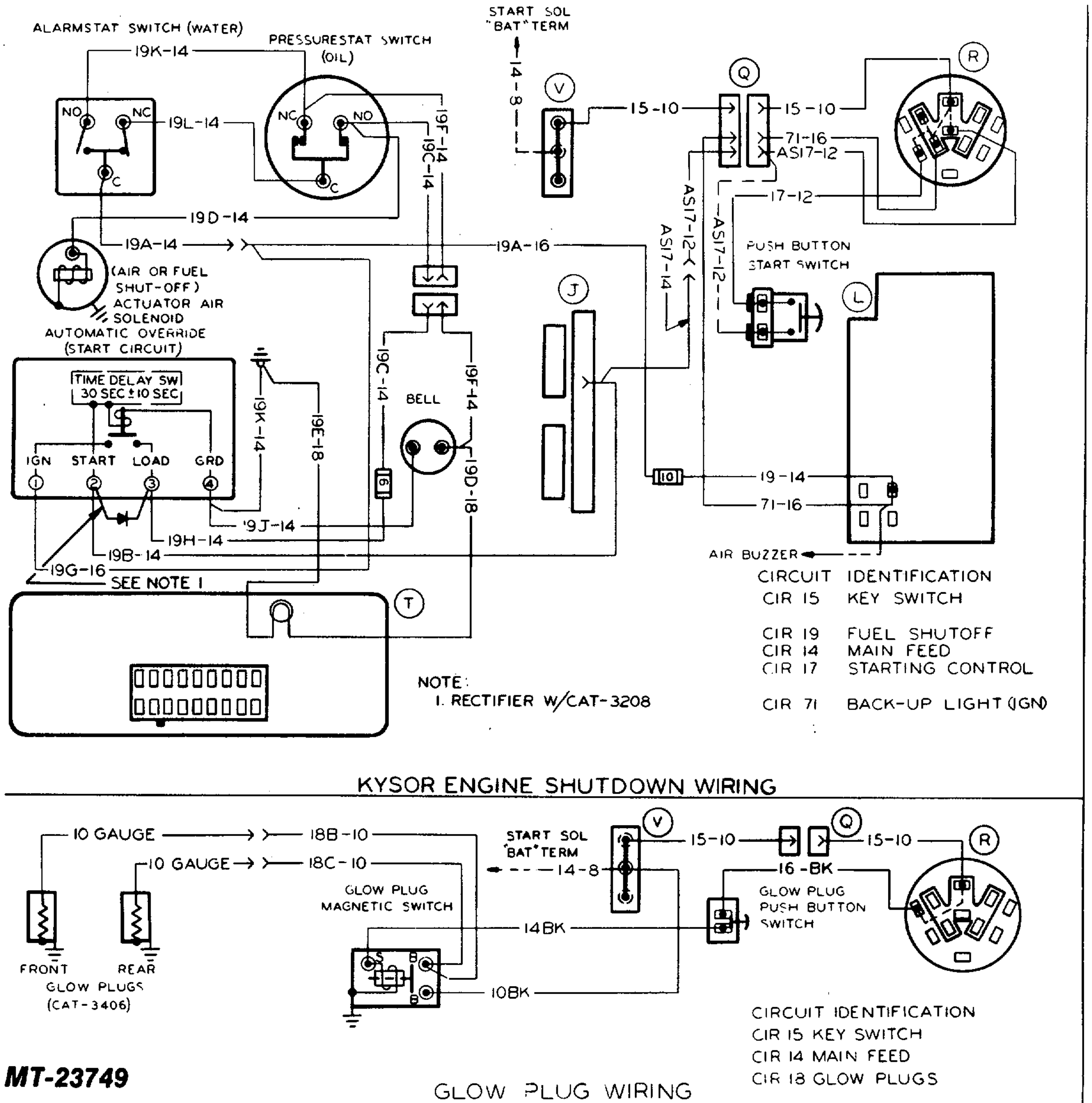


ENGINE STOP WIRING W/CAT-3406 ENGINE

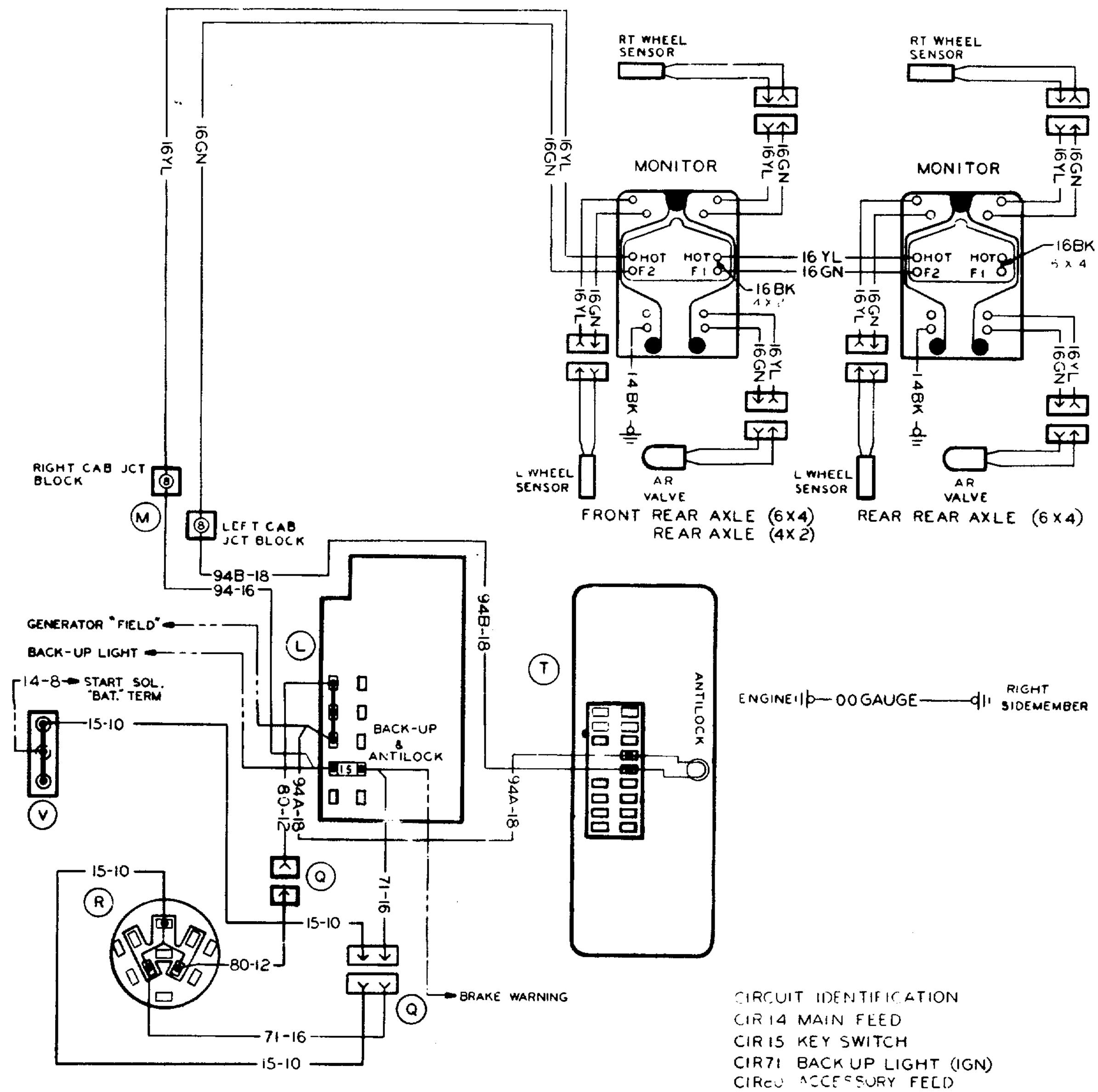


ETHER START WIRING

MT-23748

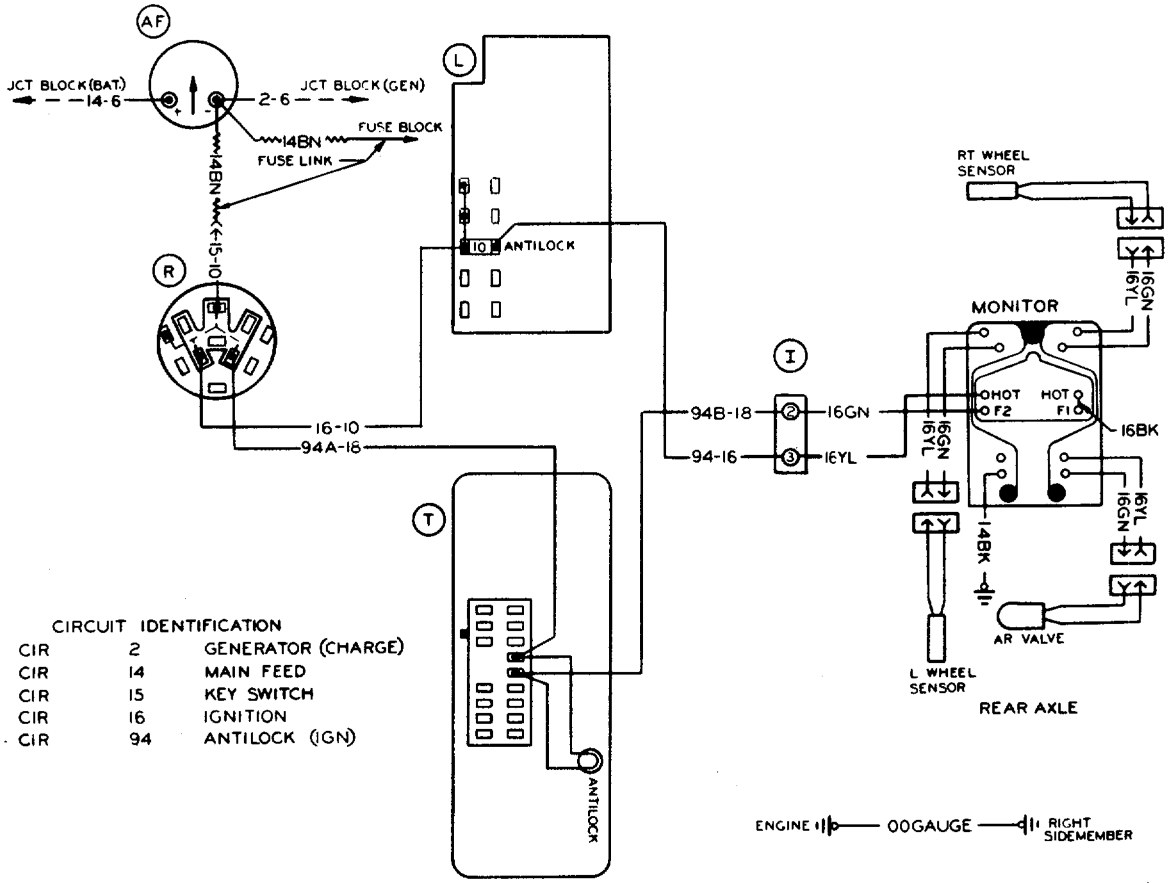

ALARMSTAT SWITCH (WATER)
PRESSURESTAT SWITCH (OIL)
START SOL "BAT" TERM
19K-14
19L-14
19D-14
19A-14
19A-16
19F-14
19C-14
15-10
71-16
AS17-12
17-12
AS17-14
PUSH BUTTON START SWITCH
(AIR OR FUEL SHUT-OFF) ACTUATOR AIR SOLENOID
AUTOMATIC OVERRIDE (START CIRCUIT)
TIME DELAY SW 30 SEC ± 10 SEC
IGN START LOAD GRD
19E-18
BELL
19D-18
19-14
19J-14
19H-14
19B-14
19G-16
SEE NOTE 1
AIR BUZZER
CIRCUIT IDENTIFICATION
CIR 15 KEY SWITCH
CIR 19 FUEL SHUTOFF
CIR 14 MAIN FEED
CIR 17 STARTING CONTROL
CIR 71 BACK-UP LIGHT (IGN)
NOTE:
1. RECTIFIER W/CAT-3208
KYSOR ENGINE SHUTDOWN WIRING
10 GAUGE
18B-10
18C-10
START SOL "BAT" TERM
14-8
15-10
16-BK
GLOW PLUG MAGNETIC SWITCH
GLOW PLUG PUSH BUTTON SWITCH
14BK
10BK
FRONT REAR GLOW PLUGS (CAT-3406)
CIRCUIT IDENTIFICATION
CIR 15 KEY SWITCH
CIR 14 MAIN FEED
CIR 18 GLOW PLUGS
GLOW PLUG WIRING

MT-23749

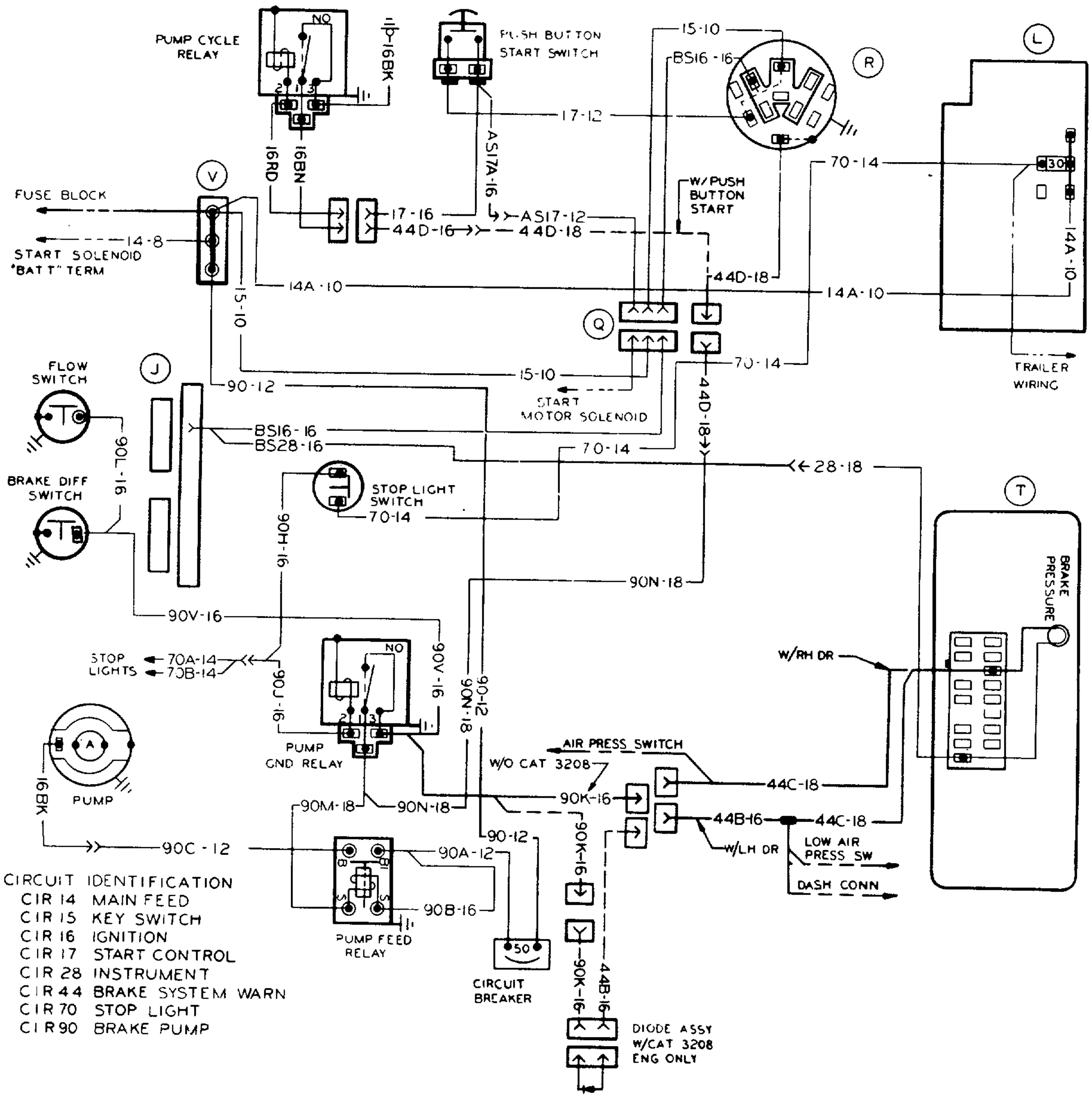


MT-23750

AIR BRAKES ANTILOCK WIRING

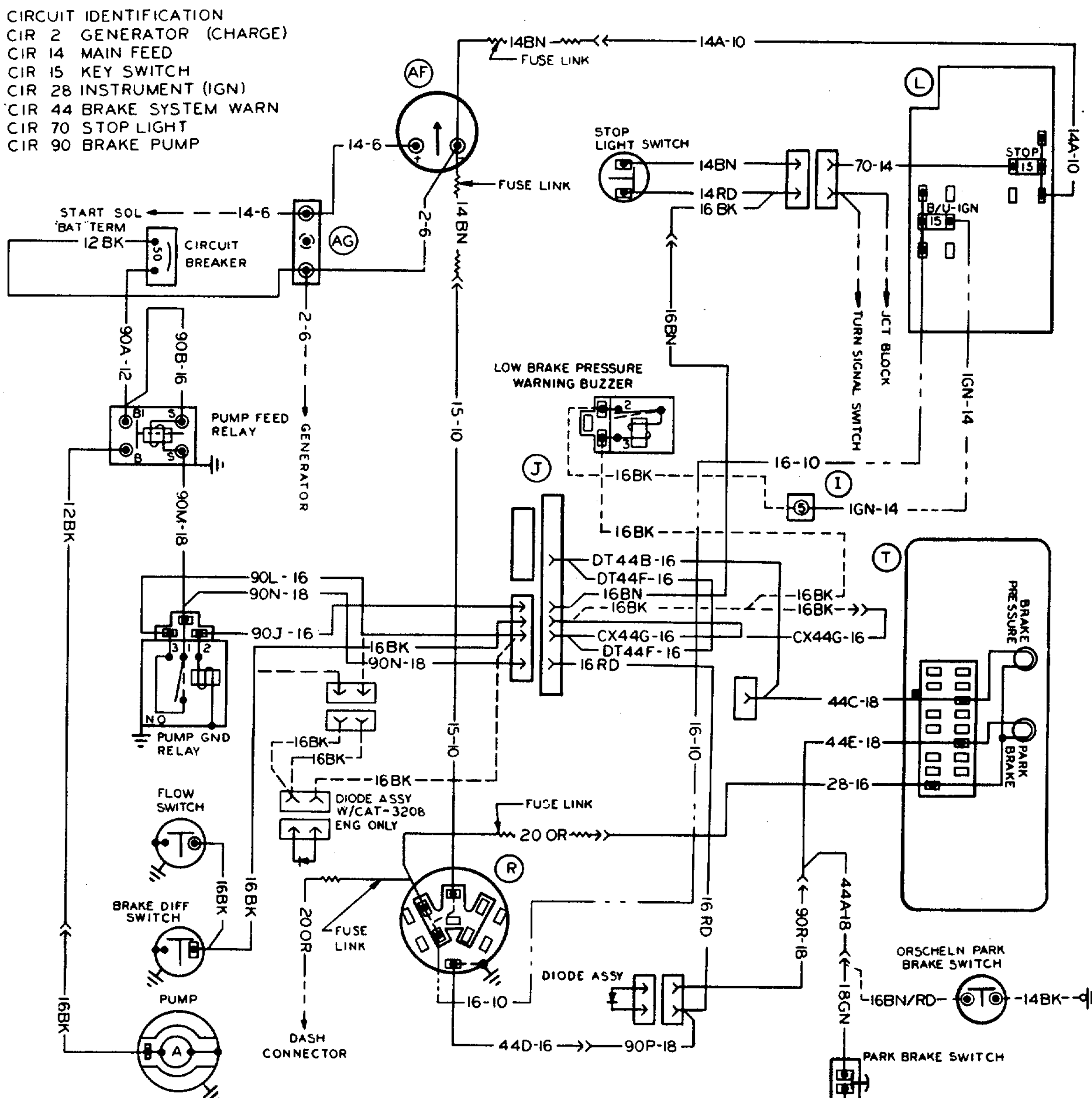


AIR BRAKES ANTILOCK WIRING FBC/BUS **MT-23751**

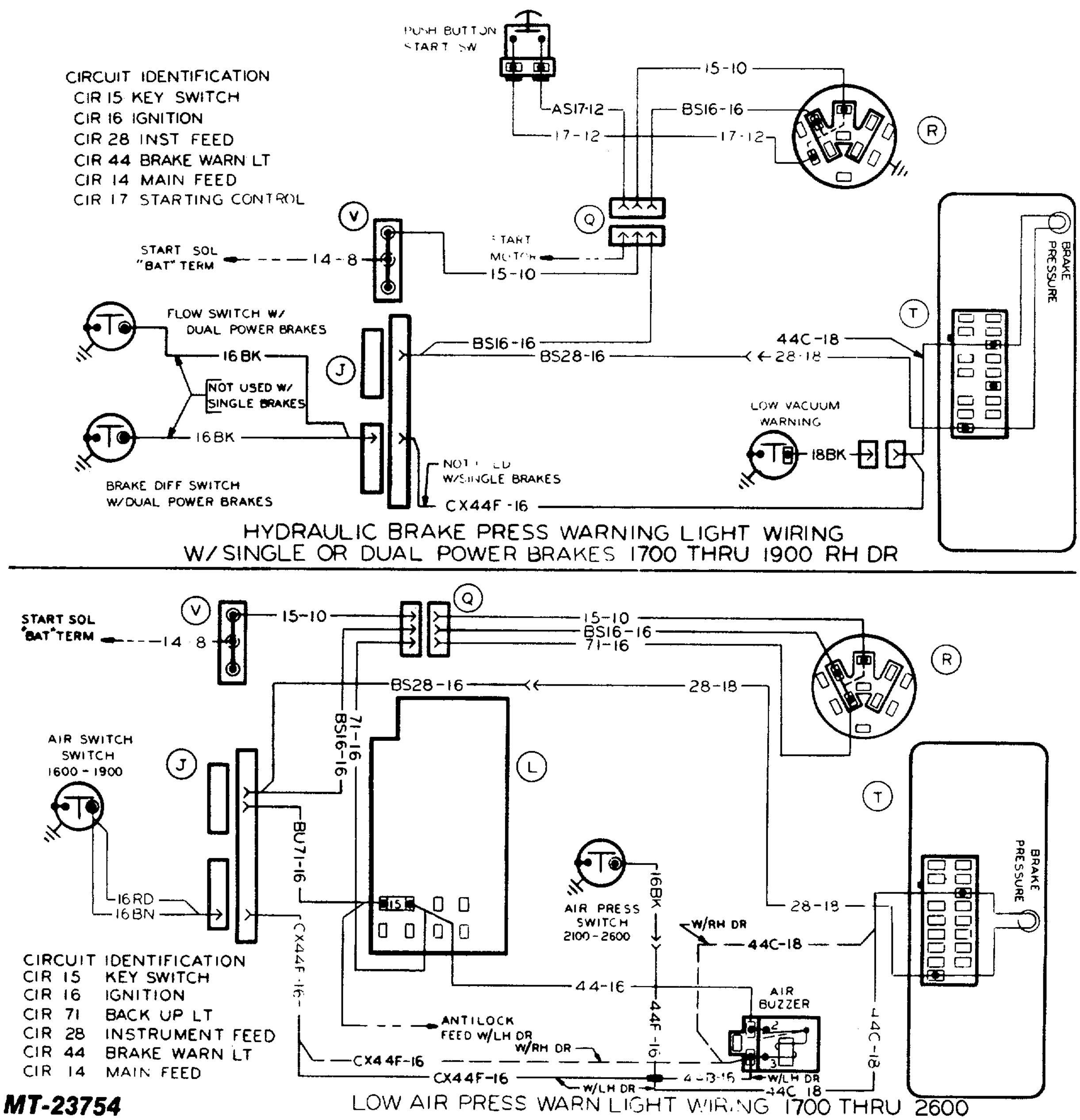


HY-POWER BRAKE WIRING

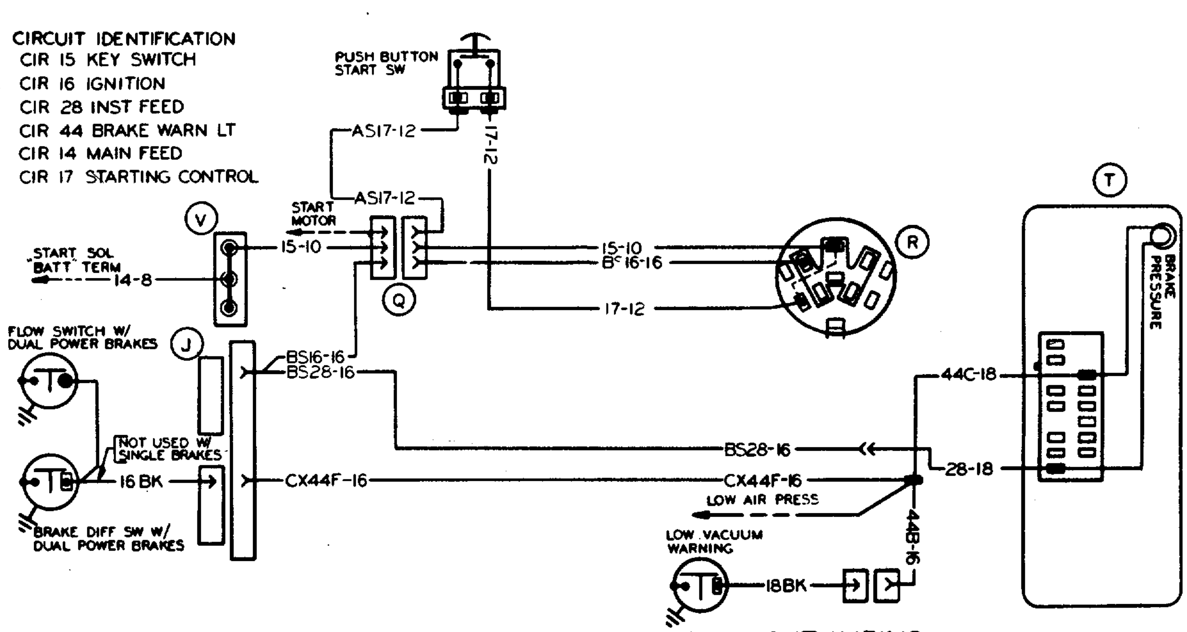
MT-23752



HY-POWER BRAKES WIRING FBC / BUS

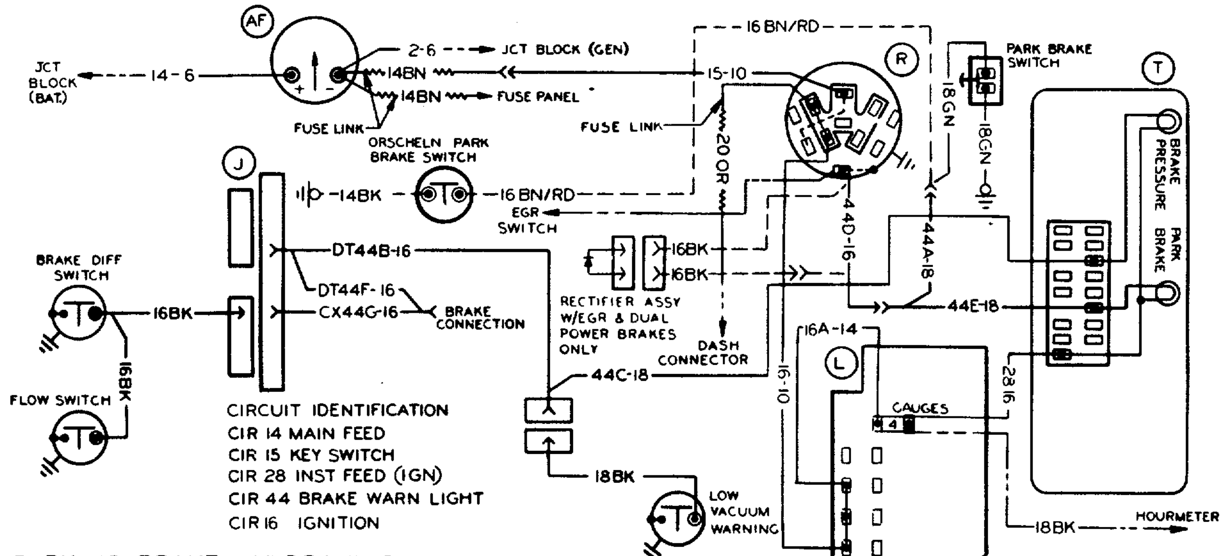


LOW AIR PRESS WARN LIGHT WIRING 1700 THRU 2600

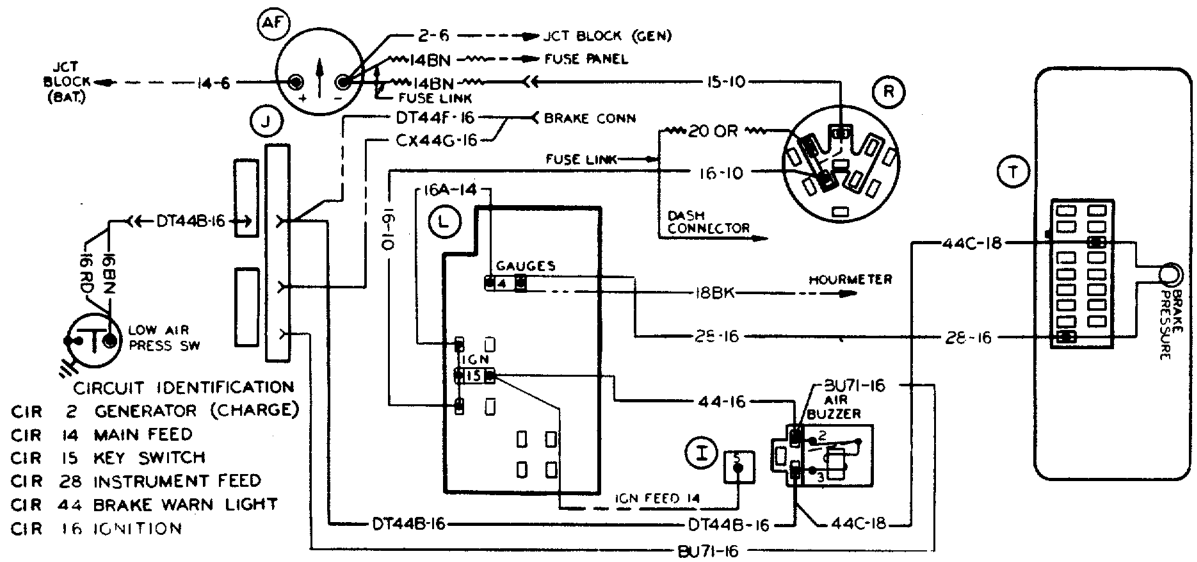


HYDRAULIC BRAKE PRESS WARNING LIGHT WIRING
W/SINGLE OR DUAL POWER BRAKES 1600 THRU 1900 LH DR

MT-23757

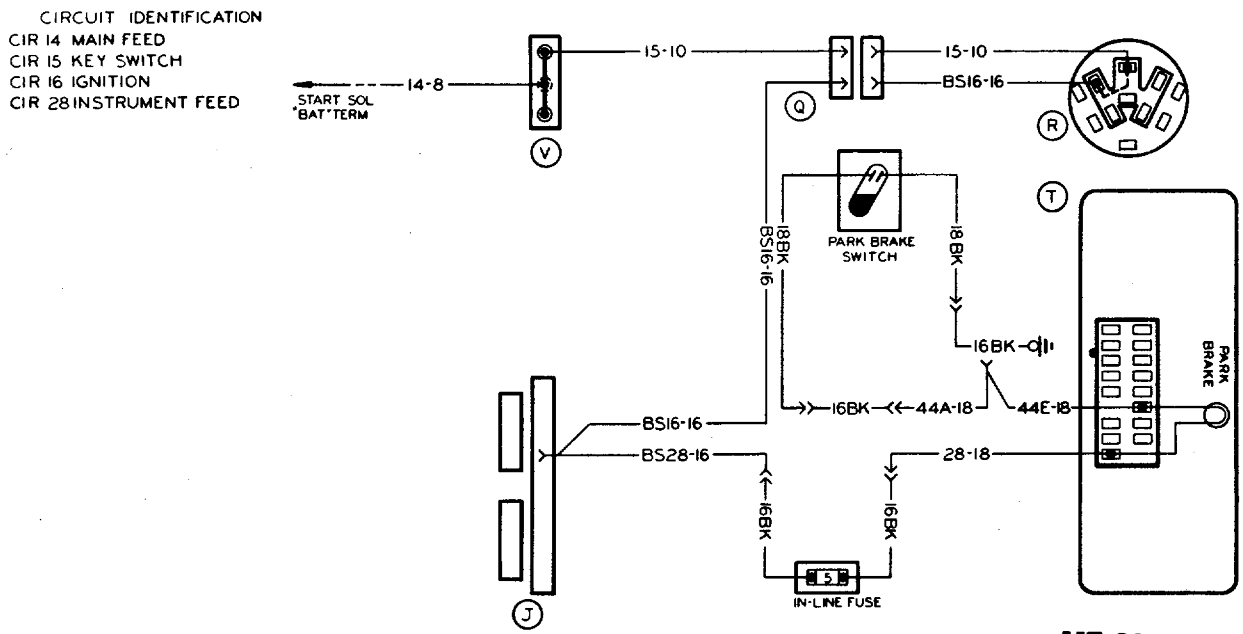


PARKING BRAKE & HYDRAULIC BRAKE PRESS WARNING LIGHT WIRING W/DUAL POWER BRAKES FBC/BUS

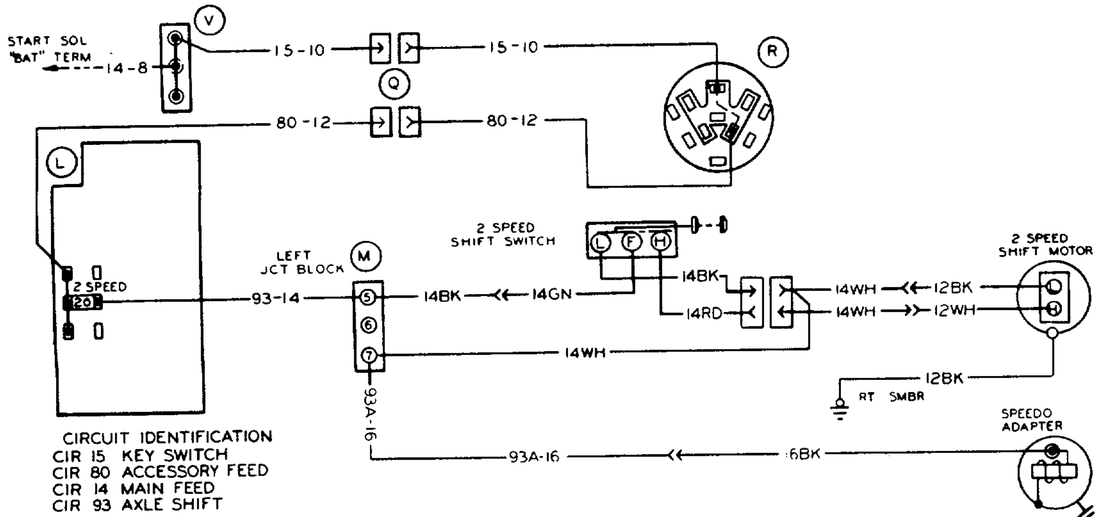


LOW AIR PRESS WARN LIGHT WIRING FBC/BUS

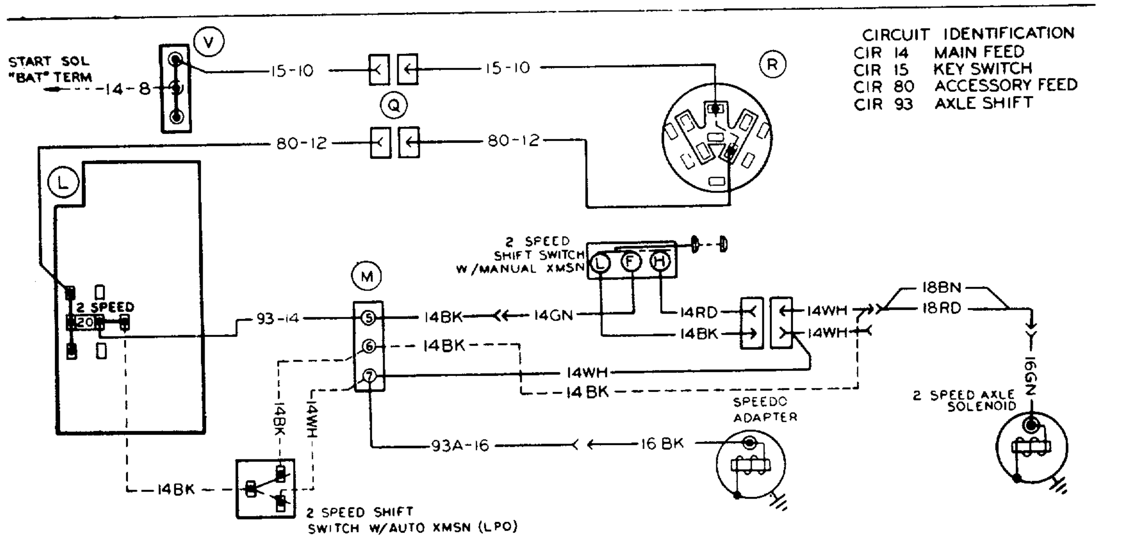
MT-23755



PARKING BRAKE WARNING LIGHT WIRING-RH DR **MT-23756**

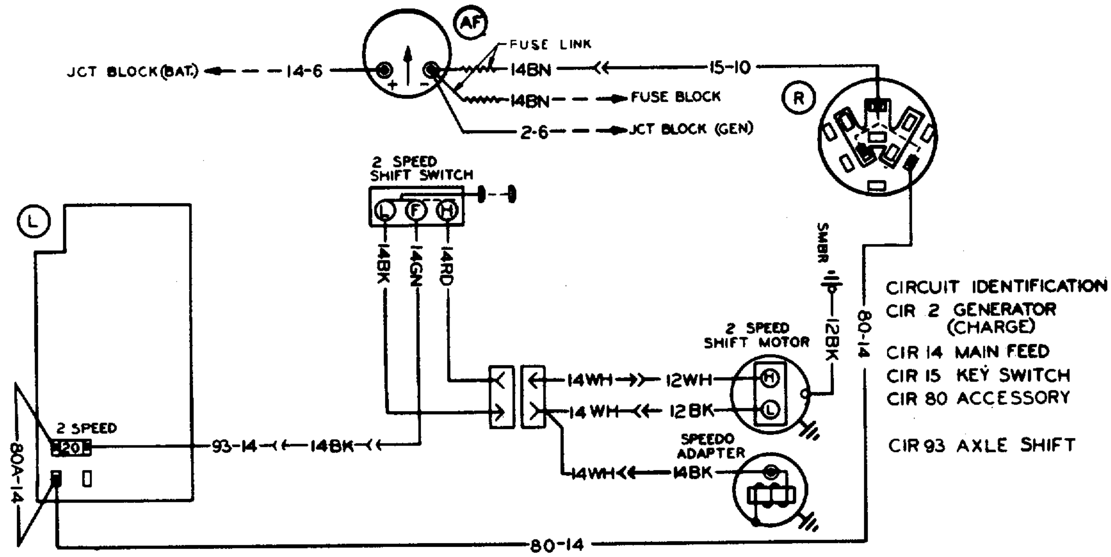


2-SPEED AXLE ALL ELECTRIC SHIFT 1600 THRU 2600

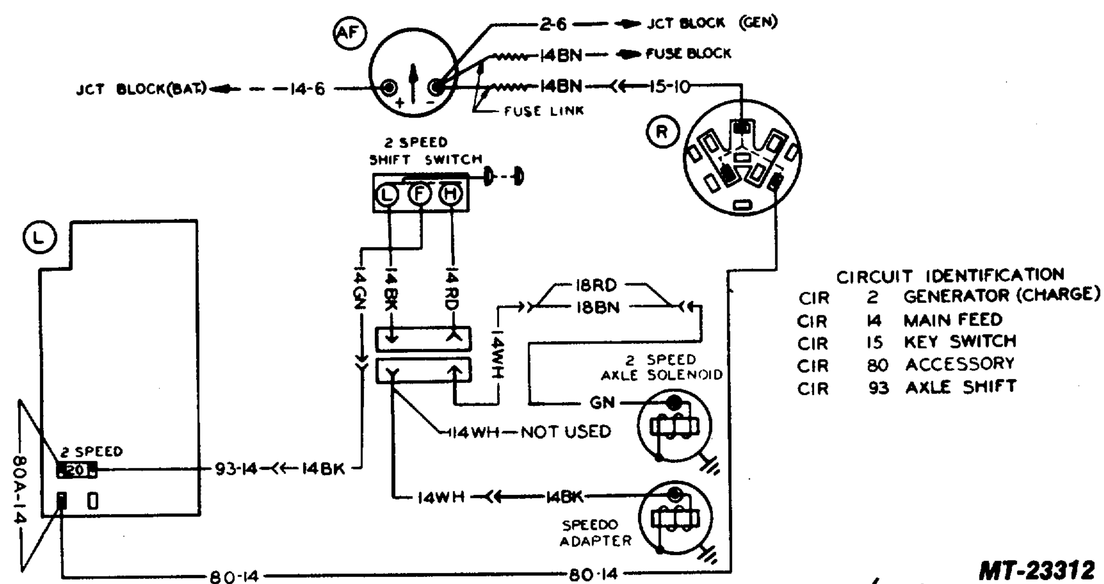


2-SPEED AXLE ELECTRIC OVER AIR 1600 THRU 2600

MT-21985

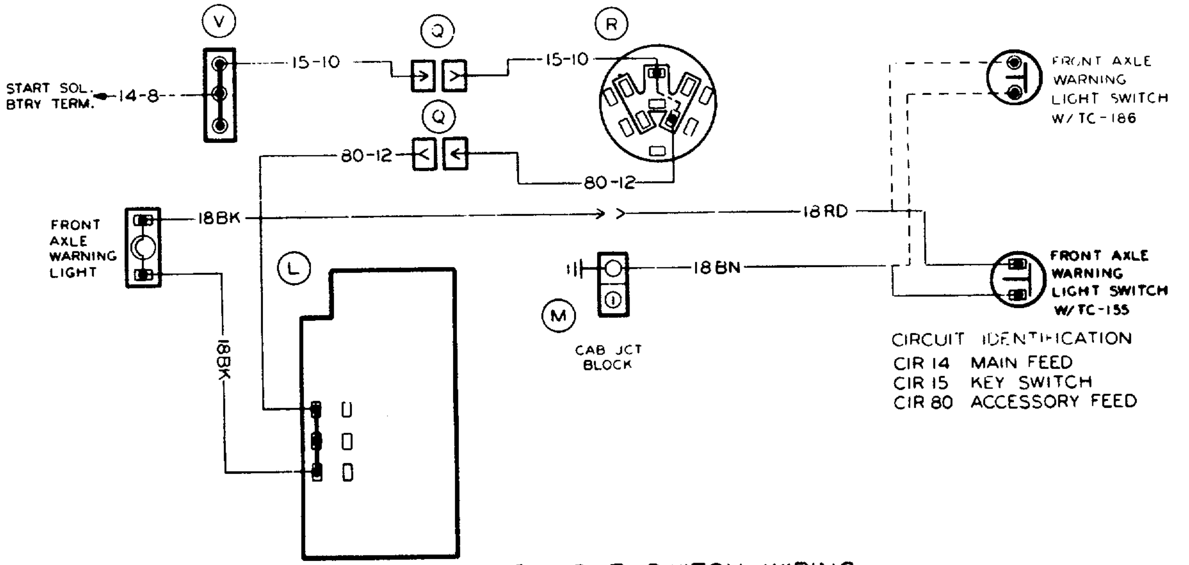


2 SPEED AXLE ALL ELECTRIC SHIFT FBC/BUS

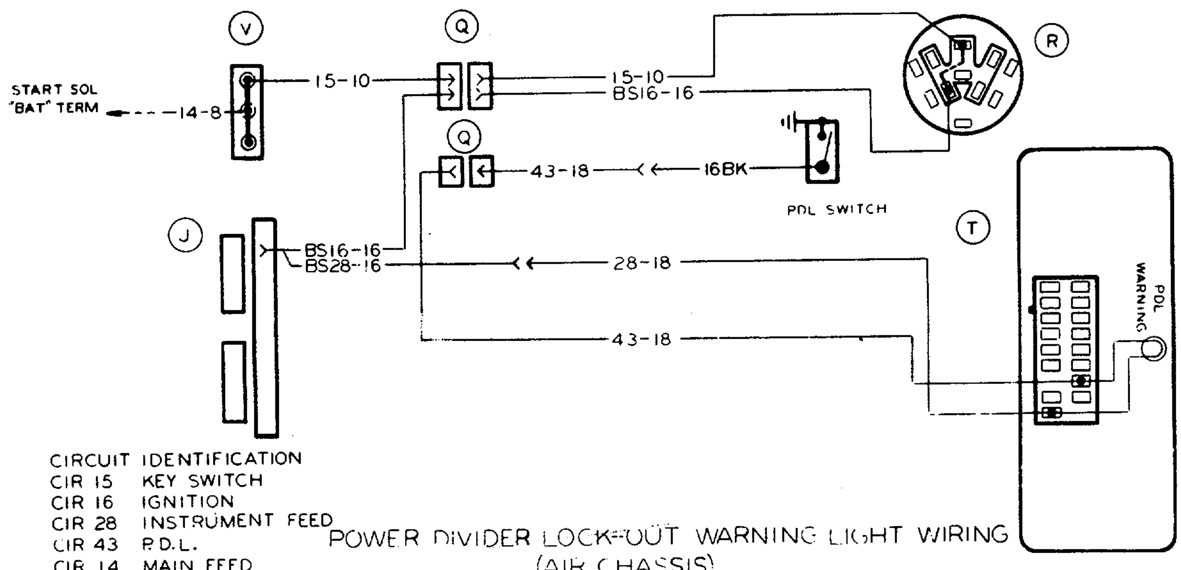


MT-23312

2 SPEED AXLE ELECTRIC OVER AIR FBC/BUS

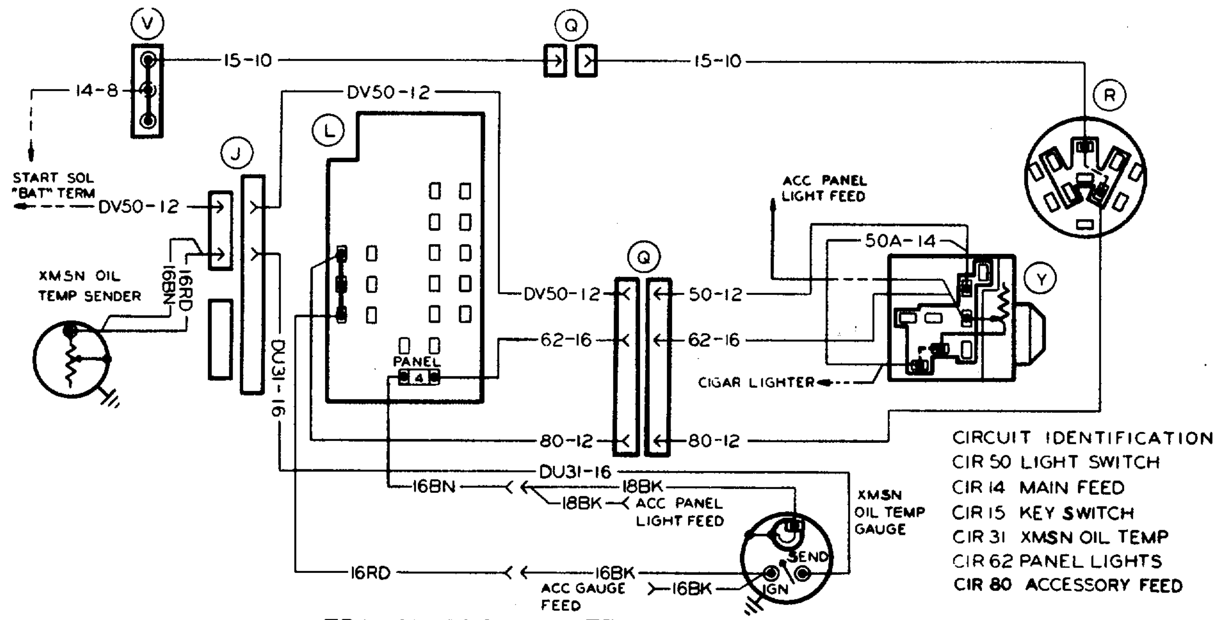


FRONT AXLE WARNING LIGHT SWITCH WIRING

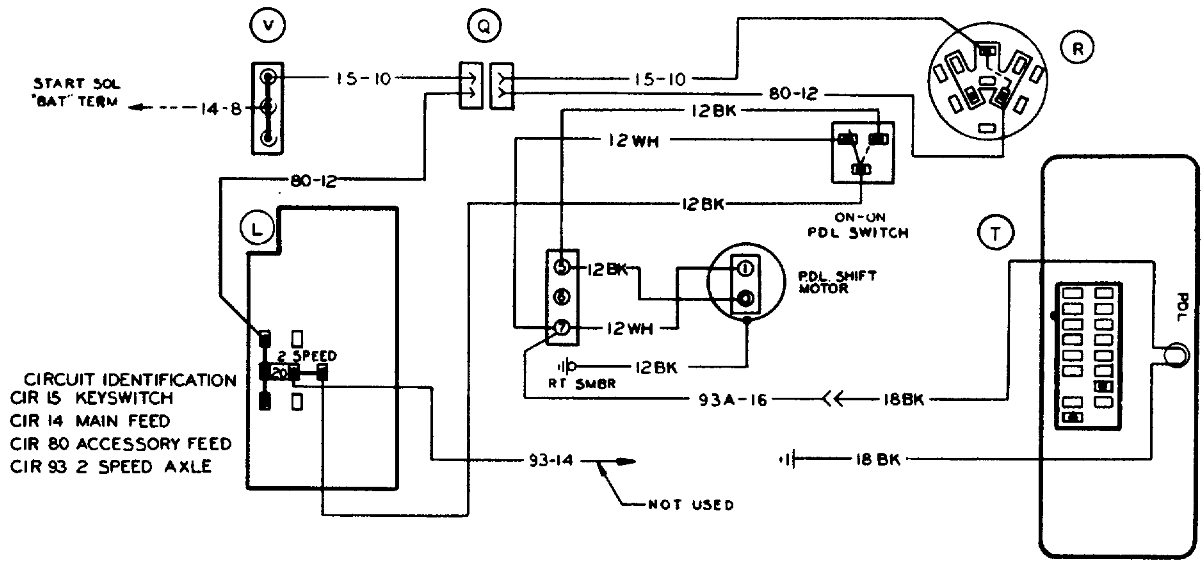


POWER DIVIDER LOCK-OUT WARNING LIGHT WIRING
(AIR CHASSIS)

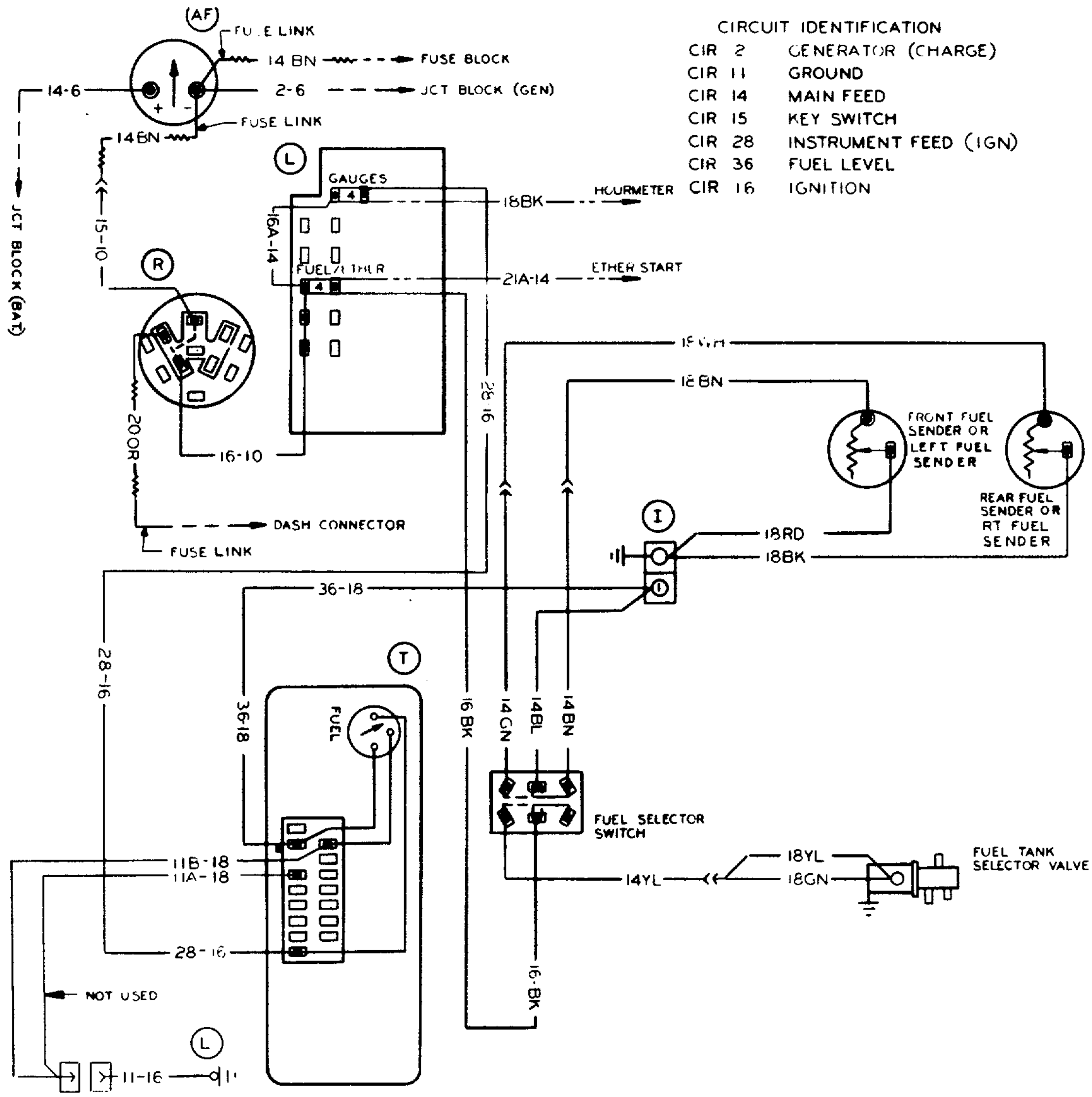
MT-23758



TRANSMISSION OIL TEMPERATURE GAUGE WIRING

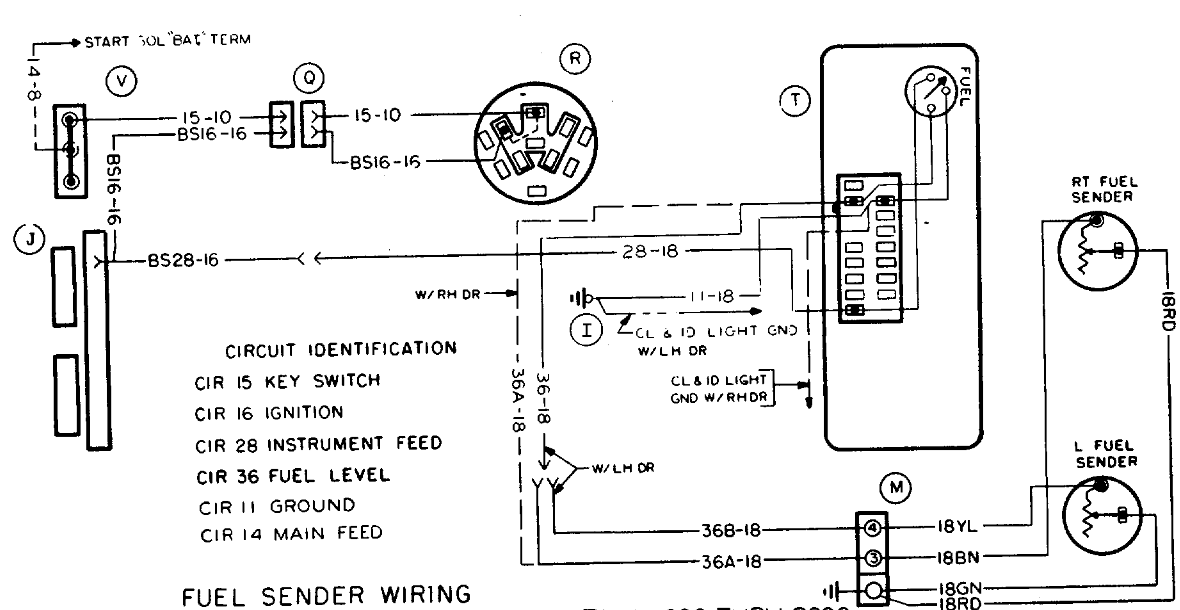


MT-23804 ELECT. POWER DIVIDER LOCK-OUT WIRING (HYD CHASSIS)

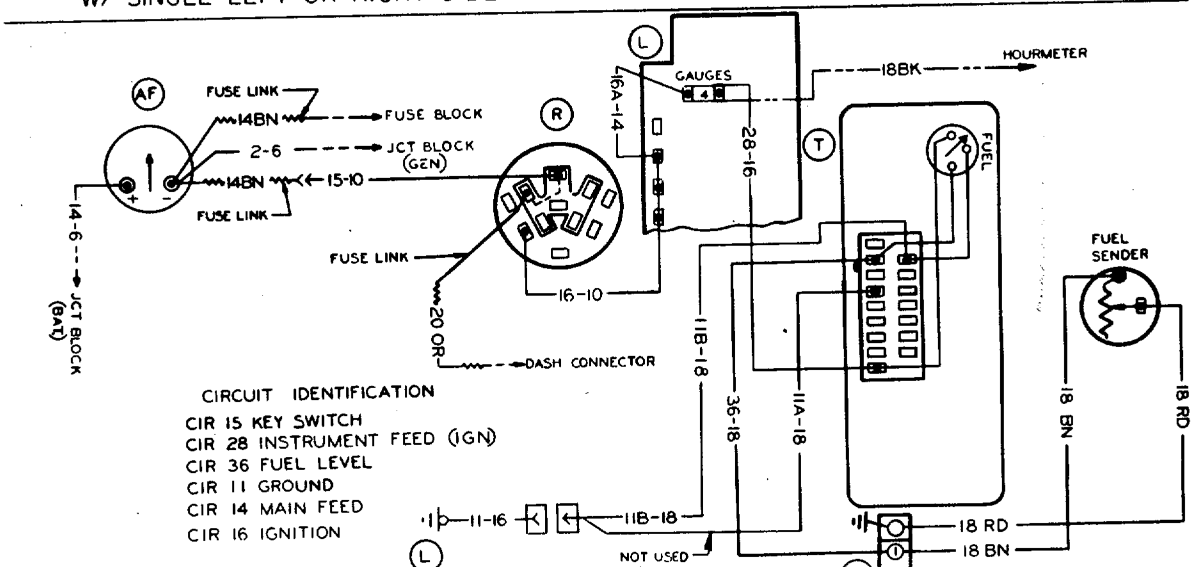


MT-23760

DUAL SENDERS WITH DUAL FUEL TANKS FBC & BUS W/GAS ENG. ONLY

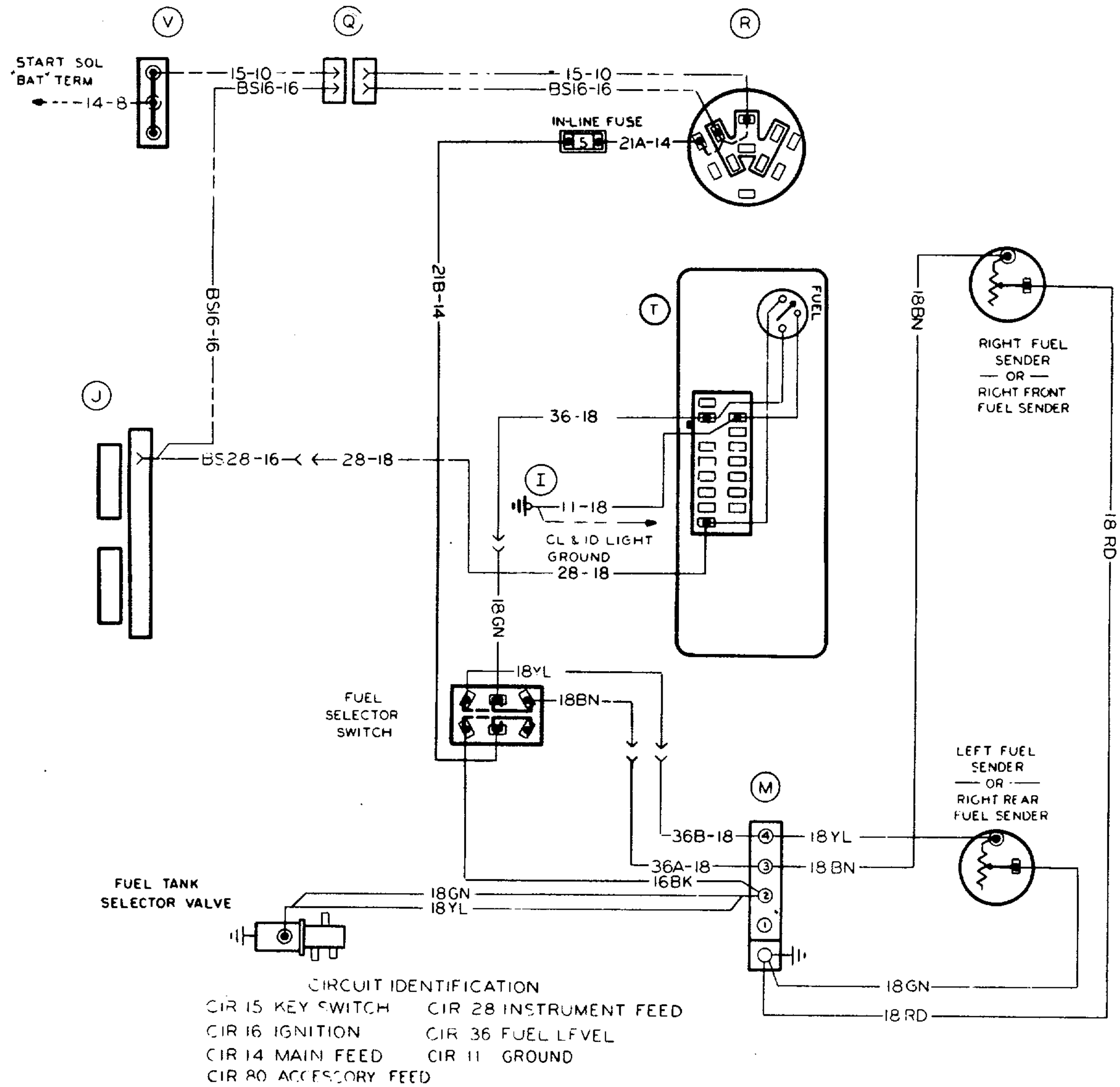


FUEL SENDER WIRING
W/ SINGLE LEFT OR RIGHT SIDE FUEL TANK 1600 THRU 2600

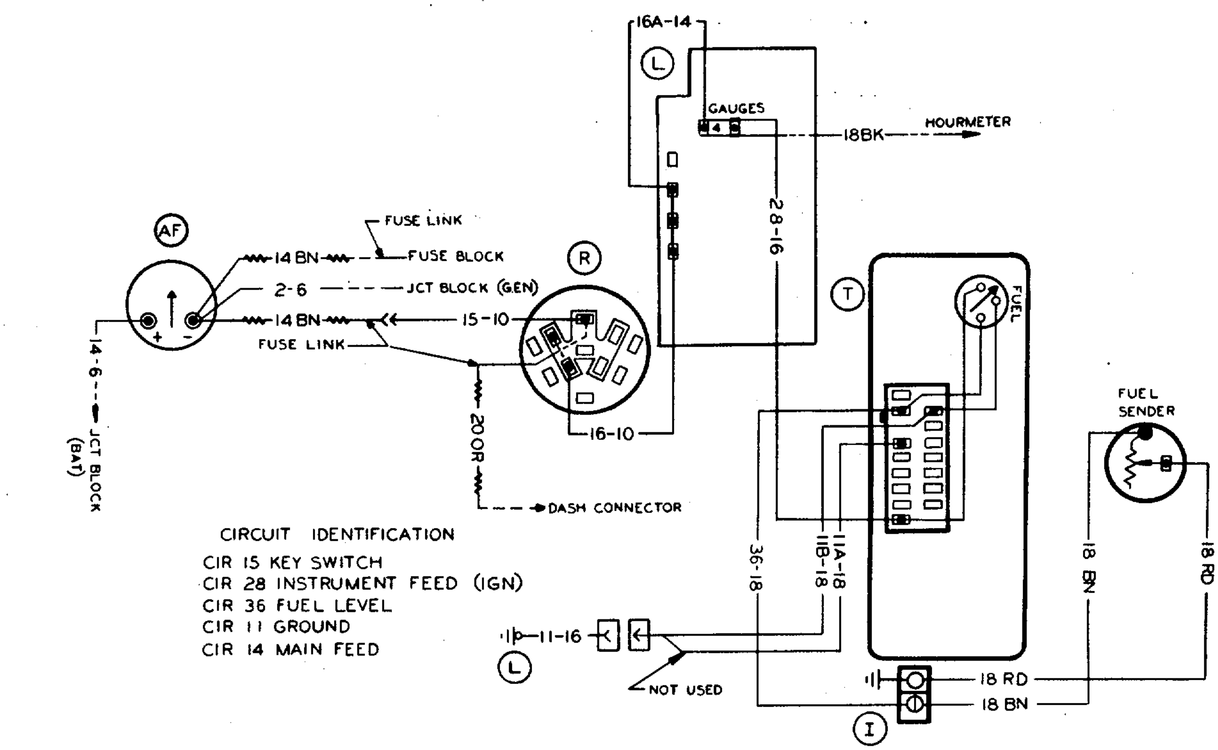


FUEL SENDER WIRING FBC/BUS

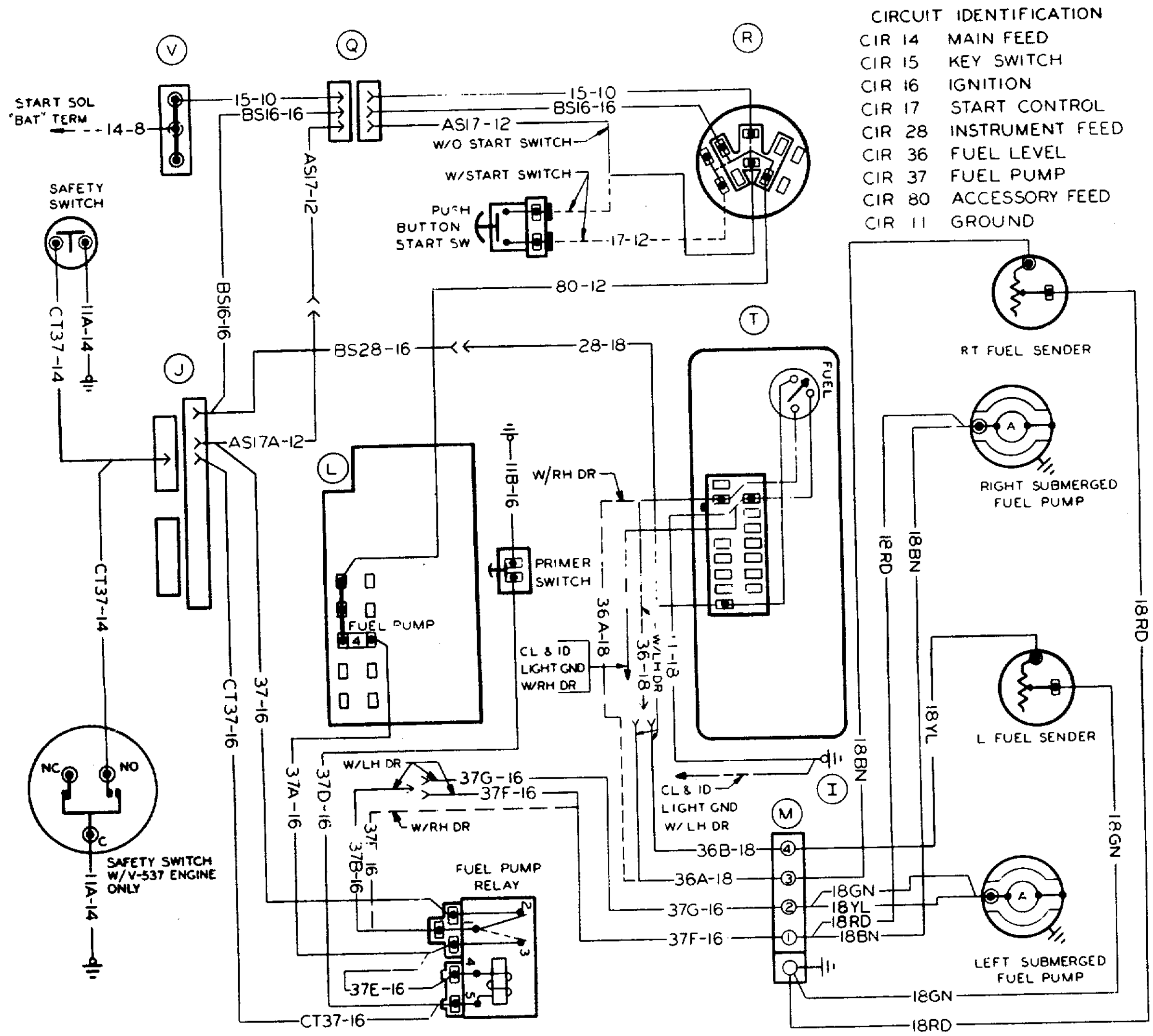
MT-23759



MT-23762 DUAL FUEL SENDERS WITH DUAL TANKS - W/ALL GAS ENGINE MODELS EXCEPT FBC

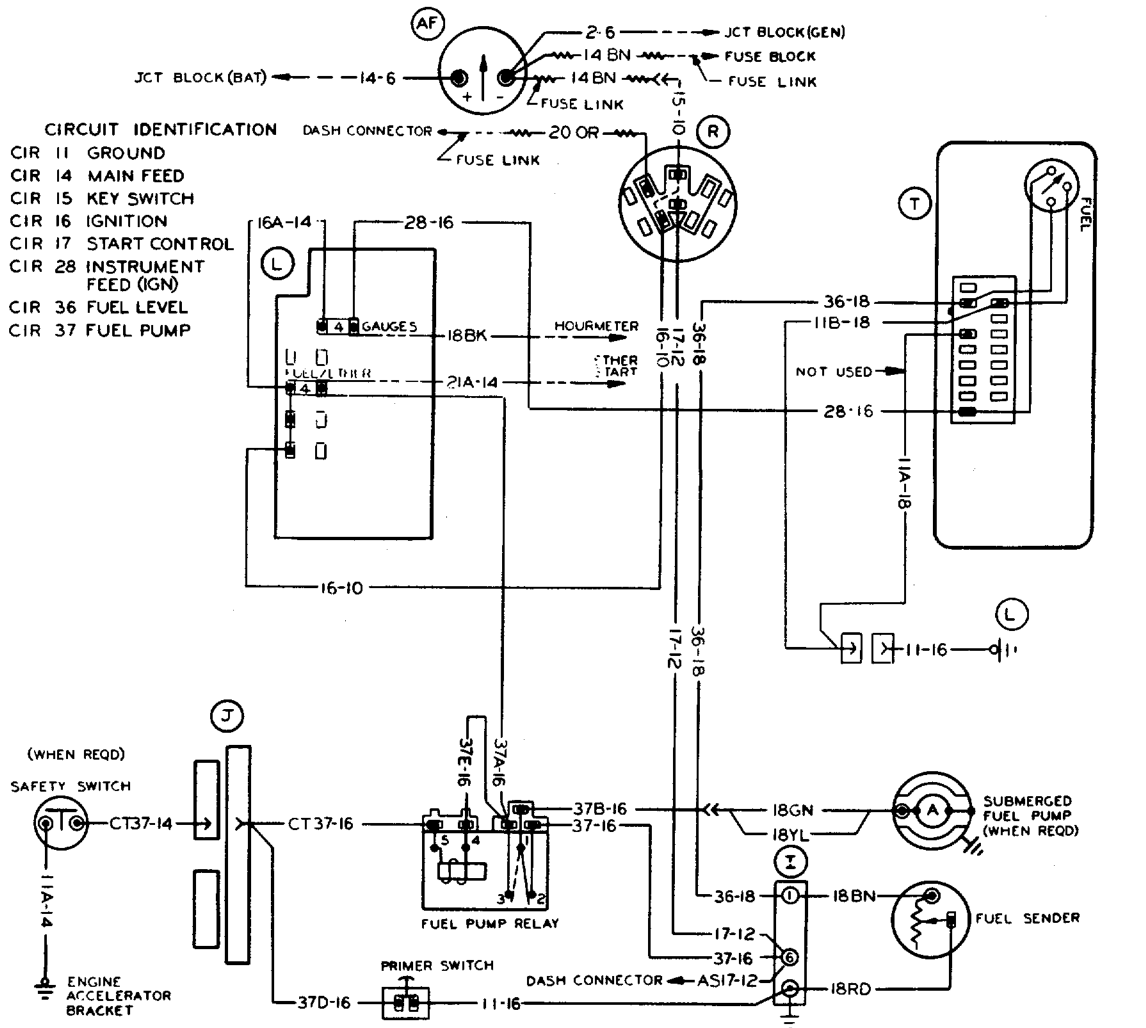


MT-23761 FUEL SENDER WIRING - DUAL TANKS W/DIESEL ENGINE FBC

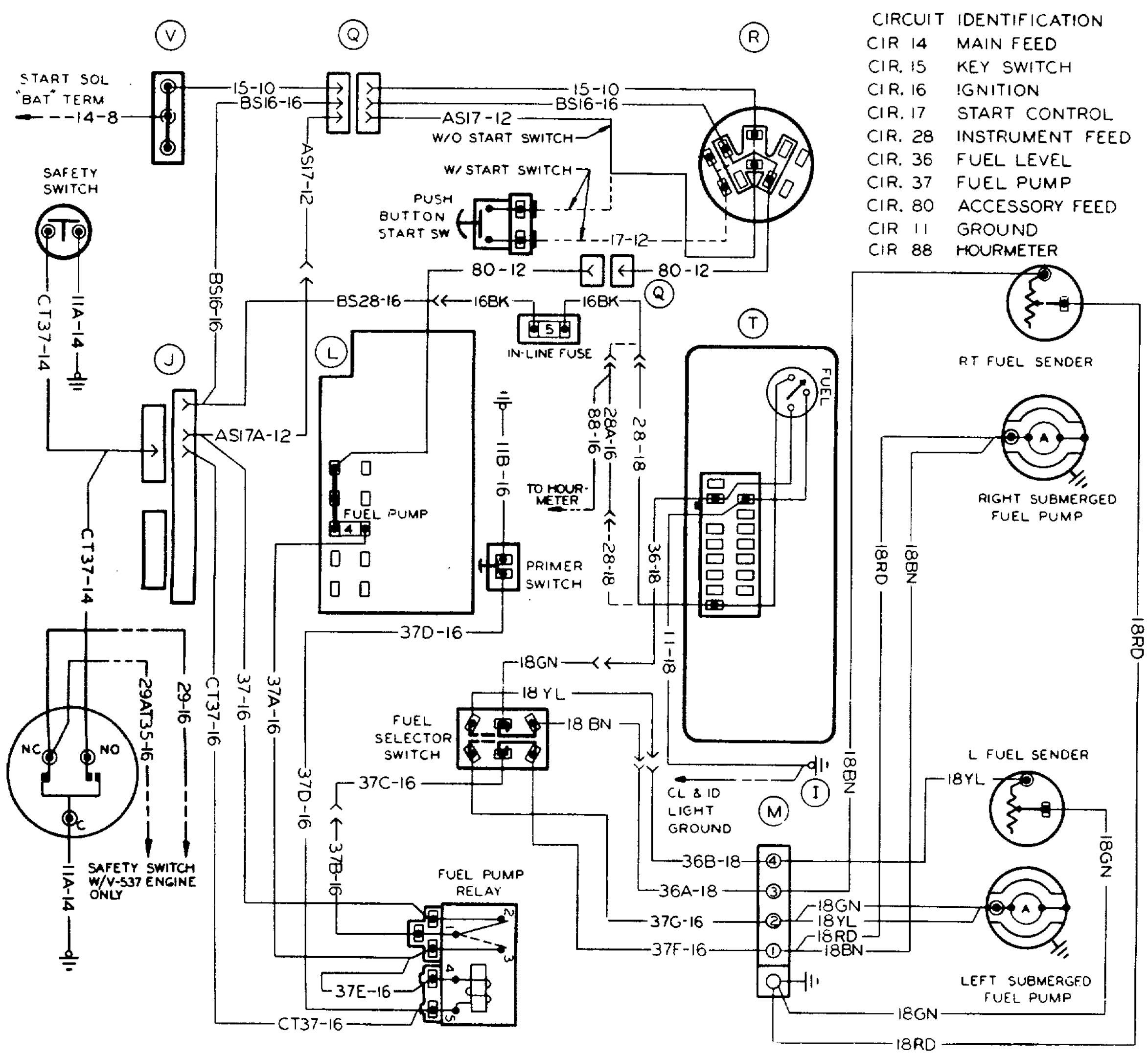


FUEL SENDER & SUBMERGED FUEL PUMP WIRING

MT-23763 W SINGLE LEFT OR RIGHT SIDE FUEL TANKS 1600 THRU 2100, 2500, 2600

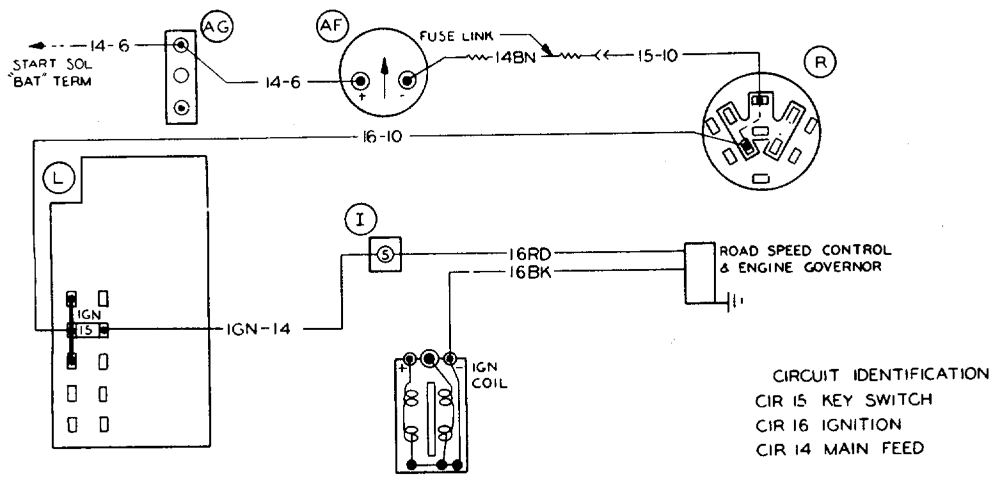


FUEL SENDER & SUBMERGED FUEL PUMP WIRING FBC/BUS **MT-23764**



FUEL SENDER & SUBMERGED FUEL PUMP WIRING W/DUAL FUEL TANKS

MT-23765



ROAD SPEED CONTROL & ENGINE GOVERNOR
W/V-345,V-392 & MV8 ENGINES W/FBC/BUS

MT-23740

INDEX

INDEX (Continued)

ELECTRICAL

IGNITION COILS AND CONDENSERS

(Construction, -Operation, Maintenance)

INDEX

DESCRIPTION

The ignition coil is a pulse transformer that steps up the low battery or alternator voltage to the high voltage necessary to jump the gaps at the spark plugs in the engine cylinders. This voltage may reach as much as 20, 000 volts in some installations.

The ignition coil, Figs. 1 and 2, contains three essential parts: a primary winding consisting of a few hundred turns of relatively heavy wire, a secondary winding consisting of many thousand turns of very fine wire, and laminated soft iron which serves to concentrate the magnetic field. The primary winding is assembled around the outside of the secondary winding, and the laminated iron is distributed so that one portion serves as a core for the windings and the remainder as a shell around the entire subassembly. This subassembly is then placed in the coil case and the remaining. space nearly filled with insulating compound :r oil and the coil cap assembled into place.

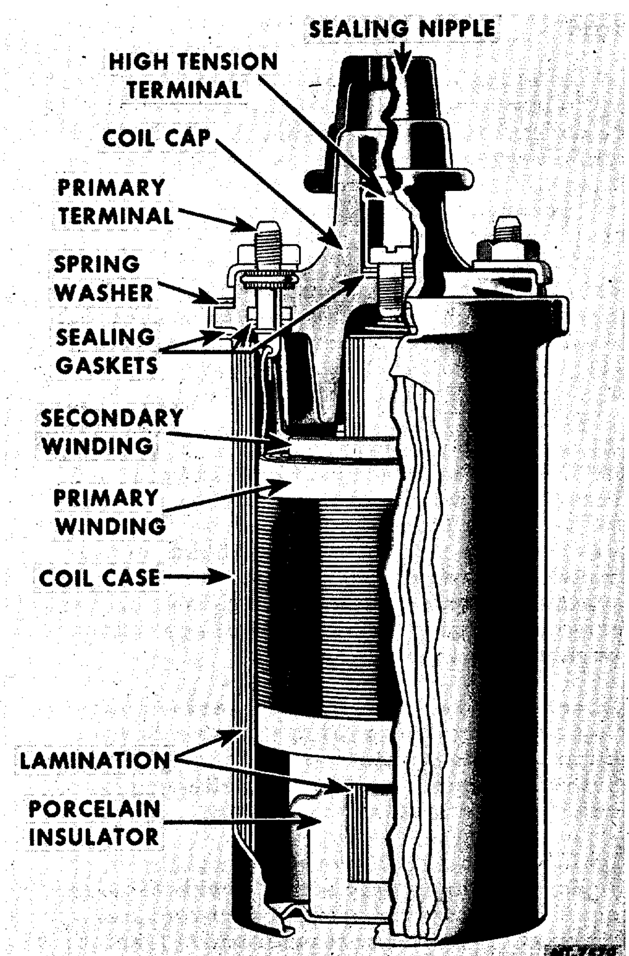


Fig. 1 Steel Encased Coil (Cutaway View)

IGNITION COIL TYPES

There are a variety of ignition coils for various types of operation, with each type of coil being supplied in several models, each designed to incorporate a specified winding to make it suitable for operation with a particular engine under specific operating conditions.

Fig. 1 illustrates an oil-filled and hermetically sealed ignition coil housed in a one piece steel case. Hermetic sealing of the ignition coil prevents the entrance of moisture, which would ultimately cause coil failure. Moisture may enter an unsealed coil either directly in the form of rain, snow, washing water, steam and so forth, or through the "breathing" action of the coil itself. Unless a coil is hermetically sealed, it will expel air when heated and will draw in outside air when cooled. This is the action termed "breathing", and it results in a gradual accumulation of water in the coil interior because of the condensation of water vapor from the incoming air. In addition to hermetic sealing, the coils are also filled with oil to impart high dielectric strength to the insulation, thus further reducing the possibility of insulation breakdown and coil failure.

Fig. 2 illustrates a heavy-duty oil-filled and hermetically sealed ignition coil housed in a one piece diecast aluminum case. The fins cast in the case, plus the oil filling, permit improved heat radiation, which is a factor in efficient ignition coil performance.

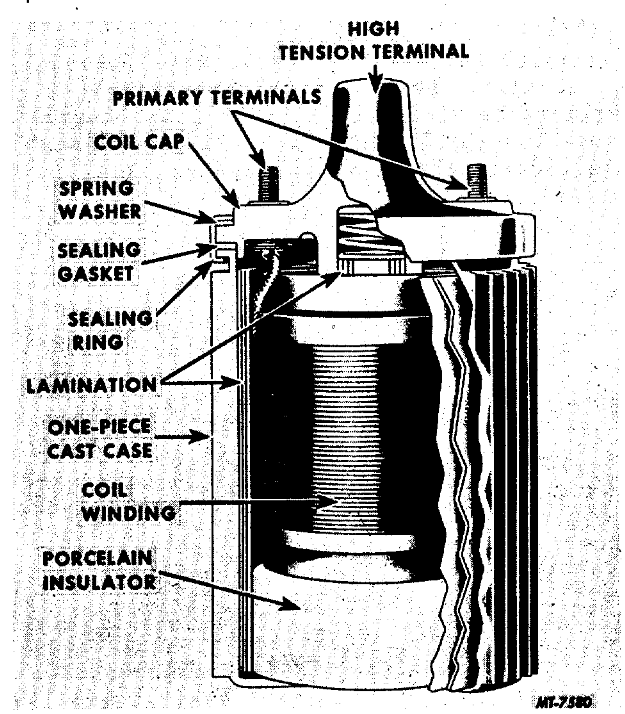


Fig. 2 Diecast Encased Heavy-Duty Coil (Cutaway View)

The coil used with the transistor ignition system has the outward appearance of a standard coil; however, it contains special high ratio windings that produce higher secondary voltage at all engine speeds.

COIL SERVICE

Ignition coils do not normally require any service except to keep all terminals and connections clean and tight. In addition, the coil should be kept reasonably clean, but it must not be subjected to steam cleaning or similar cleaning methods which may cause moisture to enter the coil unless it is of the hermetically sealed type. Rubber nipples on the high voltage terminals are valuable in preventing "tracing" or leakage of current across exposed surfaces.

If poor ignition performance is obtained, and the coil is suspected of being the cause, the coil may be tested on the truck or it may be removed for the test.

COIL TESTS

Various types of testing instruments are used in testing ignition coils. One of these makes use of an open or protected spark gap, while another reports the coil condition on a meter or scope. This second type of tester is usually so designed as to permit testing of the coil without making any connection to the secondary terminal. This eliminates certain variables caused by altitude, atmosphere or spark gap electrode conditions.

The spark gap tester should always be used comparatively. That is, a coil known to be good should be compared with the questionable coil. Both coils should be at same temperature and identical test leads must be used.

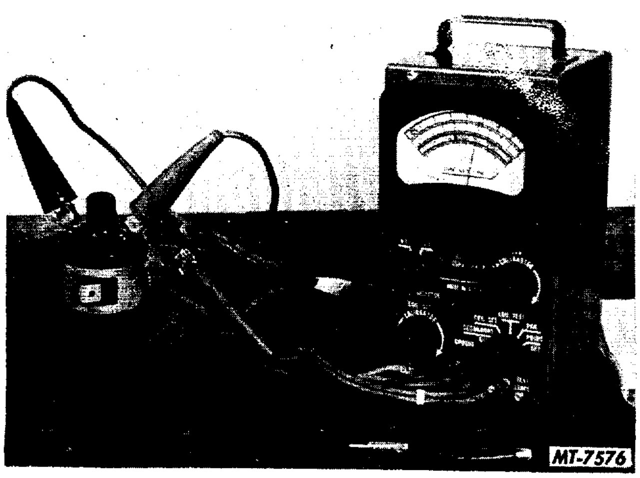


Fig. 3 Coil Tester

Before the testing instrument is used, a lamp and test point should be applied to check coil for open or grounded circuits. To test for an open primary circuit, put test points on the two primary terminals. If lamp does not light, primary circuit is open. To check secondary circuit, put one test point in high tension terminal and the other at one of the primary terminals. Lamp will not light, but tiny sparks will be noted as test points are rubbed over terminals if secondary winding is not open. If secondary is open, no sparks will occur.

Most ignition coils can be tested for grounded windings by placing one test point on a clean part of the metal container and touching the other point to primary and high tension terminals. If lamp lights or tiny sparks appear at the points of contact, windings are grounded.

NOTE: This test does not apply to secondary windings of coils used on insulated or two: wire electrical systems, since these coils have one end of the secondary winding grounded to metal container. The primary winding of this type of coil, however, may be checked for ground.

When using a meter-type coil tester to test a coil without removing it from the vehicle, be very careful to avoid touching tester case to truck. Many such testers have a ground connection to the case, touching case to truck would produce a short circuit and possible serious damage to the equipment.

Details of the testing procedures and the manner in which various testers are used will be found in the tester operating instructions.

TWELVE-VOLT SYSTEM

The coil used with the 12-volt system, Fig. 4, has more turns of wire in both the primary and secondary windings and a higher ratio between windings than in 6-volt coils of same size. The increased number of turns in primary winding results in a higher inductance in this winding, which makes it possible for coil to provide a higher secondary voltage output throughout the speed range.

In order to improve ignition performance during cranking, an ignition resistor is used with the 12-volt ignition coil. This external resistor is connected in series with primary circuit between battery and coil.

Ignition resistor is wound with wire which changes resistance only slightly with temperature. This characteristic prevents excessive primary current at low temperatures, and thus reduces the tendency for distributor contact points to oxidize during cold weather. To

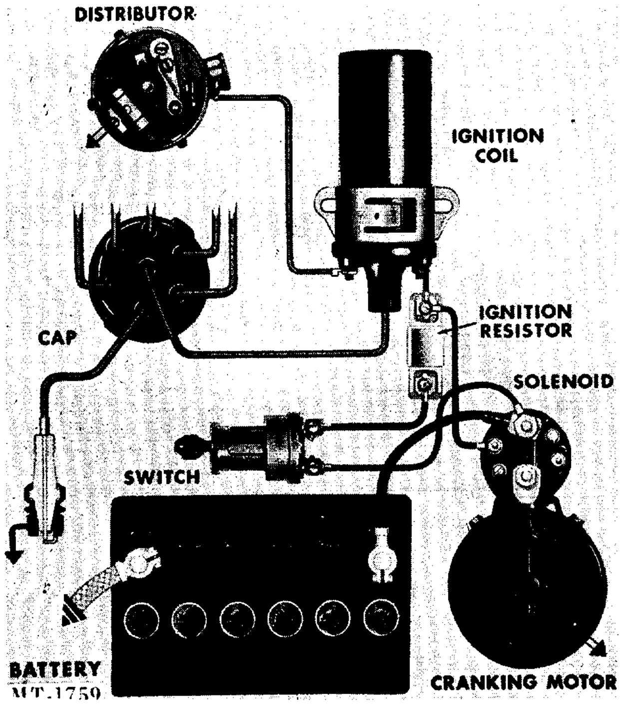


Fig. 4 Schematic Diagram of Primary and Secondary Circuits of 12-Volt Ignition System

obtain greatly improved starting performance at low temperatures, the resistor is bypassed during cranking, thereby connecting ignition coil directly to battery. This makes full battery voltage available to coil and, thus, keeps ignition voltage as high as possible during cranking. The bypassing of ignition resistor during cranking is accomplished by use of a "finger" within the solenoid which is connected to the ignition coil. As solenoid contacts close, the ignition coil is connected to battery through the solenoid "finger". To prevent the engine from firing while making underhood cranking tests on trucks using 12-volt system, ground distributor primary lead.

COIL POLARITY

One of the major causes for hard starting or spark plug misfiring under load results when the ignition coil lead wire to the distributor is installed on the wrong side of the coil. This condition causes reversed coil polarity.

Voltage at the spark plug terminals should always be negative. Whether it is or not depends on how the primary leads are attached to the coil. Remember, primary lead hook-up directly affects coil polarity, which in turn determines whether voltage at the spark plug terminals is negative or positive. On IH trucks the distributor wire to the coil should always be placed on the negative side of the coil if the electrical system is negative grounded, or on the positive side if the electrical system is positive grounded. If the primary leads are incorrectly attached, the direction of current flow through the coil is reversed. Consequently, coil polarity is reversed, resulting in positive voltage being supplied to the spark plug terminals.

What difference does it make whether positive or negative voltage is supplied to the spark plug terminals?. It directly affects the amount of voltage required to fire the spark plugs. When polarity at the spark plug terminals is positive, it's harder for the voltage to jump across the air gap than when polarity at the plug terminal is negative. Just why this is so is related to a pair of electrical theories--the electron theory and the theory of thermionic emission.

According to the electron theory, all current flows from negative to positive. The theory of thermionic emission states essentially it's easier for electrons to leave a hot surface than a cold surface.

Combining the two theories, one finds that electrons will always leave a negative charged surface for a positive charged surface, and they will leave the negatively charged surface with more ease when the surface is heated.

Spark plug design is such that the center electrode almost always operates at a higher temperature than the ground electrode. Since it's easier for electrons to leave a hot surface, it is preferred to have the electrons "jump" from the hotter center electrode to the cooler ground electrode.

When the center electrode is negatively charged (negative voltage at the spark plug terminals), this is what happens. Stated another way, putting the negative charge on the hotter center electrode causes the gap to be ionized at lower voltage. (Ionization is necessary to permit passage of the spark through the high resistance of the gases in the cylinder.)

When positive voltage is supplied to the plug terminals, which happens when coil polarity is accidentally reversed, the hotter center electrode becomes positive charged. Consequently, electrons must leave the negative charged ground electrode and move to the positive charged center electrode. But, since the ground electrode is cooler than the center electrode (and remember, it's easier for the electrons to leave a hotter surface), it takes more voltage to make the current jump the gap-in fact, up to 45 percent more. See Fig. 5.

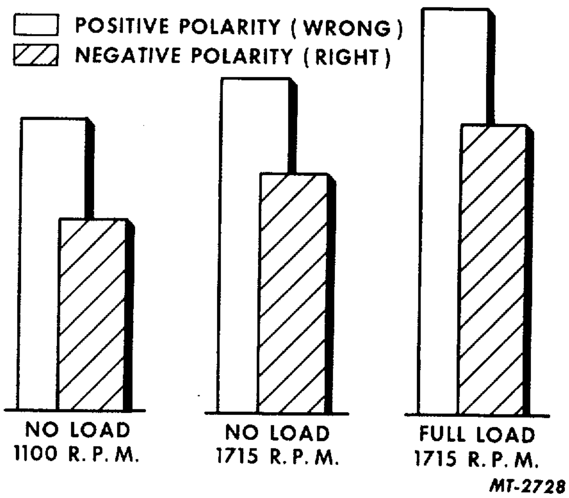


Fig. 5 Chart Showing Extra Voltage Required When Polarity Is Reversed

For a time, the engine may run fine with coil polarity reversed--until the spark plugs have been in use for some time. Then, the driver may encounter hard starting or misfiring under load, as the amount of voltage required to fire the spark plugs under these conditions is higher than at any other time.

In view of the above, it is very important that coil polarity should always be such that negative current is supplied to the spark plug terminals.

CHECKING FOR REVERSED POLARITY

A quick and easy method in checking for reversed polarity is the use of an ordinary wooden pencil, Fig. 6. Using the wooden pencil-check method, remove an ignition cable from any one of the spark plugs. Then, place the graphite tip of the pencil between the spark plug terminal and the cable and observe the spark as it jumps across the gap. If you notice the spark flaring or having an orange tinge on the spark plug side of the pencil, polarity is correct. If it flares or has a tinge on the cable side, polarity is reversed (be sure to use a wooden pencil when making this check or an uncomfortable shock may be received from the spark plugs). NOTE: The above check is used particularly on those coils not having any markings on the coil terminals. All coils recommended and used by the International Harvester Company are properly marked.

NOTE: When checking for reversed polarity, always be certain that the spark plugs are correctly gapped and in good condition.

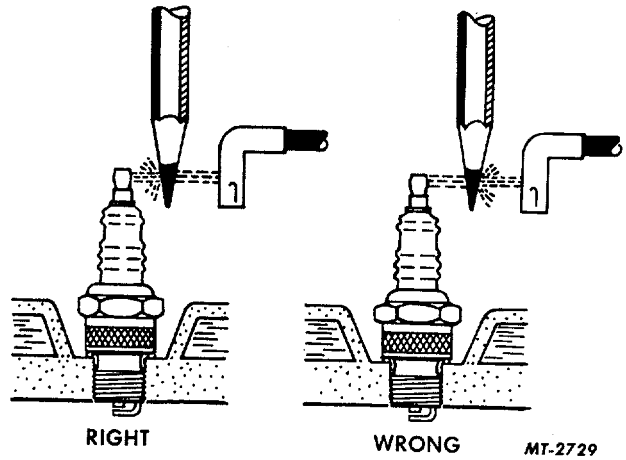


Fig. 6 Method of Checking for Reversed Polarity

CONDENSERS

The condenser which is mounted inside ignition system distributor prevents arcing of distributor points when points begin to open by providing a place for current to flow until points are safely separated. This requires special insulating between the two foil sheets which store current flow and bring it to a quick controlled stop, Fig. 7.

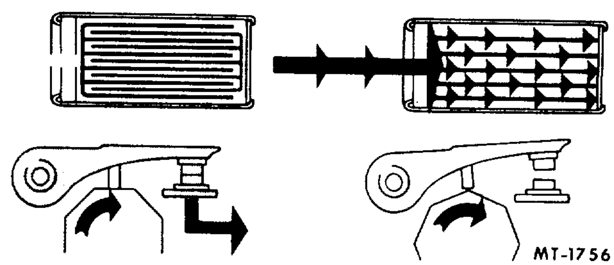


Fig. 7 Action of Current on Condenser

Ignition failures of a few years back were often the result of condenser breakdown. Subsequent investigation proved that internal moisture was responsible. With the adoption of pre-dried insulating paper and hermetic sealing in recent years, condenser breakdown has been practically eliminated. Condenser can is crimped against outer gasket and this compresses a spring at bottom of can with 40 pounds pressure to effectively seal inner and outer gasket surfaces, Fig. 8. Pressure feature provides vibration-free connections which lessen the possibility of high series resistance in condenser assembly.

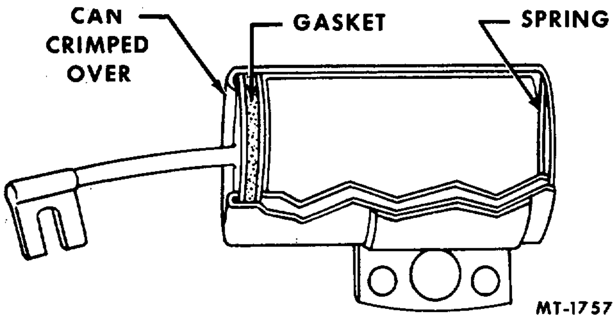


Fig. 8 Construction of Condenser

Heavy-duty condensers require more insulation between foil sheets of the winding. Since heavier insulation also increases the distance between foil sheets, more foil area is needed to obtain the same capacity. This is accomplished by using a larger assembly, Fig. 9.

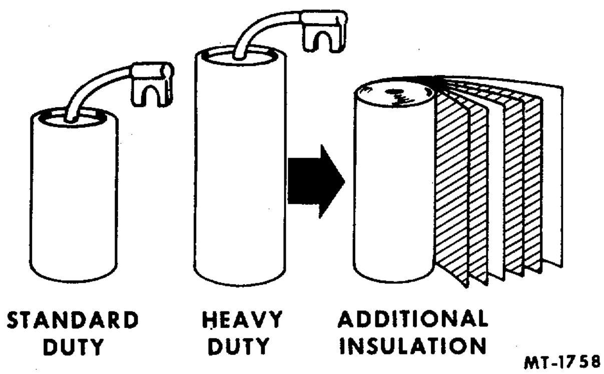


Fig. 9 Comparison Between Standard and Heavy-Duty Condenser

The quality of insulation in a condenser is checked on a scale reading in megohms (a megohm is one million ohms). When all moisture is eliminated in assembly and windings are hermetically sealed, insulating quality or dielectric strength of insulation between foil sheets will be high. If moisture is present in a condenser, insulation is low and may be said to be weak. A condenser having a resistance below 2 megohms when hot will drain sufficient energy from ignition system to cause engine missing.

Series resistance in a condenser is usually caused by loose or corroded connections. High series resistance causes a condenser to be slow in taking a charge and results in higher voltage at the separating contact points. Arcing and rapid wear of contacts along with engine missing during starting and low speed operation may be indications of this condition.

Capacity of most ignition condensers used on IH trucks is approximately .20 microfarads. This value is controlled by the area and closeness of the foil sheets. Standard condensers have two sheets of insulation assembled between foils, making a short container possible. Heavy-duty condensers have three sheets of insulation between foils and because of the greater foil area required, are housed in longer containers.

CONDENSER TESTS

To test an ignition condenser, a special condenser tester must be used, Fig. 10. Such a tester will check condenser for insulation breakdown, low insulation resistance, high series resistance and capacity. All four of these are characteristics which affect ignition performance.

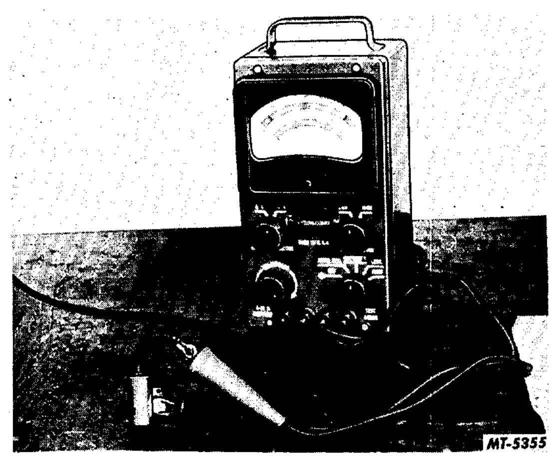


Fig. 10 Condenser Tester

ELECTRICAL
DISTRIBUTOR
(PRESTOLITE IDN-4000 Series)

BREAKERLESS
WITH INTEGRAL ELECTRONIC CONTROL UNIT

1978 thru 1981

CONTENTS

IMPORTANT

When performing ignition system dwell tests, as prescribed in this section. Check with dwell meter owner's manual to be sure it is suitable for use with electronic ignition.

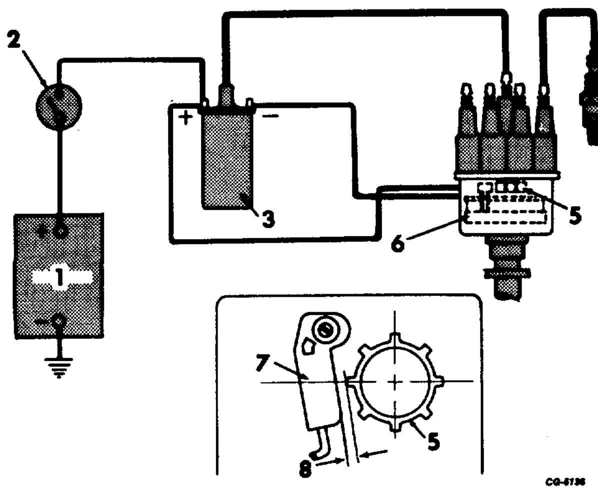


Fig. 1 Schematic View of Ignition System

1. **Battery**
2. **Ignition Switch**
3. **Ignition Coil**
4. **Spark Plug**
5. **Trigger Wheel**
6. **Electronic Control**
7. **Sensor**
8. **Air Gap**

DESCRIPTION

The electronic (breakerless) ignition system (Figure 1)consists of two major component units-a distributor and an ignition coil. These units are shown in Figure 2.

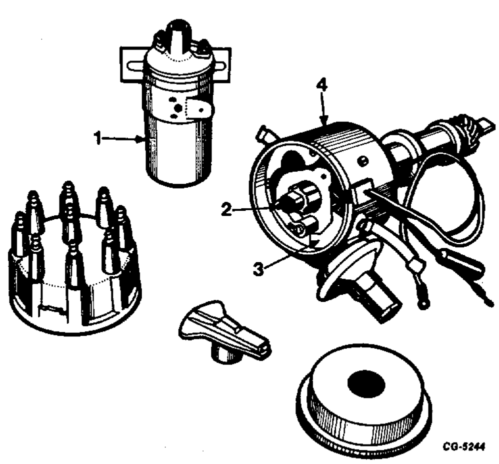


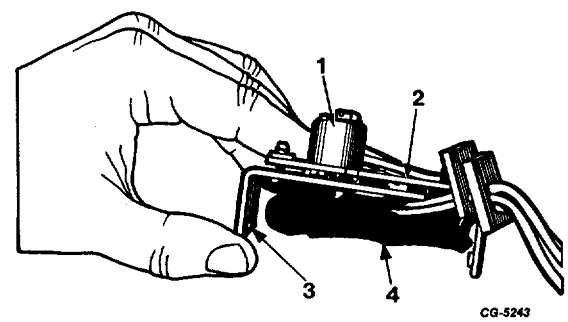
Fig. 2 Major Components of Ignition System

1. **Ignition Coil**
2. **Trigger Wheel**
3. **Electronic Control Unit**
4. **Distributor**

The distributor is conventional except that a trigger wheel and an electronic control unit (circuit board and sensor) replace the usual distributor cam, contact points and condenser. A standard type ignition coil is used.

The electronic control unit (Figure 3) is associated with the primary (low voltage) section of the ignition system. The control unit electronically "makes" and "breaks" the ignition primary circuit in response to rotation of the trigger wheel.

Fig. 3 Electronic Control Unit (Circuit Board, Sensor and Plate Assembly)



1. **Sensor**
2. **Sensor Plate**
3. **Mounting Plate**
4. **Electronic Circuit Board**

The control unit circuit board is a completely solid state unit designed for trouble free service. Its electronic components are permanently sealed in a waterproof and vibration resistant compound.

The sensor is a small coil, wound of fine wire, which is very simply a metal detector. The metal that the sensor detects is the teeth of the trigger wheel.

The electronic circuit board and sensor are mounted on the distributor plate assembly. The sensor leads are soldered directly to the circuit board. The electronic control unit (circuit board, sensor and plates) is provided for service 'as a complete assembly.

Trigger wheels of distributors for four-cylinder engines have four (4) teeth. Distributors for eight-cylinder engines have eight (8) teeth on the trigger wheel.

Distributor primary wiring consists. of two leads connected to the ignition coil primary terminals. The red wire from the distributor connects to the coil positive (+) terminal. The brown wire from the distributor connects to the coil negative (-) terminal. (See Figure 4). A third (white) wire from the distributor connects to the deceleration throttle modulator (DTM), where used. Because primary (low voltage) current is regulated within the electronic control unit, a ballast resistor or resistance wire is not required in the primary circuit.

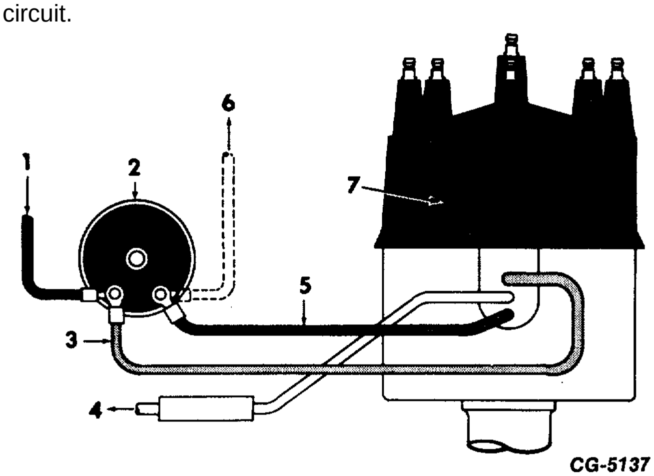


Fig. 4 Distributor Primary Wiring

1. **From ignition switch**
2. **Ignition coil**
3. **Red wire**
4. **To decelerate throttle modulator (where used)**
5. **Brown wire**
6. **To governor control unit (where used)**
7. **Distributor**

The secondary (high voltage) components are: coil tower, distributor cap, rotor, high tension cables and spark plugs. The new distributor cap featuring superior physical and dielectric strength incorporates male (spark plug type) terminals. A resistor type rotor, interference suppression type spark plugs are used to meet radio frequency interference standards.

All distributors have a mechanical (centrifugal) spark advance system. Most distributors also have a vacuum operated spark advance system. The advance systems automatically provide the optimum spark timing for various engine speed and load conditions.

OPERATION

When the ignition key is turned on, an oscillating signal is set up in the sensor circuit. This creates a field around the sensor. When a trigger wheel tooth enters the sensor's field, it squelches or reduces the strength of the oscillating signal. This weakened sensor signal is detected by what is called a demodulator circuit in the electronic circuit board. The demodulator circuit controls a transistor to turn off the current in the primary circuit of the coil. When the transistor is turned "off", it opens ("breaks") the coil primary circuit. As in a conventional system, opening the coil primary circuit induces high voltage in the coil secondary circuit which is conducted from the coil to the distributor cap and travels through the rotor and the secondary cables to the spark plugs. When the trigger wheel tooth leaves the sensor's field, the transistor is turned "on" to close ("make") the coil primary circuit.

Dwell angle is determined by the angle between adjacent teeth of the trigger wheel and by the air gap between the ends of the trigger wheel teeth and the sensor. Since there are no wearing surfaces connected with the trigger wheel and sensor, dwell remains constant and should not require adjustment for the service life of the distributor.

The mechanical (centrifugal) advance system is built internally into the distributor and consists of two flyweights which pivot on long life, low friction bearings and are controlled by calibrated springs which tend to hold the weights in the no-advance position. The flyweights respond to changes in _ engine (distributor shaft) speed and rotate the trigger wheel to advance the spark as engine speed increases and retard the spark as engine speed decreases.

The vacuum advance system incorporates a vacuum diaphragm unit which rotates the distributor sensor plate in response to changes in carburetor throttle bore vacuum.

The two systems, mechanical and vacuum (Figure 5) operate independently, yet work together to provide proper spark advance.

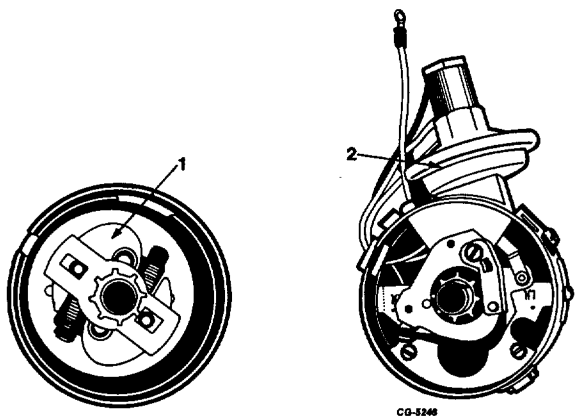


Fig. 5 Spark Advance Systems

1. **Mechanical (Centrifugal) Advance Mechanism**
2. **Vacuum Advance Diaphragm Unit**

MAINTENANCE

To perform effectively, the ignition system must be properly maintained. It is important that ignition system maintenance operations be performed at the specified time or mileage intervals.

For ignition system maintenance intervals, procedures and specifications, refer to the appropriate "Emission Control Systems and Service Operations" section of the Truck Service Manual as listed below.

For vehicles built in 1978, see	CTS-2733
For vehicles built in 1979, see	CGES-135
For vehicles built in 1980, see	CGES-215
For vehicles built in 1981, see	CGES-300

DISTRIBUTOR SERVICE

DISTRIBUTOR REMOVAL

1. Unfasten distributor cap retaining clips. Remove distributor cap (with high tension cables) and position it out of the way.

2. Disconnect vacuum hose from distributor vacuum advance unit, if equipped.

3. Disconnect distributor wiring as follows:

   a. Disconnect distributor leads from positive and negative terminals of. ignition coil.

   b. Disconnect deceleration throttle modulator lead (white wire) at connector (where used).

4. Disconnect tachometer drive cable, if equipped.

5. Scribe a mark on distributor housing in line with tip of rotor (Figure 6) and note position of rotor and distributor housing in relation to surrounding engine parts as reference points for reinstalling distributor.

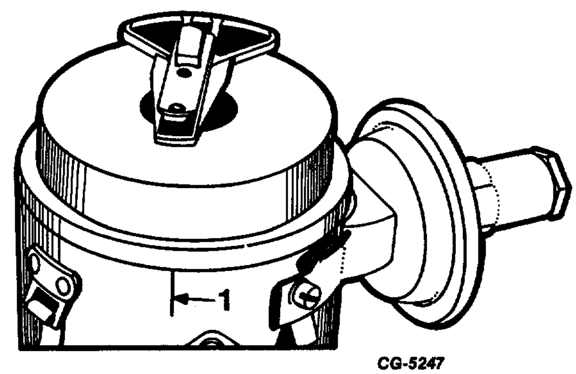


Fig. 6 Rotor Position Reference Mark

1. **Scribe Mark**

6. Remove distributor hold-down bolt and clamp.

7. Carefully withdraw distributor from engine. Do not lose gasket or "O" See Figure 7 for gasket or "O" ring location on distributor.

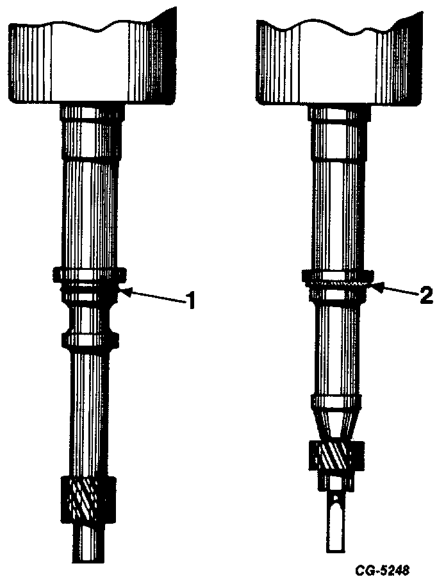


Fig. 7

1. "O" Ring **2. Gasket**

DISTRIBUTOR SHAFT AND BUSHING WEAR TEST

This procedure can be used to check condition of the distributor shaft and shaft bushings in the distributor housing.

1. Clamp distributor in a vise equipped with soft jaws and apply only enough pressure to restrict movement of distributor.

2. Remove distributor rotor and dielectric shield (dust cover).

3. Attach dial indicator to distributor housing so that indicator plunger rests against top portion of trigger wheel assembly (Figure 8). C20

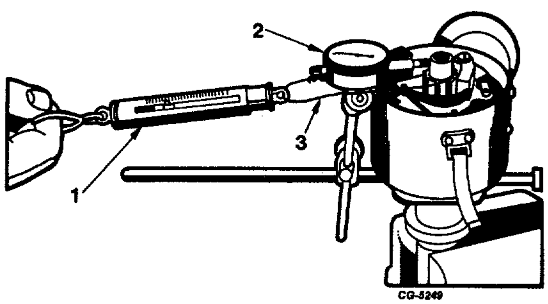


Fig. 8 Shaft and Bushing Wear Test (Checking Distributor Shaft Side Play)

1. Spring Scale
2. Dial Indicator
3. Wire Loop

4. Place one end of a wire loop around top of trigger wheel assembly (rotor shaft). Hook a spring scale in other end of wire loop and pull on a line with plunger of dial indicator (Figure 8). Wire loop must be perpendicular to shaft to assure a a straight pull. Also, loop must not interfere with dial indicator mounting bracket.

5. Apply one-half (½) pound of pull on spring scale and read movement of plunger on indicator dial. Apply one-half (½) pound of pull in opposite direction and again read movement on indicator. Peak-to-peak side play is the sum of these two readings.

   If distributor shaft side play exceeds maximum permissible limit (see DISTRIBUTOR TEST SPECIFICATIONS), replace distributor shaft bushings (see Distributor Housing Bushing Replacement).

DISTRIBUTOR OPERATION TEST
(On Test Stand)

Operation of the distributor can be checked on a distributor test stand.

It is advisable to perform the distributor operation test prior to disassembly of the distributor for service. This test will give valuable information about the condition of the distributor and indicate where parts replacement may be required.

<u>Preparation of Distributor Test Stand</u>
(Refer to Figure 9)

Additional equipment required:

Battery, 12 volt (fully charged).

Jumper Wires (2) with clips at each end.

1. Mount distributor to be tested in test stand.

2. Clip test stand distributor lead to ring connector on brown distributor lead.

3. Clip test stand ground lead to ground stud on distributor mounting frame.

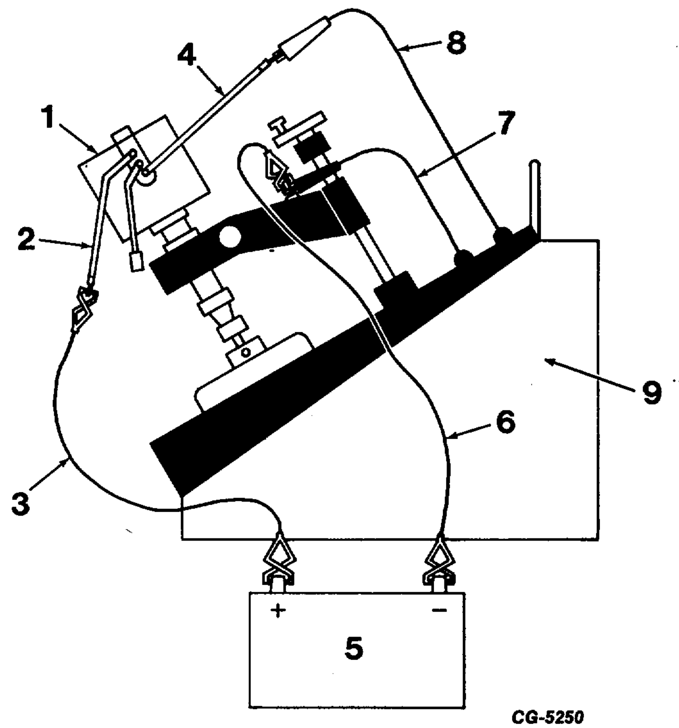


Fig. 9 Distributor-To-Test Stand Wiring

1. Distributor	**4. Brown Wire**	**7. Test Stand Ground Lead**
2. Red Wire	**5. 12 Volt Battery**	**8. Test Stand Distributor Lead**
3. Jumper Wire	**6. Jumper Wire**	**9. Distributor Test Stand**

4. Connect one jumper wire from battery negative (-) post to test stand ground stud.

5. Connect other jumper wire from battery positive (+) post to ring connector on red distributor lead. Test stand and distributor are now ready to make distributor operation test. (Refer to Operation Test Procedure.)

Operation Test Procedure

1. Mount distributor in test stand and connect test leads as outlined in Preparation of Distributor Test Stand.

2. Calibrate test stand dwell meter per manufacturers instructions.

3. Operate distributor at 300 RPM (with 12-13 volts primary input) and observe dwell reading. Dwell should be within specified limits (see Distributor TEST SPECIFICATIONS). If dwell is not within specified limits, check trigger wheel-to-sensor air gap.

4. Check trigger wheel tooth accuracy as follows:

a. Operate distributor at 300 RPM and set zero of test stand degree ring in line with arrow flash nearest front of stand.

b. Observe relative position of all arrow flashes. All flashes should be evenly spaced within + 2 degrees at 45 degree intervals on 8-cylinder distributors or 90 degree intervals on 4-cylinder distributors. If positions of arrow flashes deviate more than + 2 degrees check for damaged trigger wheel teeth and check for worn distributor shaft and bushings.

5. Check operation of mechanical advance mechanism as follows:

a. With distributor operating at minimum speed, set zero of test stand degree ring in line with arrow flash nearest front of stand.

b. Operate distributor at each specified test speed (see DISTRIBUTOR TEST SPECIFICATIONS) and observe arrow flashes opposite test stand degree ring to determine amount of advance at each test speed.

If advance is excessive, advance spring tension is weak. If advance is insufficient, advance spring tension is excessive, advance flyweights are sticking or trigger wheel assembly is binding on inner distributor shaft. If advance is erratic, advance flyweights are sticking or trigger wheel assembly is binding on inner distributor shaft.

6. Check vacuum advance diaphragm assembly (where equipped) as follows:

a. Using proper adapter, connect test stand vacuum hose to distributor vacuum advance diaphragm assembly.

b. Apply vacuum and check for operation of diaphragm assembly.

c. Remove vacuum hose from diaphragm assembly. Hold finger over end of hose and adjust vacuum regulator to obtain reading of 16 inches of vacuum on vacuum gauge.

d. Reconnect vacuum hose to diaphragm assembly and observe vacuum gauge. If gauge reading returns to 16 inches within a few seconds and holds 16 inches, diaphragm assembly is air tight. If gauge reading fails to return to 16 inches, diaphragm assembly is leaking and should be replaced.

7. Check vacuum advance operation (where equipped) as follows:

a. With vacuum hose connected to distributor vacuum diaphragm assembly, operate distributor at 300 RPM.

b. With no vacuum applied to diaphragm assembly, set zero of test stand degree ring in line with arrow flash nearest to front of stand.

c. Adjust vacuum regulator to apply specified amount of vacuum for each specified check point (see DISTRIBUTOR TEST SPECIFICATIONS) and note amount of advance obtained.

d. Momentarily exceed highest vacuum value specified, then reduce vacuum and again note vacuum obtained at each specified check point.

f advance is excessive during both steps "c" and "d", a weak diaphragm spring is indicated. If advance is insufficient during both steps "c" and "d", check for sticking or worn sensor advance plate.

8. If distributor passes checks outlined in Steps 3 through 7 above, it is satisfactory for use. If distributor fails any of the checks, it should be replaced or serviced as needed.

9. Disconnect test leads and vacuum hose from distributor and remove distributor from test stand.

DISTRIBUTOR DISASSEMBLY

The procedure outlined below can be followed to disassemble the distributor for service and overhaul.

Notice that sensor mounting plate configuration and vacuum diaphragm location varies between distributors with right hand (clockwise) rotation and those with left hand (counterclockwise) rotation as shown in (Figure 10).

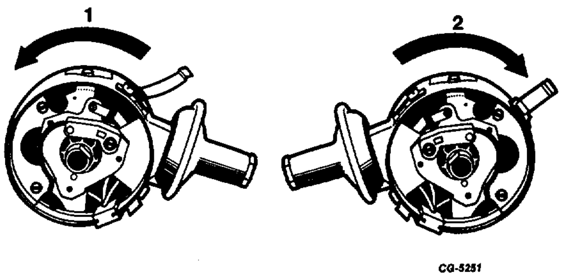


Fig. 10 Illustrating Vacuum Diaphragm Location and Distributor Rotation

1. Counterclockwise rotation
2. Clockwise rotation

1. Remove rotor and dielectric shield ("dust cover") (Figure 11)

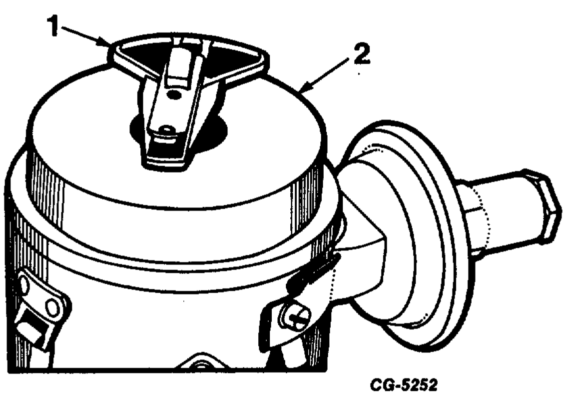


Fig. 11 Distributor Rotor and dielectric Shield (Dust Cover).

1. Rotor **2. Dielectric Shield (Dust Cover)**

2. Remove vacuum advance diaphragm rod retaining "E" clip (Figure 12) and flat washer (where used).

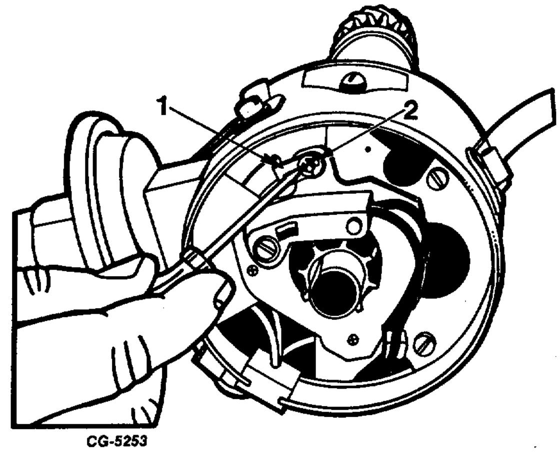


Fig. 12 Removing Diaphragm Rod Retainer

1. Diaphragm Rod **2. Retaining "E" Ring**

3. Remove vacuum advance diaphragm mounting screws and remove diaphragm assembly from distributor housing (Figure 13). Remove felt washer from diaphragm rod pin on sensor advance plate. (Figure 13).

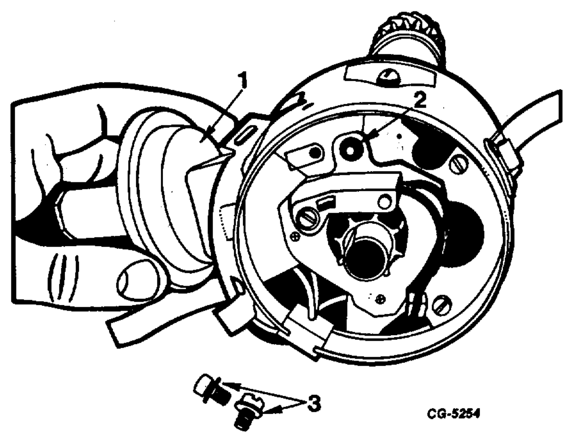


Fig. 13 Removing Vacuum Advance Diaphragm Assembly.

1. Diaphragm Assembly
2. Felt Washer
3. Retaining Screws

4. Remove electronic control unit (circuit board, sensor and plate assembly) as follows:

a. Remove distributor plate (control unit) mounting screws. (Figure 14).

b. Carefully pull wiring grommet from slot in distributor housing.

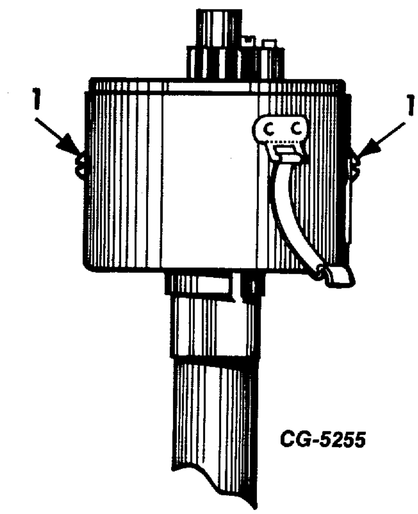


Fig. 14 Distributor Plate Mounting Screw

1. Mounting Screw

c. Lift control unit assembly out of housing.

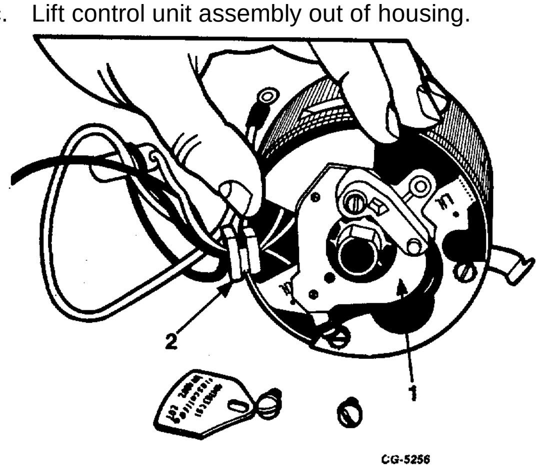


Fig. 15 Removing Electronic Control Unit

1. Electronic Control Unit
2. Grommet

5. Measure and record distributor shaft end play (Figures 16 and 17). Measure end play between thrust washer and gear (Figure 16) or thrust washer and thrust collar (Figure 17). If end play exceeds specified limits, thrust washers (upper and lower) should be replaced. Excessive end play could result in failure or improper engine timing.

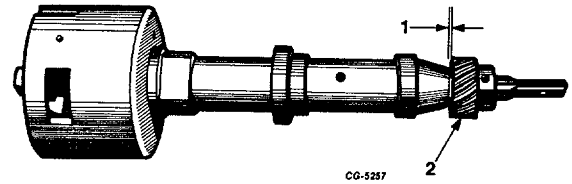
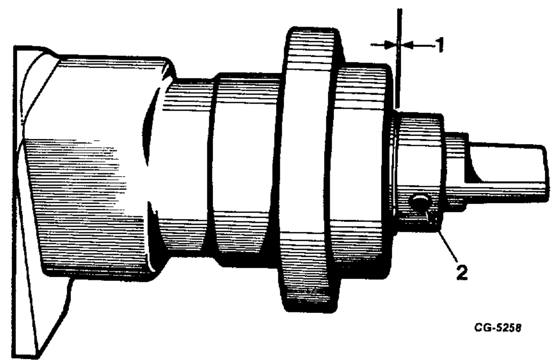


Fig. 16 Checking Distributor Shaft End Play (Thrust Washer-to-Gear Clearance) (Typical)



1. End Play **2. Driven Gear**

Fig. 17 Checking Distributor Shaft End Play (Thrust Washer-to-Thrust Collar Clearance) (Typical)

1. End Play **2. Thrust Collar**

6. Support distributor shaft on a wood block or in a vise equipped with soft jaw shields and drive roll pin from gear or thrust collar and distributor shaft using a punch and hammer (Figure 18).

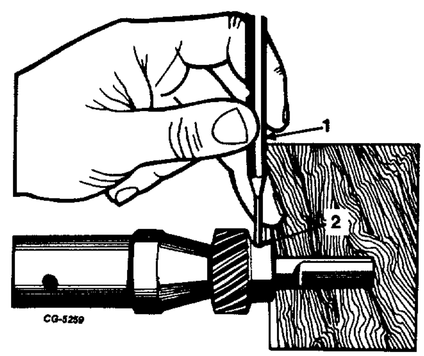


Fig. 18 Removing Distributor Driven Gear Pin

1. Punch **2. Pin**

7. Place distributor housing and shaft assembly in a press and press gear or thrust collar and lower thrust washers, Figures 19 and 20, from shaft.

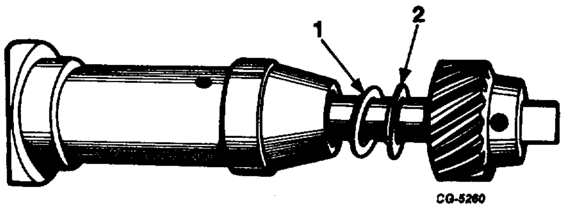


Fig. 19 Lower Thrust Washers (All Distributors Except for V-537 Engine).

1. **Thrust Washer (Inner)**
2. **Thrust Washer (Outer)**

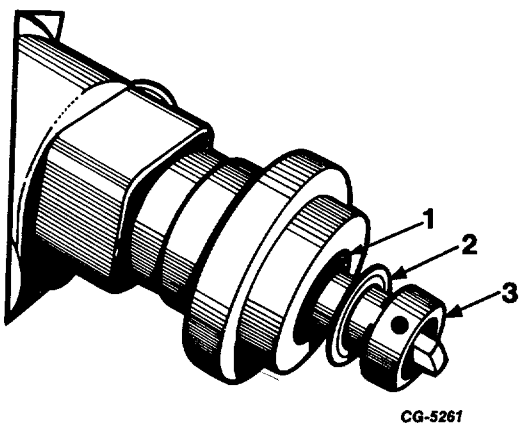


Fig. 20 Lower Thrust Washer (Distributor for V-537 Engine)

1. **Seal**
2. **Thrust Washer**
3. **Thrust Collar**

8. Withdraw distributor shaft assembly from distributor housing. Be careful not to lose upper thrust washer(s) (Figures 21 and 22).

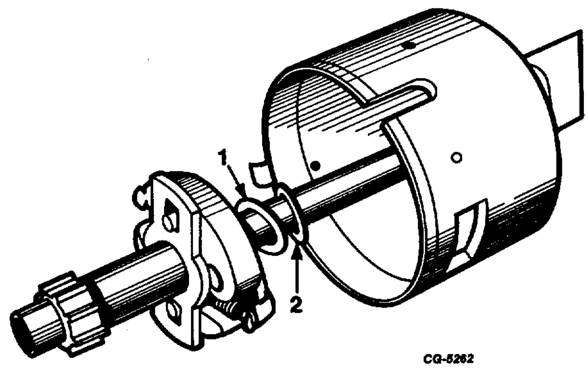


Fig. 21 Upper Thrust Washers (Distributors Without Tachometer Drive)

1. **Thrust Washer (Outer)**
2. **Thrust Washer (Inner)**

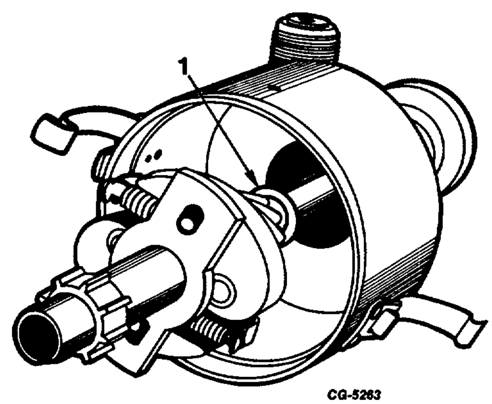


Fig. 22 Upper Thrust Washer (Distributors With Tachometer Drive)

1. **Thrust Washer**

CLEANING AND INSPECTION

1. Wash metal parts in cleaning solvent.

IMPORTANT

Do Not wash cap, rotor, vacuum advance diaphragm assembly or electronic control unit.

It is permissible to soak the distributor housing if the bushings are to be replaced. If bushings are not to be replaced, clean distributor housing carefully so as not to wash oil from bushings.

2. Inspect distributor shaft for wear and check its fit in bushings in distributor housing. If shaft and bushings are worn, replace them.

3. Mount distributor shaft in "V" blocks and check shaft alignment with dial indicator. Runout should not exceed 0.05mm (.002").

4. Inspect mechanical advance weights for free fit on their pivot pins and in slots of trigger wheel yoke without excessive looseness. If wear or damage is found, replace distributor shaft assembly.

5. Inspect trigger wheel teeth for damage. Check fit of trigger wheel assembly on distributor shaft. It should be free without roughness. If roughness or excessive looseness exists, replace distributor shaft assembly.

6. Inspect sensor advance plate of electronic control unit. 1. binding or wear of pivot pin is indicated, replace control unit assembly.

7. On distributors with tachometer drive, inspect tachometer drive parts. (See Tachometer Drive Service).

8. Inspect rotor, distributor cap and high tension cables. (See Secondary Circuit Inspection Under IGNITION SYSTEM TROUBLE SHOOTING TEST.)

DISTRIBUTOR HOUSING BUSHING REPLACEMENT

The following procedures can be followed to remove and replace the distributor shaft bushings in the distributor housing. Distributor tool set SE-1955 will assist in performing these operations.

Illustrations show bushing removal and installation operations being performed on distributor without tachometer drive. Procedures for distributors with tachometer drive are similar.

<u>Bushing Removal</u>

1. On distributors without tachometer drive, use a small screwdriver to pry upper bushing grease retainer washer from distributor housing (Figure 23).

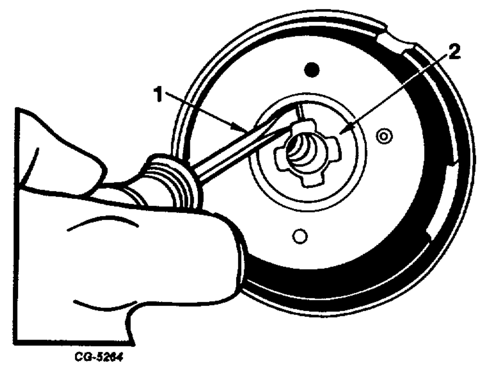


Fig. 23 Removing Grease Retainer Washer (Distributors Without Tachometer Drive)

1. Screwdriver 2. Grease Retainer

2. On distributors for V-537 engine, use a screwdriver to pry oil seal out of lower end of distributor housing (Figure 24)

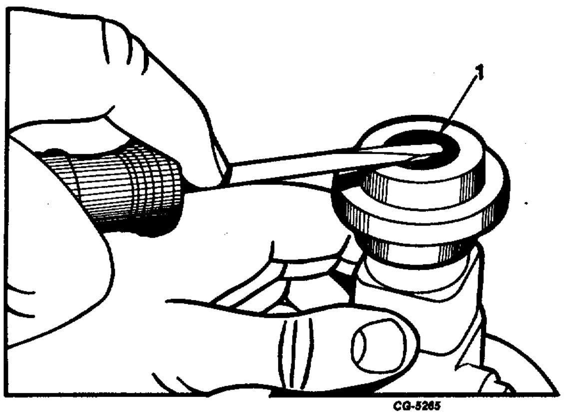


Fig. 24 Removing Lower Oil Seal (Distributors for V-537 Engine)
1. Seal

3. Install bushing remover SE-1955-5 in upper bushing (Figure 25).

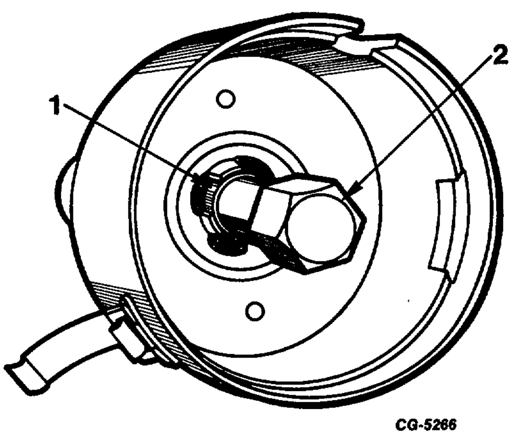


Fig. 25 Bushing Remover SE-1955-5 Installed in Upper Bushing
1. Upper Bushing 2. Remover

4. Place distributor housing on press bed. Insert knock-out bar through lower bushing and allow it to rest on bushing remover already installed in upper bushing. Press upper bushing from housing by pressing against knock-out bar (Figure 26).

   The knock-out bar can be made locally from cold rolled bar stock, 11mm (7/16 in.) in diameter by 30 cm (12 in.) long.

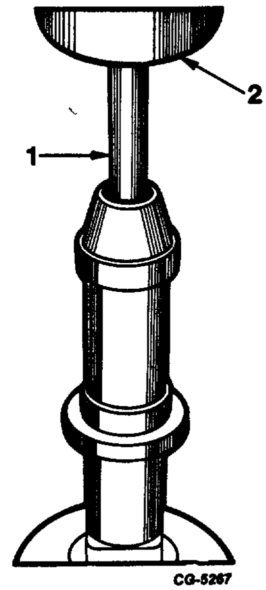


Fig. 26 Pressing Out Upper Bushing Using Knock-Out Bar

1. Knock-Out Bar 2. Press Ram

5. Install bushing remover SE-1955-5 in lower bushing (Figure 27).

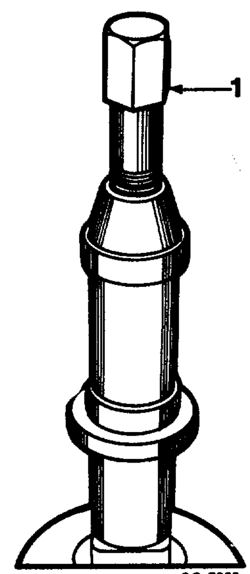


Fig. 27 Bushing Remover SE-1955-5 Installed in Lower Bushing
1. Remover

6. Place distributor housing on press bed. Insert knock-out bar through upper bushing bore and allow to rest on end of bushing remover installed in lower bushing. Pressing against knock-out bar, press lower bushing from distributor housing (Figure 28)

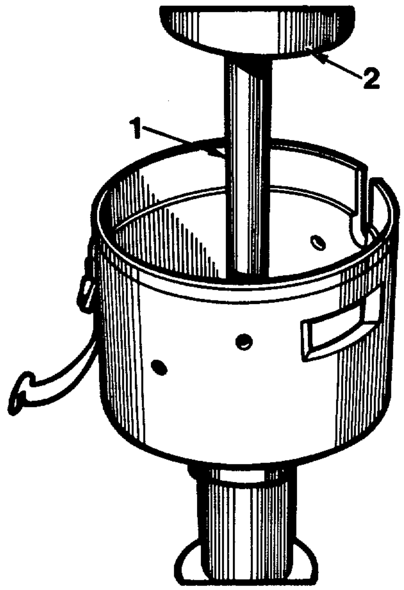


Fig. 28 Pressing Out Lower Bushing Using Knock-Out Bar
1. Knock-Out Bar 2. Press Ram

7. On distributors without tachometer drive, wash distributor housing in cleaning solvent to remove old lubricant from upper bushing lubricant reservoirs (Figure 35).

8. On distributors with tachometer drive, remove cover from tachometer drive cavity and wash distributor housing in cleaning solvent to clean old lubricant from cavity. (See Tachometer Drive Service)

Bushing Installation

1. Lubricate outer diameter of new upper bushing with a light coat of grease and start bushing into distributor housing bore.

IMPORTANT

On distributors without tachometer drive, groove in outside diameter of bushing must be positioned at the top (Figure 29).

2. Position distributor housing in press. Insert bushing installer (SE-1955-7) into bushing (Figure 29).

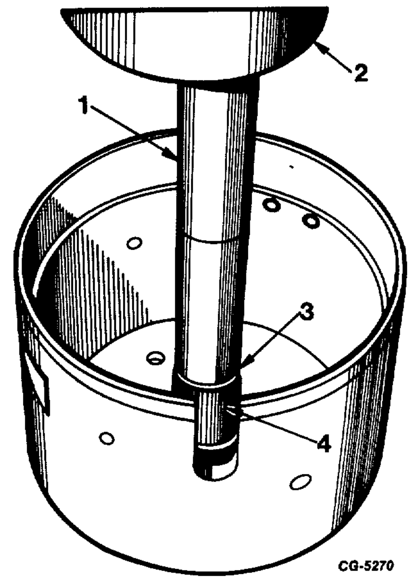


Fig. 29 Installing Upper Bushing Using Bushing Installer SE-1955-7.
1. Installer 3. Groove
2. Press Ram 4. Upper Bushing

3. Press upper bushing into housing to dimension shown in Figure 30:

On distributors without tachometer drive, 2.4 mm (3/32 inch) below top of bushing support ribs.

On distributors with tachometer drive, flush to 0.8 mm (1/32 inch) below surface of tachometer drive counterbore.

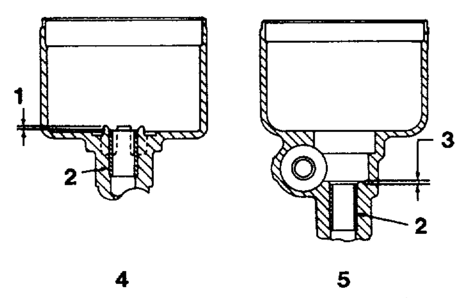


Fig. 30 Upper Bushing Location Dimensions
1. 2.4mm (3/32 in.)
2. Bushing
3. Flush to 0.8mm (1/32 in.)
4. Without Tach Drive
5. With Tach Drive

4. Lubricate outer diameter of new lower bushing with a light coat of grease and start bushing into distributor housing bore.

5. Position distributor housing in press. Insert bushing installer (SE1955-7) into bushing (Figure 31).

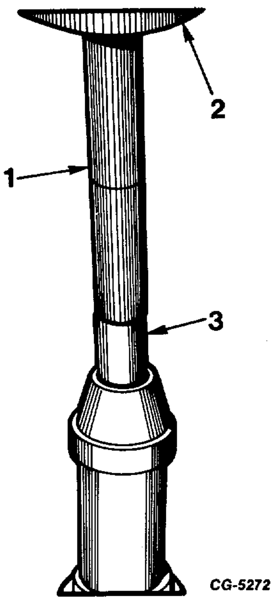


Fig. 31 Installing Lower Bushing using Installer SE-1955-7.
1. Installer
2. Press Ram
3. Lower Bushing

6. Press lower bushing into housing to dimension shown in Figure 32.

On distributors for all engines except V-537, 2.4 mm (3/32 inch) below bottom end of distributor housing.

On distributors for V-537 engines, flush with surface of oil seal counterbore.

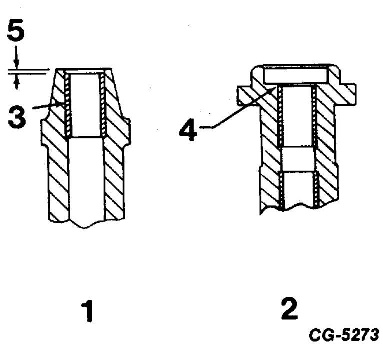


Fig. 32 Lower Bushing Location Dimensions.

1. All distributors except for V-537 engine
2. Distributor for V-537 engine
3. Bushing
4. Bushing flush with housing.
5. 2.4 mm (3/32 in.)

After bushings have been installed, check fit of distributor shaft in bushings. Size bushings if necessary to obtain .008 - .038 mm (.0003 - .0015 inch) running clearance.

IMPORTANT

The oilite bushings should not be reamed. Swelling and burrs may be removed with a burnishing tool. For distributors without tachometer drive, use burnisher tool SE-1955-2. For distributors with tachometer drive, use burnisher tool SE-2779.

7. If shaft passes through upper bushing but binds in lower bushing, burnish lower bushing. Burnish lower bushing only. If shaft does not pass through or binds in upper bushing, burnish upper bushing first and repeat check for shaft fit. Then burnish lower bushing, if needed.

To burnish bushings:

a. Place flat end of burnisher in a vise. Coat burnisher with SAE-20 engine oil.

b. Burnish upper bushing by carefully placing distributor housing on burnisher and rotating the housing clockwise using light pressure until tool passes through bushing (Figure 33).

c. Burnish lower bushing per step "b" above.

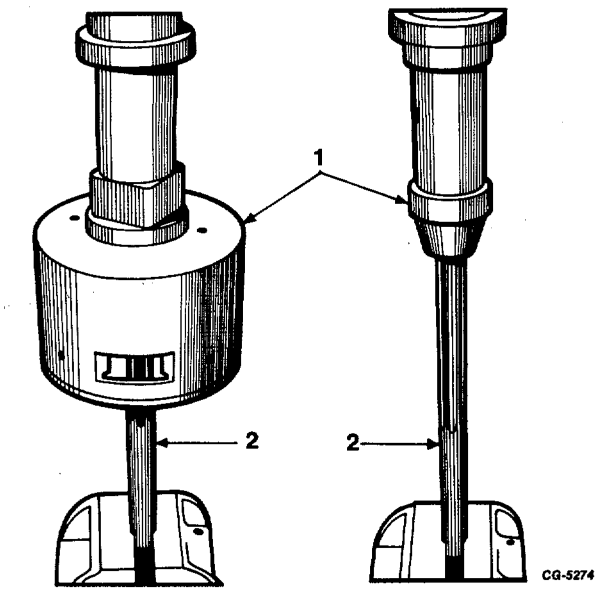


Fig. 33 Burnishing Upper and Lower Bushings Using Burnisher Tool.

1. Housing 2. Burnisher

8. On distributors for V-537 engine, press new oil seal into lower end of housing until seal is flush with end of housing.

   Lip of seal must face outward as shown in Figure 34.

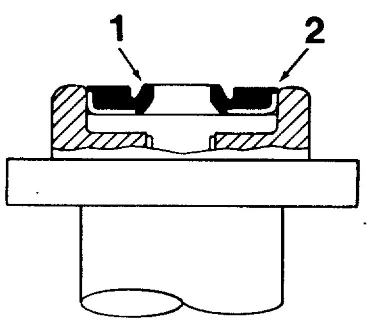


Fig. 34 Oil Seal Installation (Distributors) for V-537 Engine.

1. Lip of seal to face outward
2. Install seal flush with distributor housing

9. On distributors without tachometer drive, fill upper bushing lubricant reservoirs as follows:

   a. Fill reservoirs (Figure 35) with lubricant (oil saturated cotton).

   At distributor manufacture, reservoirs are filled with Permawick #560NP which is also recommended for use at distributor overhaul. Where this product is not available, adequate lubrication can be obtained by packing lubricant reservoirs with cotton (such as medical or cosmetic cotton balls) saturated with engine oil.

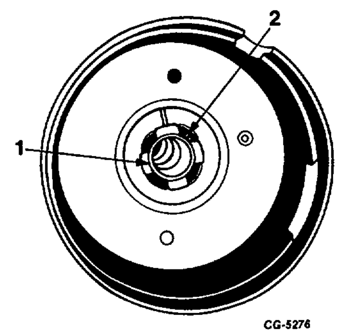


Fig. 35 Upper Bushing Lubricant Reservoirs (Distributors Without Tachometer Drive)

1. Bushing 2. Lubricant Reservoir

   b. Wipe excess oil from floor of distributor housing and install grease retainer washer (Figure 36). Tangs of washer must lock into groove in upper bushing.

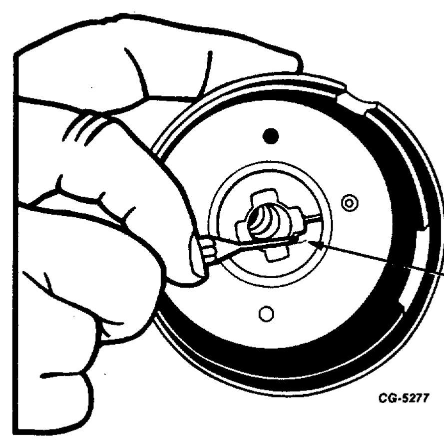


Fig. 36 Installing Grease Retainer Washer (Distributors Without Tachometer Drive)

1. Grease Retainer

MECHANICAL ADVANCE SYSTEM SERVICE

Mechanical advance system components are not provided for service individually. However, it is recommended that the mechanical advance system be disassembled for inspection and lubrication, as outlined below, at the time of distributor overhaul.

Disassembly

(Refer to Figure 37).

IMPORTANT
Mark Advance weights, weight pivot pins and trigger wheel assembly to assure reassembly in the same positions.

1. Remove felt wick.
2. Remove trigger wheel assembly retainer from distributor shaft using hooked extractor tool.

NOTE: Do not remove trigger wheel from the trigger wheel assembly, Figure 37.

3. Slide trigger wheel assembly from distributor shaft.
4. Remove primary and secondary advance weight springs.
5. Remove advance weights and thrust washer.

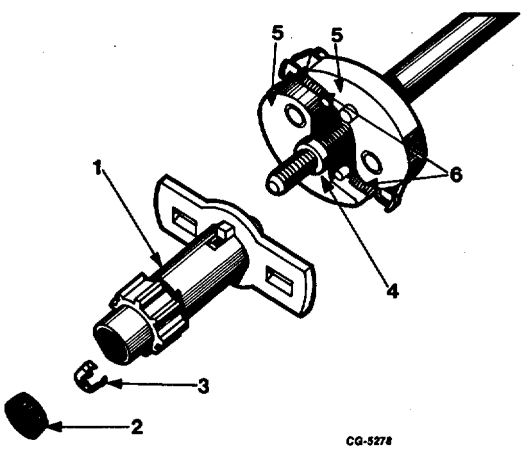


Fig. 37 Mechanical Advance System Components

1. Trigger wheel assembly	4. Thrust washer
2. Felt wick	5. Weights
3. Retainer	6. Springs

Inspect mechanical advance components. If wear or damage is found, replace distributor shaft assembly.

Reassembly

1. Lubricate advance weight bushings and pivot pins with a light film of premium quality grease (Mobile No. 532 or equivalent). Install weights on pivot pins.
2. Install advance springs.
3. Make sure advance weights pivot freely on pins.
4. Lubricate trigger wheel assembly pilot surface of distributor shaft with premium quality grease. Grooves in pilot diameter should be filled with lubricant. Lands between grooves should have only a thin film of lubricant.
5. Apply a light coat of premium quality grease to thrust washer and position thrust washer on distributor shaft.
6. Position trigger wheel assembly on pilot surface of distributor shaft. Align slots in trigger wheel yoke with pins on advance weights and push trigger wheel assembly into position.
7. Install trigger wheel assembly retainer. If necessary bend arms of retainer to assure that retainer grips slow in distributor shaft.
8. Install felt wick.
9. Make sure mechanical advance mechanism operates freely.

TACHOMETER DRIVE SERVICE

Tachometer Drive Gear and Bearing Replacement

Tachometer drive gear and bearing (Figure 38) can be replaced by following the procedure outlined below.

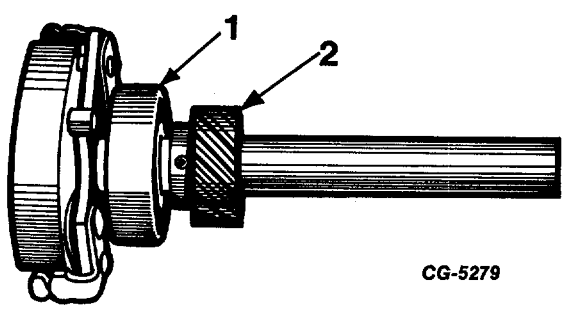


Fig. 38 Tachometer Drive Gear and Bearing
1. Bearing 2. Tachometer drive gear

1. Remove trigger wheel assembly and mechanical advance components from distributor shaft. (See Mechanical Advance System Service).

2. Support distributor shaft and drive roll pin from tachometer drive gear using punch and hammer (Figure 39).

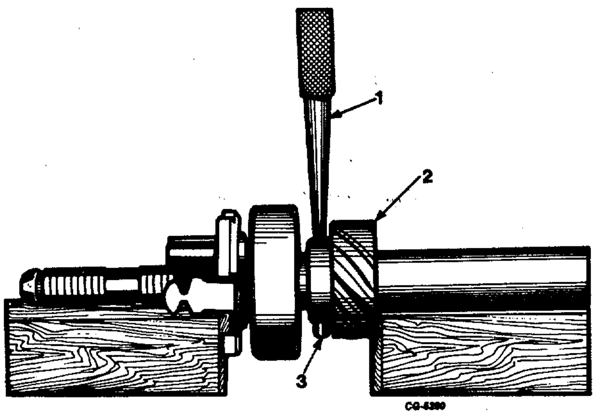


Fig. 39 Removing Tachometer Drive Gear Pin
1. Punch
2. Tachometer drive gear
3. Roll pin

3. Remove tachometer drive gear from distributor shaft.

4. Remove bearing from distributor shaft as follows:

   a. Position bearing puller attachment SE-1336-16 (Owatonna No. 950 or equivalent) under bearing (Figure 40).

IMPORTANT

Avoid distorting advance weight plate when installing bearing puller.

   b. Support bearing puller in press bed and press shaft from bearing.

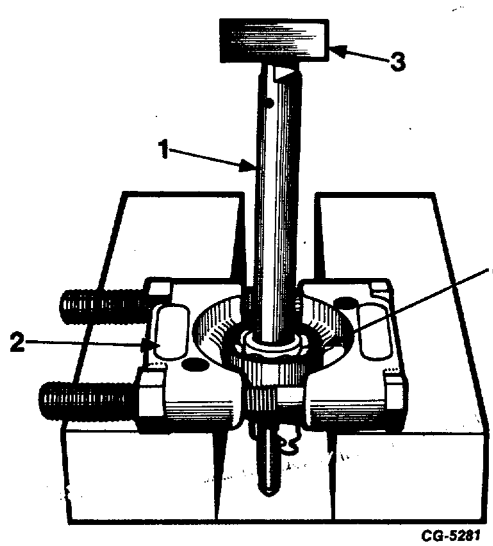


Fig. 40 Removing Tachometer Drive Bearing Using SE-1336-16 Bearing Puller
1. Distributor shaft
2. Puller
3. Press ram
4. Bearing

5. Install new bearing as follows:

   a. Using a piece of pipe 12.7 mm (1/2 inch) I.D. x 60 mm (2¼ inches) long as a support base (Figure 41), position distributor shaft in press.

   b. Place bearing on distributor shaft with sealed side toward advance weight plate.

   c. Using a piece of pipe 12.7 mm (½ inch) I.D. of suitable length as a driver tool, press bearing onto shaft to a dimension of 14.3 mm (9/16 inch) from bottom of advance weight plate to bottom of bearing (Figure 41).

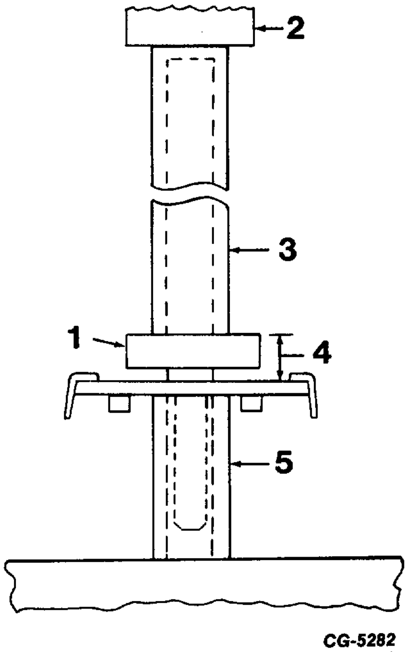


Fig. 41 Installing Tachometer Drive Bearing

1. Bearing
2. Press ram
3. Driver tool (pipe)
4. 14.3 mm (9/16 in.)
5. Support (pipe)

6. Install new tachometer drive gear on distributor shaft. New gear will have pin hole drilled in one side only. Install as follows:

    a. Position gear on distributor shaft and align pin hole with hole in shaft.

    b. Support distributor shaft in drill press and drill hole through other side of gear.

    c. Install roll pin.

7. Lubricate and install mechanical advance components and trigger wheel assembly (See Mechanical Advance System Service).

Tachometer Driven Gear and Shaft

The tachometer driven gear, shaft and bushing are not provided for service. However, at the time of distributor overhaul, these parts should be thoroughly cleaned and lubricated as outlined below.

1. Remove tachometer drive shaft cover as follows:

    a. Drill a 3mm (1/8 inch) hole in center of cover (Figure 42).
    b. Insert a hooked tool or a punch into hole in cover and pry cover from distributor housing (Figure 42).

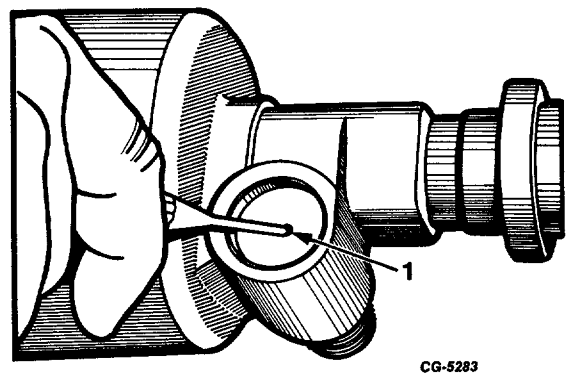


Fig. 42 Removing Tachometer Drive Shaft Cover

1. Drill Hole in Cover.

2. Clean old lubricant from tachometer drive gear and cavity in distributor housing. (See "IMPORTANT" under Cleaning and Inspection).

3. Inspect tachometer driven gear, shaft and bushing. If excessive wear or damage is indicated, replace distributor assembly.

4. If parts are satisfactory for reuse:

    a. Fill tachometer drive gear and cavity with ball bearing lubricant (Humble "Andok 260" or equivalent).

    b. Install new tachometer drive shaft cover in distributor housing.

DISTRIBUTOR REASSEMBLY

1. Install distributor shaft into distributor housing as outlined below:

IMPORTANT

If a new distributor shaft is being installed, a new distributor driven gear or thrust collar and new thrust washers must also be installed.

    a. Position new upper thrust washer(s) on shaft.

Distributors with tachometer drive have one thrust washer (Figure 22).

Distributors without tachometer drive have two thrust washers (Figure 21) which must be installed properly. Install outer washer (blue steel) first with lip of washer facing toward lower end of shaft. Install inner thrust washer (silver color) with lip facing lower end of shaft. Inner (silver color) washer should seat on lip of outer (blued) washer.

b. Lubricate distributor shaft engine oil.

c. Slide distributor shaft into distributor housing. Use care to avoid damaging lower oil seal where used, when installing shaft.

2. Position new lower thrust washer(s) on shaft.

Distributors for V-537 engine have one thrust washer (Figure 20).

All distributors except for V-537 engine have two thrust washers (Figure 19) which must be installed properly. Install inner washer (silver color) first with lip of washer facing toward distributor housing. Install outer washer (blued steel) with lip facing toward distributor housing. Outer (blued) washer should seat in inner (silver color) washer.

3. Install distributor driven gear or thrust collar as outlined below:

<u>If original distributor driven gear or thrust collar is being used:</u>

a. Position gear or thrust collar on distributor shaft and align roll pin hole in gear or thrust collar with roll pin hole in shaft.

b. Install driven gear or thrust collar roll pin.

<u>If new distributor driven gear or thrust collar is being installed:</u>

New gear or thrust collar will have pin hole drilled in one side only. Install as follows:

a. Position gear or thrust collar on distributor shaft and align hole with pin hole in shaft.

b. Support distributor assembly in drill press. Using existing hole in gear or thrust collar as a guide, drill roll pin hole in other side of gear or thrust collar.

c. Install roll pin.

<u>If new distributor shaft and gear or thrust collar are being installed:</u>

a. Position gear or thrust collar on distributor shaft and establish specified shaft end play (See DISTRIBUTOR TEST SPECIFICATIONS).

b. Support distributor assembly in drill press. Using existing hole in gear or thrust collar as a guide, drill roll pin hole in distributor shaft and other side of gear or thrust collar.

c. Install roll pin.

4. Install electronic control unit (circuit board, sensor and plate assembly) as follows:

a. Lift sensor advance plate of control unit and put a small amount of premium quality grease (Mobile No. 532 or equivalent) under each of the three thrust buttons.

b. Position control unit assembly and wiring grommet in distributor housing.

c. Install distributor plate (control unit) mounting screws.

5. Position vacuum advance diaphragm assembly on distributor housing and install mounting screws.

6. Install felt washer on diaphragm rod pin of sensor advance plate (Figure 13). Oil felt washer with engine oil.

Connect diaphragm rod to pin on sensor advance and install flat washer (where used) and rod retaining "E" clip. (Figure 12)

7. Adjust trigger wheel-to-sensor air gap as follows:

a. Rotate trigger wheel until one tooth is aligned with centerline of sensor (trigger wheel tooth perpendicular to flat surface of sensor). (Figure 43)

b. Using feeler gauge, measure air gap between sensor and end

end of tooth (Figure 43). Move sensor as needed to obtain specified air gap (see DISTRIBUTOR TEST SPECIFICATIONS).

Tighten sensor mounting screw and recheck air gap.

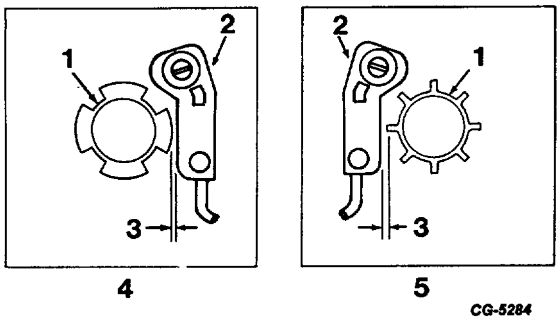


Fig. 43 Trigger Wheel-to-Sensor Air Gap

1. Trigger wheel
2. Sensor
3. Air gap
4. 4 cylinder engine
5. 8 cylinder engine

8. Mount distributor in distributor test stand. (See Distributor Operation Test).

9. Operate distributor at 300 RPM (with 12-13 volts primary input and observe dwell reading. Dwell should be within specified limits.

   a. If dwell reading is within specified limits, trigger wheel to-sensor gap is satisfactory.

   b. If dwell reading is not within specified limits, loosen sensor mounting screw and adjust trigger wheel-to-sensor air gap as required to obtain specified dwell. Move sensor toward trigger wheel to decrease dwell or away from trigger wheel to increase dwell. Dwell is affected approximately one-half (½) degree per .025 mm (.001 in.) of sensor movement. After correct dwell is obtained, tighten sensor mounting screw.

10. The mechanical advance mechanism is calibrated at the factory and no further calibration is required.

11. Connect test stand vacuum hose to vacuum advance diaphragm and check operation of vacuum advance. If advance does not fall within specified vacuum readings, replace vacuum diaphragm and recheck vacuum advance operation.

12. If distributor operation is satisfactory, remove distributor from test stand and install dielectric shield (dust cover) and rotor.

DISTRIBUTOR INSTALLATION

1. Clean distributor mounting area of engine block.

2. Install a new distributor mounting gasket in counterbore of engine block or install a new "O" ring seal on distributor housing, whichever is applicable.

3. Position distributor in engine. If engine was not rotated while distributor was removed -

   a. Align rotor tip with mark scribed on distributor housing during removal. Then, on distributors with driven gear mounted on lower end of distributor shaft, turn rotor about 1/8 turn clockwise past scribed mark.

   b. Slide distributor down into engine and position distributor housing in approximately the same location (in relation to surrounding engine parts) as when removed.

      It may be necessary to move rotor and shaft slightly to start gear into mesh with camshaft gear and/or to engage oil pump shaft drive tang, but rotor should align with scribed mark when distributor is down in place.

   c. Install distributor hold-down clamp, bolt and lock washer, but do not tighten bolt.

   If engine was rotated while distributor was removed, it will be necessary to re-establish timing as follows -

   a. Remove No. 1 spark plug (No. 8 on V-304, V-345, V-392 engines). Hold finger over spark plug hole and rotate engine until compression pressure is felt. Slowly continue to rotate engine until timing mark on crankshaft pulley lines up with specified initial timing mark on timing quadrant. (For initial timing setting, refer to tune-up data decal on engine.) Always rotate engine in direction of normal rotation. Do not "back" engine to align timing marks.

   b. Turn distributor shaft until rotor tip points in the direction of the No. 1 terminal in the distributor cap (No. 8 terminal on V-304, V-345, V-392 engines). Then, on distributors with driven gear mounted on lower end, of distributor shaft, turn rotor about 1/8 turn clockwise past position of initial timing terminal.

   c. Slide distributor down into engine and position distributor housing in approximately the same location (in relation to surrounding engine parts) as when removed.

      It may be necessary to move rotor and shaft slightly to start gear into mesh with camshaft gear and/or to engage oil pump shaft drive tang, but rotor should align with the position of initial timing terminal when distributor is down in place.

   d. Install distributor hold-down clamp, bolt and lock washer, but do not tighten bolt.

4. Install distributor cap (with high tension cables) on distributor housing making sure tang on vacuum advance unit aligns with slot in distributor cap and that cap fits down snug on distributor housing.

   IMPORTANT

   If distributor cap is incorrectly positioned on distributor housing, cap or rotor may be damaged when engine is cranked.

5. Connect distributor primary wiring as follows: (See Figure 4)

   a. Connect brown distributor lead to ignition coil negative (-) terminal.

   b. Connect red distributor lead to ignition coil positive (+) terminal.

   c. Connect deceleration throttle modulator lead (white wire) to harness connector (where used).

6. Connect tachometer drive cable, if equipped.

7. Connect timing light to No. 1 spark plug (No. 8 spark plug on V-304, V-345, V-392 engines).

IMPORTANT

Do not puncture high tension cables or boots to make contact. Use proper adapters. (Figure 44)

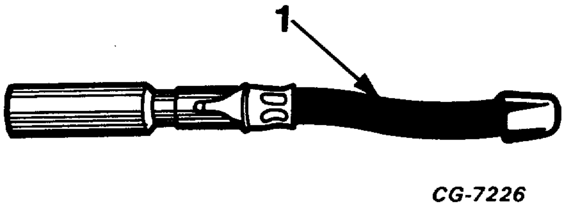


Fig. 44

1. Adapter

8. Operate engine at idle speed and observe timing marks with timing light. Rotate distributor housing as needed to align timing mark on crankshaft pulley with specified initial timing mark on timing quadrant (Figure 45). When timing is correct, tighten distributor hold down bolt and recheck timing to be sure it did not change.
9. Disconnect timing light and connect vacuum hose to distributor advance unit (where equipped).

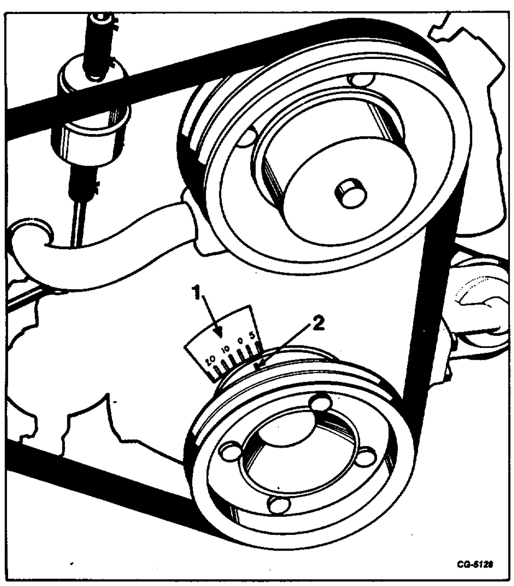


Fig. 45. Timing Marks (V-304, V-345, V392 Engines Shown)

1. Timing quadrant
2. Timing mark

IGNITION SYSTEM TROUBLE SHOOTING TEST

The procedure outlined below can be used to check operation of the electronic (breakerless) ignition system. Electrical components (coil and electronic control unit) are not repairable. If the operation test indicates that they are faulty, replace them.

TEST EQUIPMENT

The following equipment is required to make the operation test:

D. C. Voltmeter

Insulated grippers for handling high tension cables.

Extension (adapter) to plug into high tension cable terminals.

Jumper Wire

TEST PROCEDURE

1. Test Battery Voltage.

   Using voltmeter, test battery (Figure 46) voltage should be 12-13 volts for a fully charged battery. If necessary, charge or replace battery.

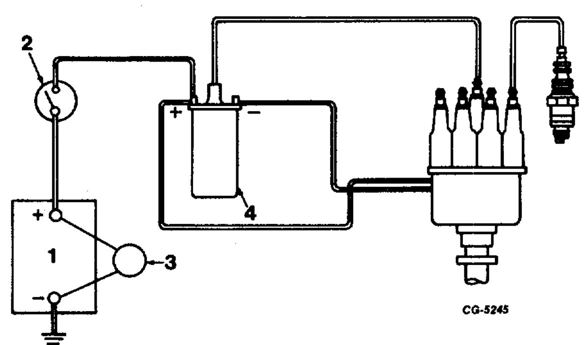


Fig. 46. Testing Battery Voltage

1. Battery
2. Ignition switch
3. Voltmeter
4. Ignition coil

2. Test for Spark at plug.

   Disconnect high tension cable from one spark plug. (always grasp spark plug boot and use a twisting motion when removing plug cables so as not to destroy resistance wire termination.) Insert extension adaptor into boot and engage in cable terminal. Using insulated pliers, hold plug cable to create about 13 mm (1/2") gap between extension adapter and engine (Figure 47). Have an assistant crank engine. Observe for spark across gap.

   Test at least two cables.

   If spark occurs, ignition system is functioning. Check spark plugs and ignition timing. Then look elsewhere (engine condition, fuel system, etc.) for problem.

   If no spark occurs, proceed to step 3.

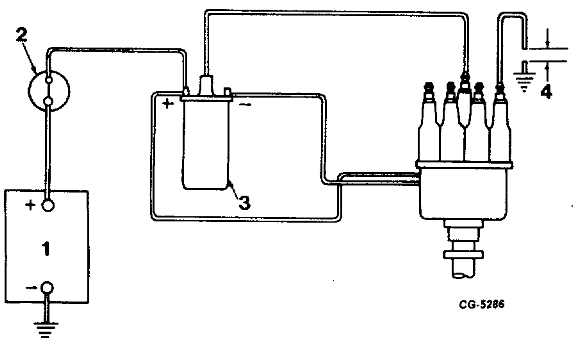


Fig. 47 Checking for Spark at Plug

1. Battery
2. Ignition Switch
3. Ignition Coil
4. 13mm (1/2 in)Gap

3. Test for spark at distributor cap. Disconnect high tension cable from center tower terminal of distributor cap. Insert extension adapter into boot and engage in cable terminal. (Figure 44). Using insulated pliers, hold cable to create about 13mm (1/2") gap between cable terminal and engine (Figure 47). Have an assistant crank engine. Observe for spark across gap.

   If spark occurs, problem lies in distributor cap, rotor or spark plug cables. (See Secondary Circuit Inspection).

   If no spark occurs, proceed to step 4.

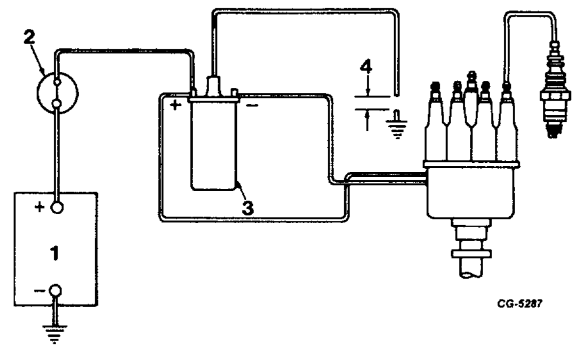


Fig. 48 Checking for Spark at Distributor Cap

1. Battery
2. Ignition Switch
3. Ignition Coil
4. 13mm (1/2 in.) Gap

4. Check trigger wheel-to-sensor air gap

   Remove distributor cap rotor and shield. "Bump" starter to align one of the trigger wheel teeth with the sensor coil (trigger wheel tooth perpendicular to flat surface of sensor) as shown in Fig. 49. Check air gap between trigger wheel tooth and sensor (see SPECIFICATIONS). If air gap is to specifications, proceed to step 5.

   If air gap is out of specification, adjust air gap and repeat step 3. If there is still no spark, proceed to step 5.

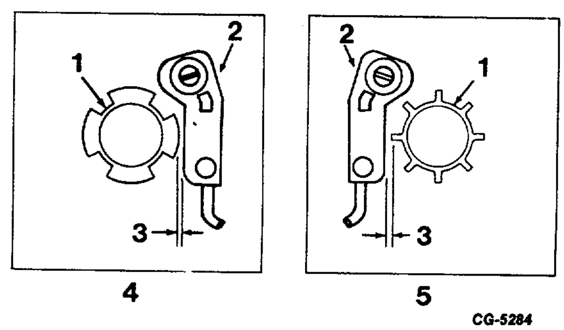


Fig. 49 Trigger Wheel-to-Sensor Air Gap

1. Trigger Wheel
2. Sensor
3. Air Gap
4. 4 Cylinder Engine
5. 8 Cylinder Engine

5. Test primary voltage.

   "Bump" starter to position sensor coil between two trigger wheel teeth (see Figure 50).

   Connect voltmeter between coil positive (+) terminal and ground. Turn ignition switch "on" and observe voltmeter. If voltmeter reads battery voltage (12-13V), proceed to step 6.

   If voltage is noticeably lower than battery voltage, a high resistance exists between battery (through ignition switch) and coil which must be located and repaired. (See Primary Voltage Drop Test).

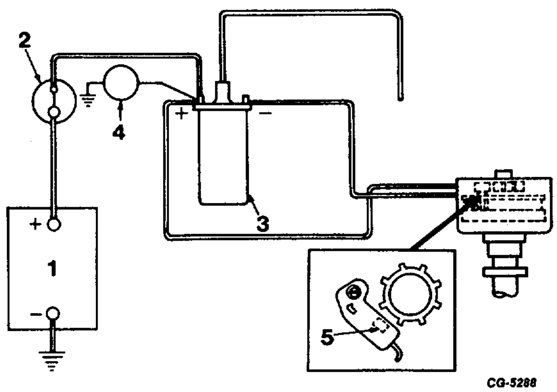


Fig. 50 Testing Primary Voltage

1. Battery
2. Ignition Switch
3. Ignition Coil
4. Voltmeter
5. Sensor Coil Between Two Trigger Wheel Teeth

6. Test voltage at coil negative (-) terminal.

   Sensor coil should be between two trigger wheel teeth. Connect voltmeter between coil negative (-) terminal and ground (Figure 51).

   With ignition switch "on", one of the following voltmeter readings will be obtained: (A) 5 to 8 volts (normal) (B) 12 to 13 volts (problem area) (C) 0 to 5 volts (problem area)

A. If voltage is 5 to.8 volts:
   Proceed to Step 7.

B. If voltage reading is 12 to 13 volts:
   Connect jumper wire between distributor housing and battery negative (-) terminal (Figure 52). Observe voltmeter.

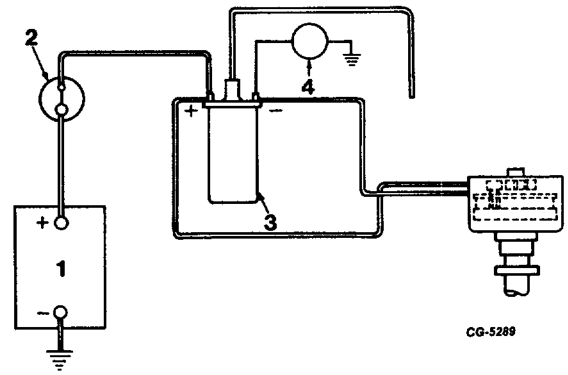


Fig. 51 Testing Voltage at Coil Negative (-) Terminal

1. Battery
2. Ignition Switch
3. Ignition Coil
4. Voltmeter

If voltage remains at 12 - 13 volts, electronic control unit in distributor is faulty and must be replaced.

If voltage changes to 5 - 8 volts with jumper wire connected, a problem exists in the ground circuit between the distributor and the battery. Check battery negative (-) cable (at battery and engine) and cab-to-engine ground strap and/or other ground straps. Repair as needed.

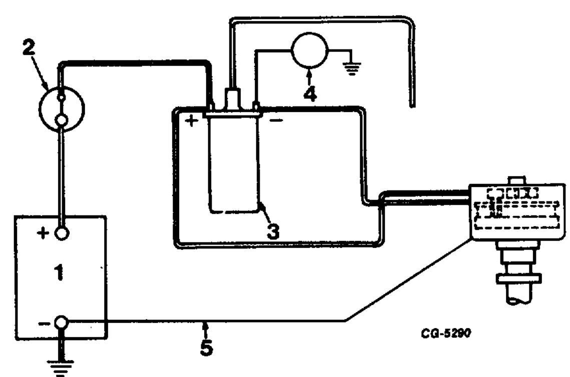


Fig. 52. Testing With Jumper Wire Between Dist. Housing and Batt. (-) Terminal.

1. Battery
2. Ignition Switch
3. Ignition Coil
4. Voltmeter
5. Jumper Wire

C. If voltage is 0 to 5 volts:

Disconnect voltmeter. Remove brown wire from coil negative (-) terminal. Reconnect voltmeter between coil negative (-) terminal and ground (Figure 53). With ignition switch "on", observe voltmeter. If voltage reading is still 0 to 5 volts, coil is faulty and must be replaced.

If voltage increases to 12 - 13 volts, electronic control unit in distributor is faulty, and must be replaced.

Reconnect brown wire to coil (negative (-) terminal).

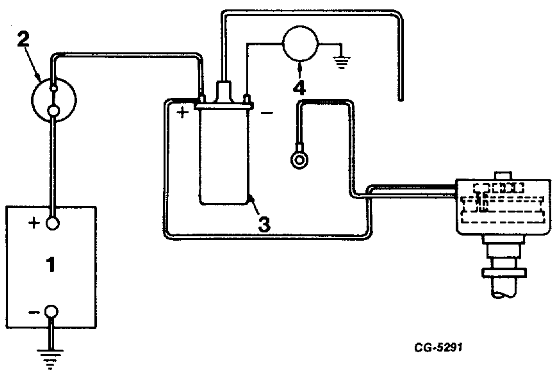


Fig. 53 Testing With Brown Wire Removed

1. Battery
2. Ignition Switch
3. Ignition Coil
4. Voltmeter

7. Test control unit operation.

Voltmeter should be connected between coil negative (-) terminal and ground (Figure 53).

With ignition switch "on", place blade of screwdriver against face of sensor (Figure 54) while observing voltmeter. Voltage should increase to 12 - 13 volts.

Remove screwdriver blade. Voltage should drop to 5 - 8 volts.

If voltage switches up and down, proceed to step 8.

If voltage does not switch up and down when screwdriver blade is placed against and then removed from face of sensor, electronic control unit in distributor is faulty and must be replaced.

8. Test Coil Operation

Re-establish the 13 mm (1/2 inch) gap between extension adapter (connected to coil high tension cable) and engine (Figure 55).

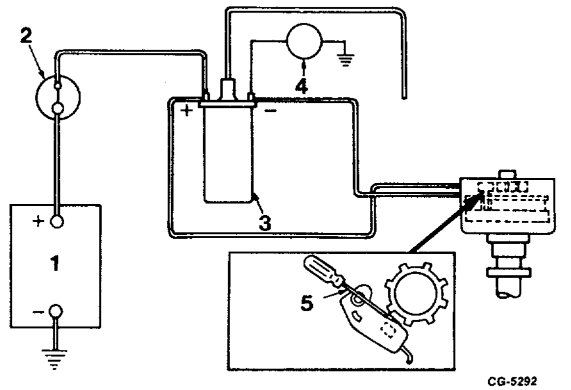


Fig. 54 Testing Electronic Control Unit Operation

1. Battery
2. Ignition Switch
3. Ignition Coil
4. Voltmeter
5. Screwdriver

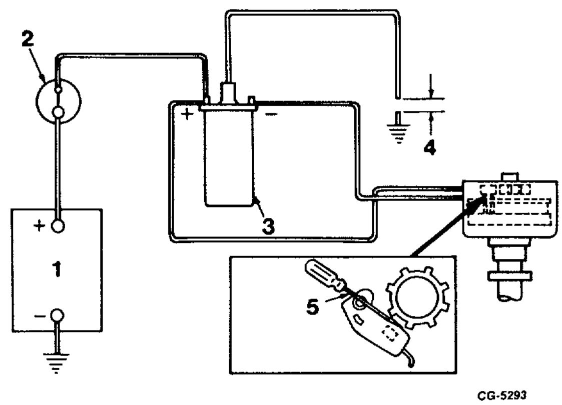


Fig. 55 Testing Coil Operation

1. Battery
2. Ignition Switch
3. Ignition Coil
4. 13 mm (1/2 in.) gap
5. Screwdriver

With ignition switch "on" observe for spark across gap each time screwdriver blade is placed against face of sensor.

If no spark occurs, coil is faulty and must be replaced.

9. Retest for Spark at Plug.

After replacing components, disconnect test equipment. Reinstall shield, rotor and distributor cap and reconnect coil high tension cable to distributor cap.

Recheck for spark at spark plug (Step 2).

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10. Check Dwell.

    Connect dwell meter to engine. Operate engine and observe dwell reading. If necessary, re-adjust trigger wheel-to-sensor air gap to obtain specified dwell.

11. Check Timing.

    Connect timing light to engine. Operate engine at idle speed (distributor vacuum hose disconnected) and check timing. Adjust timing if necessary.

SECONDARY CIRUCIT INSPECTION

Secondary (high voltage) system components (distributor cap, rotor, coil, high tension cables and spark plugs) should be checked as possible sources of trouble before condemning the electronic units.

Distributor Cap and Rotor

Inspect distributor cap and rotor for cracks, carbon tracking, loose terminals, dirt and contamination. Clean or replace as needed.

Check rotor blade and spring for tightness. Check fit of rotor on distributor shaft. Check resistance type rotor with ohmmeter. (Figure 56). If resistance exceeds 6000 ohms, replace rotor.

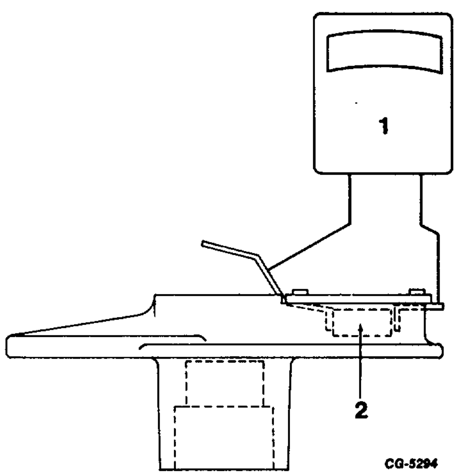

Fig. 56 Rotor Resistance Test
1. Ohms X1000 Meter 2. Resistor

Coil

Inspect coil tower for cracks or carbon tracking. Inspect primary terminals for corrosion and/or looseness. Replace coil if any of these conditions are found.

Test resistance of coil primary and secondary circuits with an ohmmeter (See Figure 57).

COIL RESISTANCE TESTS

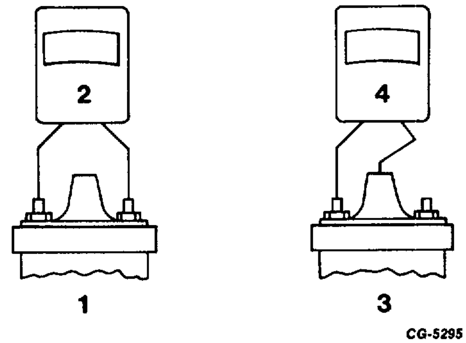

Fig. 57 Coil Resistance Tests
1. Primary Circuit 3. Secondary Circuit
2. Ohms X1 4. Ohms X1000

If coil resistance tests are made with coil mounted in vehicle, coil must be electrically isolated from the vehicle's electrical system by disconnecting primary leads from coil terminals and removing secondary cable from coil tower.

Set ohmmeter in OHM x 1 position. Connect ohmmeter between coil primary terminals. Reading should be between 1.2 and 1.4 ohms at 21 degrees C (70 degrees F).

Set ohmmeter in OHM x 1000 position. Connect ohmmeter between one coil primary terminal and the coil tower terminal. Reading should be within 9,000 to 12,000 ohms at 21 degrees C (70 degrees F).

If coil fails either resistance test, replace it.

High Tension Cables

Inspect secondary (high tension) ignition cables for deterioration, carbon tracking at terminal boots and high voltage leakage, especially at cable support brackets.

Test resistance of cables with an ohmmeter. Resistance should not exceed 30,000 ohms on cables up to 914 mm (36") long or 45,000 ohms on cables over 914 mm (36") long.

Check sealing and insulating qualities, of distributor cap, coil tower and spark plug boots. Replace if needed.

Clean cable terminals and apply a light coat of lubricant/sealer (IH part number 472141-C1) of terminals at assembly. Make sure cables seat properly on distributor cap and spark plug terminals and in coil tower terminal.

Be sure ignition cables are routed correctly. Proper routing of cables must be maintained to prevent crossfire.

PRIMARY VOLTAGE DROP TEST

This test can be used to help locate any high resistance or loose connections in primary feed circuit between the battery and the ignition coil positive (+) terminal.

Test Procedure (Refer to Figure 58)

1. Remove distributor cap, rotor and shield. "Bump" starter to position sensor coil between two trigger wheel teeth.

2. Connect voltmeter positive (red) lead to battery positive (+) terminal. Connect voltmeter negative (black) lead to coil positive (+) terminal.

3. Turn ignition switch "on" and observe voltmeter. A reading of less than 1 volt should be obtained.

4. Check circuit conditions by observing voltmeter while flexing (moving) the connectors at the following locations:

   a. Battery cables.

   b. Starter solenoid battery terminal.

   c. Dash panel (bulkhead) connector (where used).

   d. Ammeter terminals.

   e. Ignition switch connections.

If fluctuation or an upswing of the voltmeter needle is observed while flexing the connectors, a poor connection exists and must be corrected.

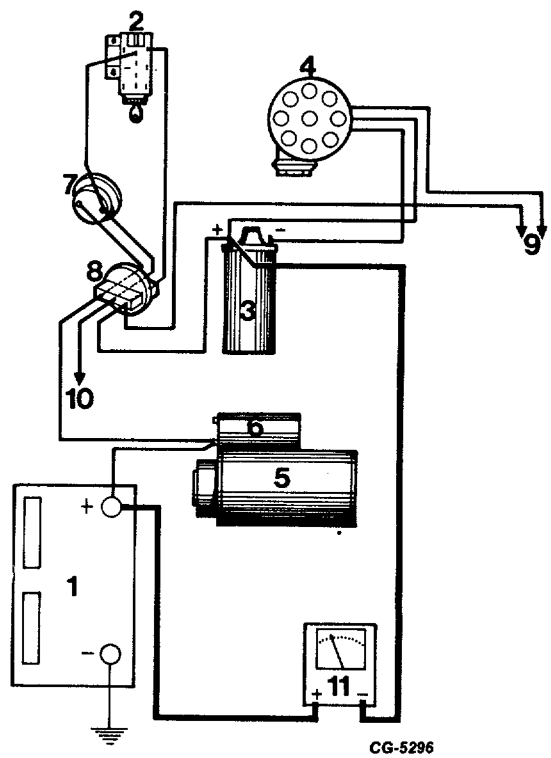

Fig. 58 Primary Voltage Drop Test

1. Battery
2. Ignition Switch
3. Ignition Coil
4. Distributor
5. Starter
6. Solenoid
7. Ammeter
8. Bulkhead Connector
9. To DTM
10. To Alternator
11. Voltmeter

Listed here are only those causes for the indicated problem conditions which are chargeable to the ignition system.

CONDITION	POSSIBLE CAUSE	REMEDY
Engine fails to start	No primary voltage to coil.	Check battery, ignition switch, primary feed and ground circuits.(Perform "Primary Voltage Drop Test"). Repair as needed.
(Perform "Ignition System Trouble Shooting Test")	Moisture in distributor cap or high tension cable boots.	Clean and dry parts. Correct cause for entry of moisture.
	Trigger wheel-to-sensor air gap incorrect.	Check air gap. Adjust if needed.
	Open rotor.	Replace rotor.
	Faulty distributor cap.	Replace cap.
	Coil high tension cable not seated in coil tower or distributor cap.	Check cable installation.
	Faulty high tension cables.	Replace cables.
	Coil open or shorted.	Test coil, replace if faulty.
	Faulty electronic control unit.	Replace control unit.
Engine backfires but fails to start.	Incorrect ignition timing.	Check timing. Adjust as needed.
	Moisture in distributor cap.	Dry cap and rotor.
	Distributor cap faulty or carbon tracked.	Check cap for loose terminals, cracks and dirt. Clean or replace as needed.
	Spark plug cables connected incorrectly.	Check cables for correct position.
Engine does not operate smoothly or engine misfires at high speed	Spark plugs fouled.	Clean and regap plugs.
	Spark plug electrodes worn (gap too wide).	Regap or replace plugs.
	Spark plug cables faulty.	Check cables, replace if needed.
	Spark advance system(s)	Check operation of advance
	faulty. system(s).	Repair as needed.
	Worn distributor shaft bushings.	Check for worn bushings. Rebuild or replace distributor.
Excessive fuel consumption.	See causes listed under "engine does not operate smoothly."	

Erratic timing advance	Vacuum leaks in vacuum advance system.	Check vacuum hoses. Replace as needed.
	Faulty vacuum advance diaphragm assembly. needed.	Check operation of advance diaphragm. Replace if
	Sticking or worn sensor plate.	Replace electronic control unit.
	Misadjusted, damaged or weak mechanical advance springs.	Readjust spring tension. Replace distributor shaft assembly.
	Mechanical advance flyweight bushings worn.	Replace distributor shaft assembly.
	Trigger wheel assembly binding or excessively loose or distributor shaft.	Free-up and lubricate trigger wheel assembly. Replace distributor shaft assembly, if needed.

DISTRIBUTOR TEST SPECIFICATIONS
(For Use With Distributor Test Stand)
1978

Engine Model	4-196		V-304, V-345
Distributor: Part No. (Manufacturer's No.)	484776-C91 484776-C92 (IDN-4001)	484777-C91 484777-C92 (IDN-4001A)	484778-C91 484778-C92 (IDN-4002B)
Air Gap, mm (in.) Trigger Wheel-to-Sensor (1)	0.2 (.008)		0.2 (.008)
Dwell, Degrees (2)	28 - 34		26 - 32
Vacuum Advance: Vacuum Req'd. to Start Advance kPa (In. of Hg.)	16.9 - 23.6 (5 - 7)	10.1 - 16.9 (3 - 5)	16.9 - 23.6 (5 - 7)
Advance Check Points: Vacuum, kPa (In. of Hg.) Degrees	20.3 (6) 0 - 1.5	23.6 (7) 2.8 - 5.8	20.3 (6) 0 - 1.5
Vacuum Degrees	30.4 (9) 2.8 - 5.8	43.9 (13) 4 - 6	27.0 (8) 1.5 - 4.5
Vacuum Degrees	50.7 (15) 4 - 6	- - - - - -	40.5 (12) 4 - 6
Mechanical Advance: Distributor RPM to Start Advance	375 - 450	375 - 450	325 - 475
Advance Check Points: Distributor RPM Degrees	- - -	- - -	- - -
Distributor RPM Degrees	600 4 - 6	600 4 - 6	1000 7.5 - 9.5
Distributor RPM Degrees	1000 8.5 - 10.5	1000 8.5 - 10.5	1200 9.7 - 11.7
Distributor RPM Degrees	1900 15.2 - 17.2	1900 15.2 - 17.2	1850 14.0 - 16.0
Distributor RPM Degrees	2200 15.8 - 17.8	2200 15.8 - 17.8	2100 15 - 17
Total Advance, Degrees Mechanical and Vacuum	19.8 - 23.8	19.8 - 23.8	19 - 23
Distributor Shaft End Play, mm (in-)	0.89 - 1.02 (.035 - .040)		
Distributor Shaft Side Play (3) New, mm (in.) Maximum Permissible, mm (in.)	0.05 - 0.1 (.002 - .004) 0.15 (.006)		
Distributor Rotation (As Viewed From Top)	Right Hand (Clockwise)		

(1) Clearance between sensor and end of trigger wheel tooth.

(2) At 300 distributor RPM (with 12 - 13 volts primary input).

(3) With force of ½ pound applied as side load to top of shaft.

DISTRIBUTOR TEST SPECIFICATIONS
(For Use With Distributor Test Stand)
1979

Engine Model	4-196	V-304, V-345	V-345
Distributor: Part No. (Manufacturer's No.)	496003-C91 496003-C92 (IDN-4001B)	496004-C91 496004-C92 (IDN-4002R)	1700769-C91 1700769-C92 (IDN4002X)
Air Gap, mm (in.) Trigger Wheel-to-Sensor (1)	0.2 (.008)	0.2 (.008)	0.2 (.008)
Dwell, Degrees (2)	28 - 34	28 - 34	28 - 34
Vacuum Advance: Vacuum Req'd. to Start Advance kPa (In. of Hg.)	16.9 - 23.6 (5.0 - 7.0)	10.1 - 16.9 (3.0 - 5.0)	10.1 - 16.9 (3.0 - 5.0)
Advance Check Points: Vacuum, kPa (In. of Hg.) Degrees	30.4 (9) 3 - 6	23.6 (7) 2.8 - 6.0	23.6 (7) 2.8 - 6.0
Vacuum Degrees	37.1 (11) 4 - 6	43.9 (13) 4.0 - 6.0	43.9 (13) 4.0 - 6.0
Vacuum Degrees	64.2 (19) 4 - 6		
Mechanical Advance: Distributor RPM to Start Advance	350 - 450	325 - 475	350-730
Advance Check Points: Distributor RPM Degrees	500 1.5 - 3.9	1000 7.5 - 9.5	1000 1.4 - 3.4
Distributor RPM Degrees	650 5.5 - 7.9	1100 9.0 - 11.0	2000 6.5 0 8.5
Distributor RPM Degrees	1000 8.3 - 10.3	2000 13.0 - 15.0	2100 6.5 - 8.5
Distributor RPM Degrees	1800 12.0 - 14.0	2100 13.0 - 15.0	
Distributor RPM Degrees	2200 13.0 - 15.0		
Total Advance, Degrees Mechanical and Vacuum	17.0 - 21.0		10.5 - 14.5
Distributor Shaft End Play, mm (in.)	0.89 - 1.02 (.035 - .040)		
Distributor Shaft Side Play (3) New, mm (in.) Maximum Permissible, mm (in.)	0.05 - 0.1 (.002 - .004) 0.15 (.006)		
Distributor Rotation (As Viewed From Top)	Right Hand (Clockwise) Right Hand (Clockwise)		

(1) Clearance between sensor and end of trigger wheel tooth.

(2) At 300 distributor RPM (with 12 - 13 volts primary input).

(3) With force of ½ pound applied as side load to top of shaft.

DISTRIBUTOR TEST SPECIFICATIONS
(For Use With Distributor Test Stand)
1980

Engine Model	4-196		V-304,	V-345
Distributor: Part No. Manufacturer's No.	1700343-C91 1700343-C91 (IDN-4001C)	497600-C91 497600-C92 (IDN-4010)	1700344-C91 1700344-C92 (IDN-4002U)	1700345-C91 1700345-C92 (IDN-4002W)
Air Gap, mm (in.) Trigger Wheel-to-Sensor (1)	0.2 (.008)			
Dwell, Degrees (2)	28 - 34		26 - 32	
Vacuum Advance: Vacuum Req'd to Start Advance kPa, (In. of Hg.)	3.4 - 10.1 (1 - 3)	16.9 - 23.6 (5 - 7)	11.8 - 18.6 (3.5 - 5.5)	10.1 - 16.9 (3 - 5)
Advance Check Points: Vacuum, kPa, (In. of Hg.) Degrees	13.5 (4) 1.5 - 4.0	20.3 (6) 0.0 - 1.5	27.0 (8) 4.3 - 7.1	27.0 (8) 4.7 - 8.0
Vacuum Degrees	27.0 (8) 6.0 - 8.0	30.4 (9) 2.8 - 5.8	43.9 (13) 9.0 - 11.0	43.9 (13) 11.0 - 13.0
Vacuum Degrees	40.5 (12) (6.0 - 8.0)	50.7 (15) 4.0 - 6.0	47.3 (14) 9.0 - 11.0	47.3 (14) 11.0 - 13.0
Mechanical Advance: Distributor RPM to Start Advance:	350 to 450	375 - 450	225 - 575	350 - 730
Advance Check Points: Distributor RPM Degrees	650 3.5 - 7.9	600 4.0 - 6.0	1000 2.4 - 4.4	1000 1.4 - 3.40
Distributor RPM Degrees	1000 8.3 - 10.3	1000 8.5 - 10.5	2000 8.0 - 10.0	2000 6.5 - 8.5
Distributor RPM Degrees	2000 13.0 - 15.0	1900 15.2 - 17.2	2100 8.0 - 10.0	2100 6.5 - 8.5
Distributor RPM Degrees	2100 13.0 - 15.0	2200 15.8 - 17.8		
Total Advance, Degrees Mechanical and Vacuum	19.0 - 23.0	19.8 - 23.8	17.0 - 21.0	17.5 - 21.5
Distributor Shaft End Play, mm (in.)	0.89 - 1.02 (.035 - .040)			
Distributor Shaft Side Play (3) New, mm (in.) Maximum Permissible, mm (in.)	0.05 - 0.1 (.002 - .004) 0.15 (.006)			
Distributor Rotation (As Viewed From Top)	Right Hand (Clockwise)			

(1) Clearance between sensor and end of trigger wheel tooth.

(2) At 300 distributor RPM (with 12 - 13 volts primary input).

(3) With force of 1/2 pound applied as side load to top of shaft.

DISTRIBUTOR TEST SPECIFICATIONS
(For Use With Distributor Test Stand)
1978 thru 1981

Engine Model	V-345	V-345	V-345, V-392	V-392
Distributor: Part No. (Manufacturer's No.)	484785-C91 484785-C92 (IDN-4002L)	484786-C91 484786-C92 (IDN-4007)	484783-C91 484783-C92 (IDN-4002)	484788-C91 484788-C92 (IDN-4002A)
Air Gap, mm (in.) Trigger Wheel-to-Sensor (1)	0.2 (.008)			
Dwell, Degrees (2)	26 - 32			
Vacuum Advance:				
Vacuum Req'd. to Start Advance kPa (In. of Hg.)	33.8 - 40.5 (10 - 12)	- - - - - -	16.9 - 23.6 (5 - 7)	16.9 - 23.6 (5 - 7)
Advance Check Points:				
Vacuum, kPa (In. of Hg.)	43.9 (13)	- - -	27.0 (8)	27.0 (8)
Degrees	1.5 - 4	- - -	1.5 - 4.5	2.8 - 8
Vacuum	50.7 (15)	- - -	40.5 (12)	32.1 (9.5)
Degrees	2 - 4	- - -	4 - 6	6 - 8
Vacuum	- - -	- - -	- - -	64.2 (19)
Degrees	- - -	- - -	- - -	6 - 8
Mechanical Advance:				
Distributor RPM to Start Advance	370 - 580	300 - 500	350 - 475	350 - 475
Advance Check Points:				
Distributor RPM				
Degrees	- - -	- - -	- - -	- - -
Distributor RPM	700	600	700	700
Degrees	0.[illegible] - 2.9	1 - 3	4 - 6	3.4 - 5.4
Distributor RPM	1000	1000	1000	1000
Degrees	3.5 - 5.5	5 - 7	5.5 - 7.5	8 - 10
Distributor RPM	1900	1800	1900	1400
Degrees	11.2 - 13.2	13 - 15	10 - 12	10 - 12
Distributor RPM	2100	2100	2100	1800
Degrees	11.9 - 13.9	14.8 - 16.8	10.3 - 12.3	12 - 14
Total Advance, Degrees Mechanical and Vacuum	13.9 - 17.9	14.8 - 16.8 (Mech only)	14.3 - 18.3	18 - 22
Distributor Shaft End Play, mm (in.)	0.89 - 1.02 (.035 - .040)			
Distributor Shaft Side Play (3) New, mm (in.) Maximum Permissible, mm (in.)	0.05 - 0.1 (.002 - .004) 0.15 (.006)			
Distributor Rotation (As Viewed From Top)	Right Hand (Clockwise)			

(1) Clearance between sensor and end of trigger wheel tooth.

(2) At 300 distributor RPM (with 12 - 13 volts primary input).

(3) With force of ½ pound applied as side load to top of shaft.

DISTRIBUTOR TEST SPECIFICATIONS

(For Use With Distributor Test Stand)
1978 thru 1980

Engine Model	V-345	V-304,V-345,V-392 Low Compression
Distributor: Part No. (Manufacturer's No.)	484797-C91 484797-C92 (IDN-4002N)	484804-C91 484804-C92 (IDN-4002G)
Air Gap, mm (in.) Trigger Wheel-to-Sensor (1)	0.2 (.008)	
Dwell, Degrees (2)	26-32	
Vacuum Advance: Vacuum Req'd to Start Advance kPa (In. of Hg.)	16.9 - 23.6 (5-7)	15.9 - 20.9 (4.7 - 6.2)
Advance Check Points: Vacuum, kPa (In. of Hg.) Degrees	20.3 (6) 0-1.4	20.3 (6) 0-2.5
Vacuum Degrees	30.4 (9) 3-5.8	30.4 (9) 5-7.7
Vacuum Degrees	50.7 (15) 6-8	50.7 (15) 6-8
Mechanical Advance: Distributor RPM to Start Advance	250-375	250-350
Advance Check Points: Distributor RPM Degrees	400 0-2	300 0-1
Distributor RPM Degrees	-----	-----
Distributor RPM Degrees	700 4-6	700 7.5-9.5
Distributor RPM Degrees	-----	-----
Distributor RPM Degrees	2000 10.5-12.5	1800 15-17
Total Advance, Degrees Mechanical and Vacuum	16.5-20.5	21-25
Distributor Shaft End Play, mm (in.)	0.89 - 1.02 (.035 - .040)	
Distributor Shaft Side Play (3) New, mm (in.) Maximum Permissible, mm (in.)	 0.05-0.1 (.002-.004) 0.15 (.006)	
Distributor Rotation (As Viewed From Top)	Right Hand (Clockwise)	

(1) Clearance between sensor and end of trigger wheel tooth.

(2) At 300 distributor RPM (with 12-13 volts primary input).

(3) With force of 1/2 pound applied as side load to top of shaft.

DISTRIBUTOR TEST SPECIFICATIONS
(For Use With Distributor Test Stand)
1978 thru 1981

Engine Model	MV-404	MV-404	MV-446	V-537
Distributor: Part No. (Manufacturer's No.)	484790-C91 484790-C92 (IDN-4003)	1700571-C91 1700571-C92 (IDN-4003A)	484792-C91 484792-C92 (IDN-4003A)	484794-C91 484794-C92 (IDN-4006)
Air Gap, mm (in.) Trigger Wheel-to-Sensor (1)	0.2 (.008)			
Dwell, Degrees (2)	26-32			
Vacuum Advance:				
Vacuum Req'd to Start Advance kPa (In. of Hg.)	16.9-23.6 (5-7)	----	33.8-40.5 (10-12)	----
Advance Check Points: Vacuum, kPa (In. of Hg.)	27.0 (8)		43.9 (13)	
Degrees	1.5-4		1.5-4	
Vacuum	37.1 (12)		50.7 (15)	
Degrees	2-4		2-4	
Vacuum				
Degrees	----		----	
Mechanical Advance:				
Distributor RPM to Start Advance	300-500	300-500	300-500	275-475
Advance Check Points: Distributor RPM	----	600	----	500
Degrees		1.0-3.0		.2-2.5
Distributor RPM	600	1000	600	800
Degrees	1-3	5.3-7.3	1-3	3.7-5.7
Distributor RPM	1000	1450	1000	1000
Degrees	5.3-7.3	10.0-12.0	5.3-7.3	5.2-7.2
Distributor RPM	1450	1500	1450	1400
Degrees	10-12	10.8-12.8	10-12	6.4-8.4
Distributor RPM	1800		1800	1700
Degrees	10.8-12.8		10.8-12.8	6.9-8.9
Total Advance, Degrees Mechanical and Vacuum	12.8-16.8 (Mech only)	10.8-12.8 (Mech Only)	12.8-16.8	6.9 - 8.9 (Mech Only)
Distributor Shaft End Play, mm (in.)	0.10-0.46 (.004-.018)			0.05-0.25 (.002-.010)
Distributor Shaft Side Play (3) New, mm (in.) Maximum Permissible, mm (in.)	0.05-0.1 (.002-.004) 0.15 (.006)			0.05-0.1 (.002-.004) .15 (.006)
Distributor Rotation (As Viewed From Top)	Left Hand (Counterclockwise)			Right Hand (Clockwise)

(1) Clearance between sensor and end of trigger wheel tooth.

(2) At 300 distributor RPM (with 12-13 volts primary input).

(3) With force of 1/2 pound applied as side load to top of shaft.

DISTRIBUTOR TEST SPECIFICATIONS
(For Use With Distributor Test Stand)
1981

Engine Model	V-345		V-392
Distributor: Part No. (Manufacturer's No.)	1700695-C91 (IDN-4002Y)	1700696-C91 (IDN-4002AA)	1701051-C91 (IDN-4002AB)
Air Gap, mm (in.) Trigger Wheel-to-Sensor (1)	0.2 (.008)		
Dwell, Degrees (2)	26 - 32		
Vacuum Advance:			
Vacuum Req'd to Start Advance KPa (In. of Hg.)	3.4 - 10.1 (1-3)	0.34 - 10.1 (.1-3)	16.9 - 23.6 (5-7)
Advance Check Points: Vacuum, KPa (In. of Hg.) Degrees	20.3 (6) 4.8-8	13.5 (4) 1.5-4	27.0 (8) 1.5-4
Vacuum Degrees	37.1 (12) 11-13	37.1 (12) 6-8	37.1 (12) 2-4
Mechanical Advance:			
Distributor RPM sto Start Advance	390-710	390-710	325-475
Advance Check Points: Distributor RPM Degrees	1000 2.6 - 4.7	1000 2.6 - 4.7	700 3.4 - 5.6
Distributor RPM Degrees	1400 6.4 - 8.3	1400 6.4 - 8.3	1000 7.9 - 10
Distributor RPM Degrees	1500 6.4 - 8.3	1500 6.4 - 8.3	1400 10 - 12
Distributor RPM Degrees	- - - - - -	- - - - - -	1800 12 - 14
Distributor RPM Degrees	- - - - - -	- - - - - -	- - - - - -
Total Advance, Degrees Mechanical and Vacuum	17.4 - 21.3	12.4 - 16.3	14.0 - 18.0
Distributor Shaft End Play, mm (in.)	0.89 - 1.02 (.035 - .040)		
Distributor Shaft Side Play (3) New, mm (in.) Maximum Permissible, mm (in.)	0.05 - 0.1 (.002 - .004) 0.15 (.006)		
Distributor Rotation (As Viewed From Top)	Right Hand (Clockwise)		

(1) Clearance between sensor and end of trigger wheel tooth.

(2) At 300 distributor RPM (with 12-13 volts primary input).

(3) With force of 1/2 pound applied as side load to top of shaft.

ELECTRICAL

LIGHTS

S-SERIES
VEHICLES

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

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.

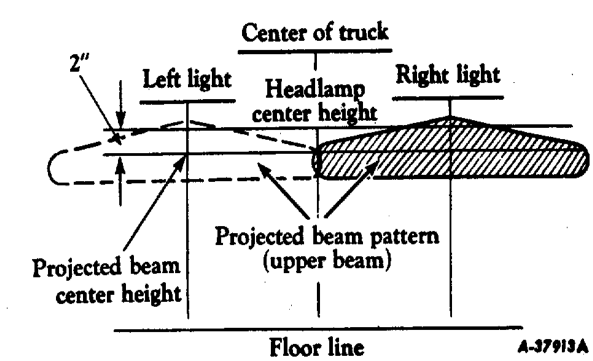

Fig. 1 Headlight Aiming Pattern

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.

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).

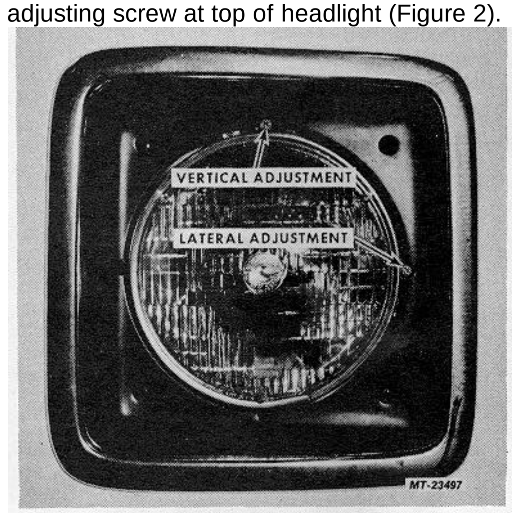

Fig. 2 Headlight Adjusting Screws

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.

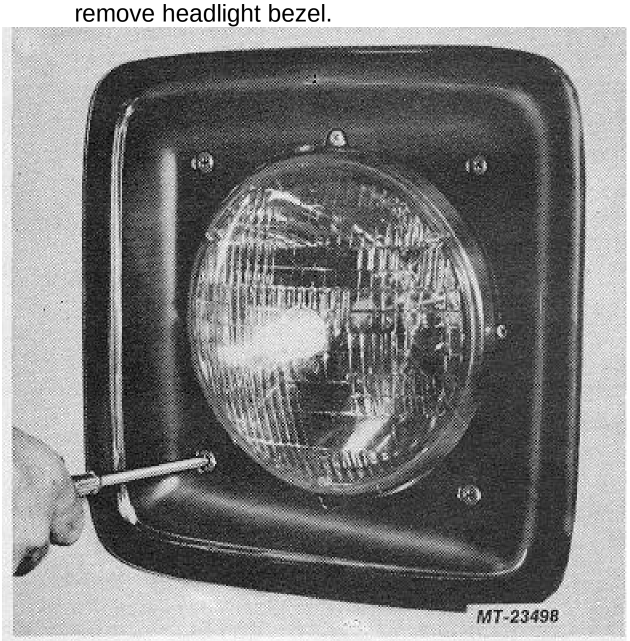

Fig. 3 Removing Headlight Bezel

2. Remove three (3) retaining screws and remove sealed beam unit retaining ring (Figure 4).

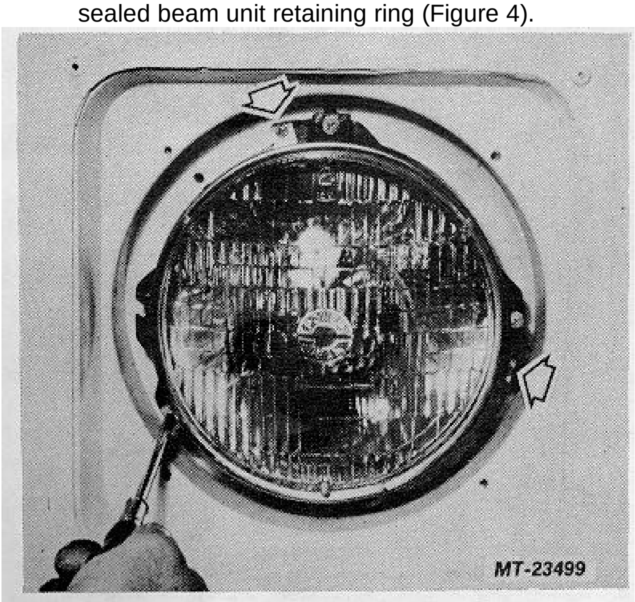

Fig. 4 Removing Sealed Beam Unit Retaining Ring

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.

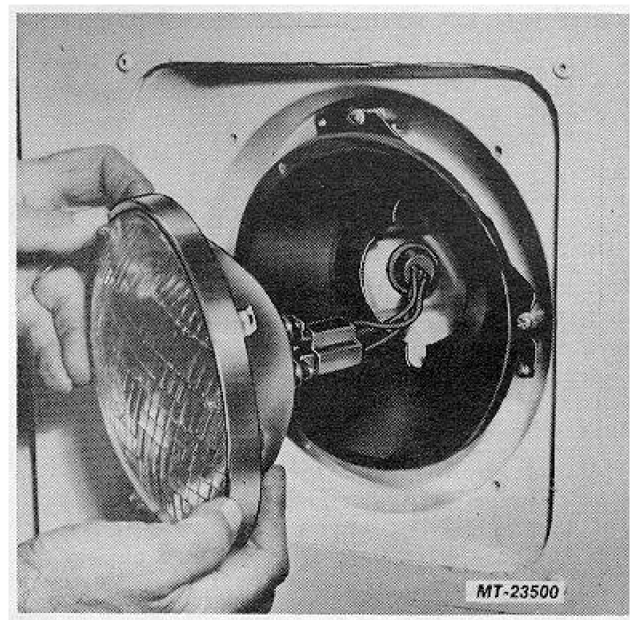

Fig. 5 Removing Sealed Beam Unit

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 (fender).

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.

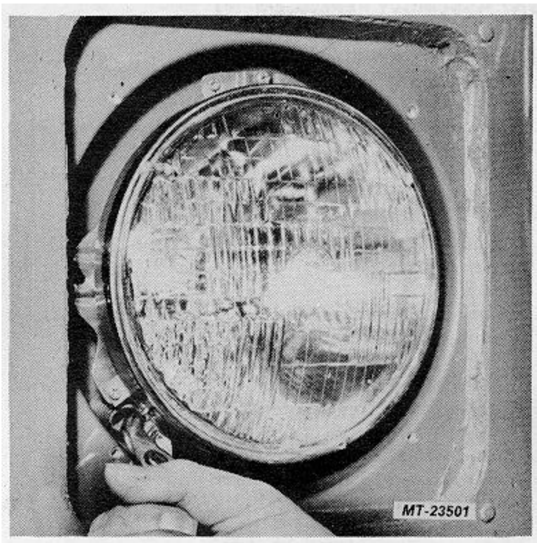

Fig. 6 Disconnecting Headlight Retainer Spring

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 (90°) counterclockwise until retainer tabs on rear tangs engage with slot in hood (fender) and front tangs are perpendicular to slot.

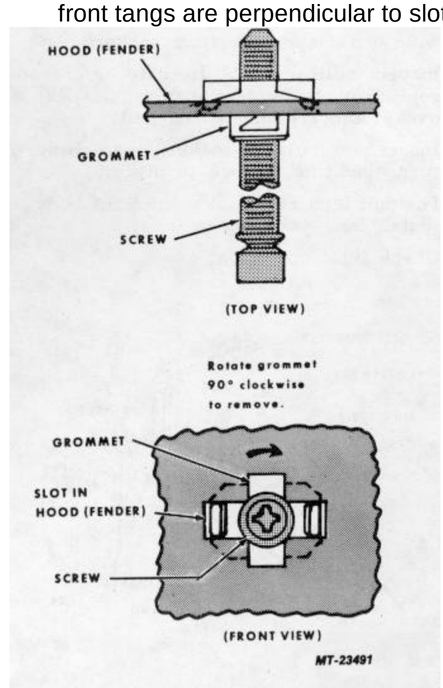

Fig. 8 Adjusting Screw Mounting Details

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.

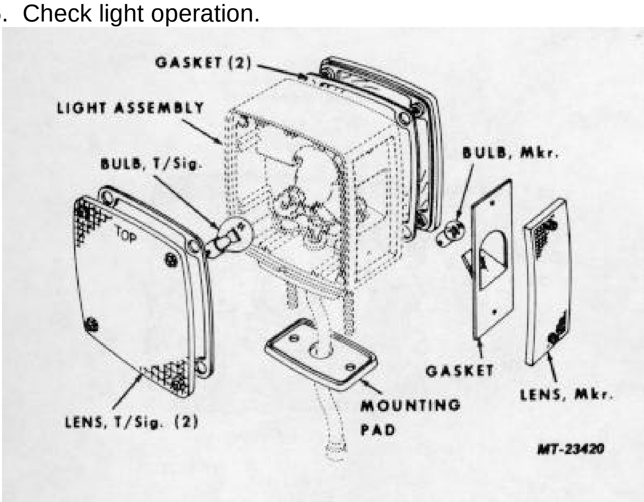

Fig. 9 Front Turn Signal/Marker Light

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.

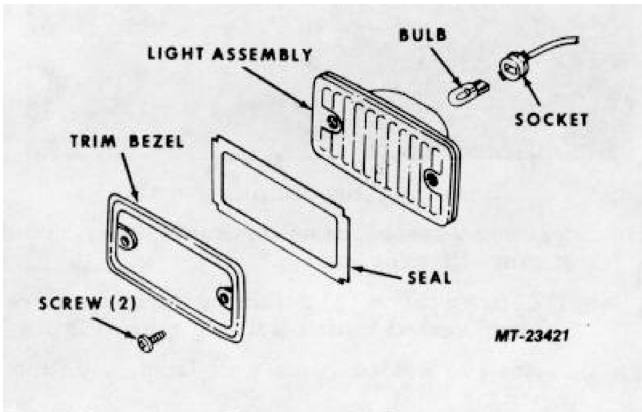

Fig. 10 Clearance Light

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 clock-wise 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.

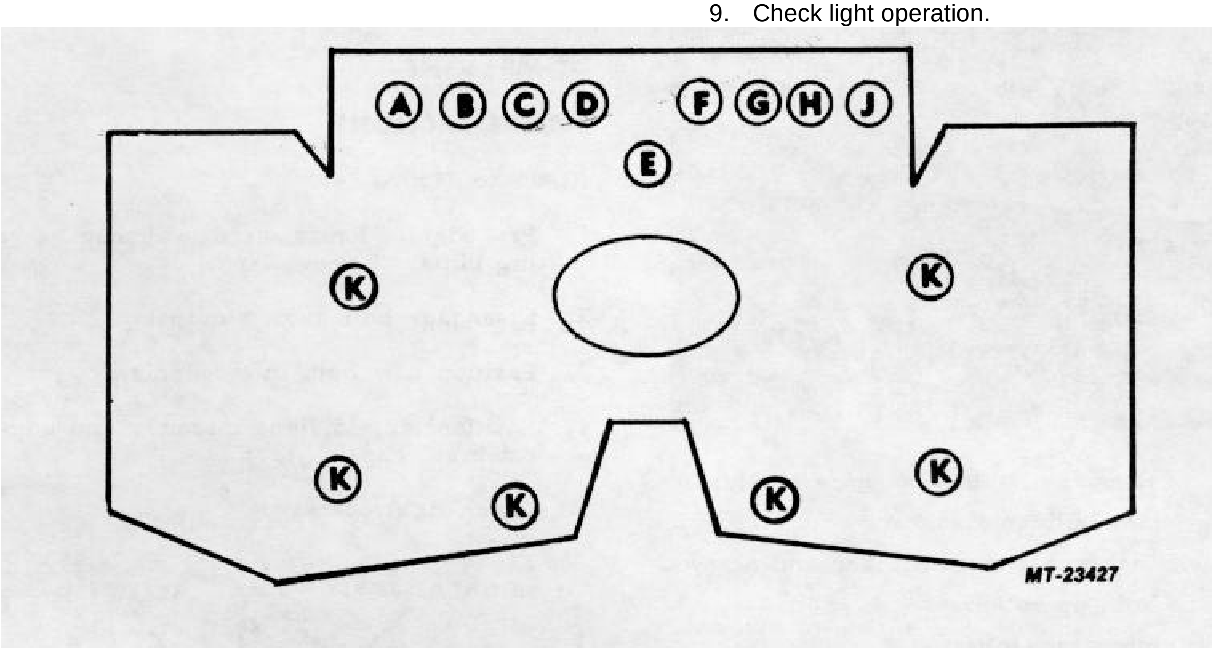

Fig. 11 Instrument Cluster Light Locations (As viewed from front of vehicle)

Legend

A. Right Turn Indicator
B. Low Air Pressure Warning
C. Antilock Warning (Some Models)
D. Park/Hydr. Brake Warning
E. High Beam Indicator
F. Power Divider Lock Warning or FGR Service Indicator
G. Antilock Warning (Some Models)
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.

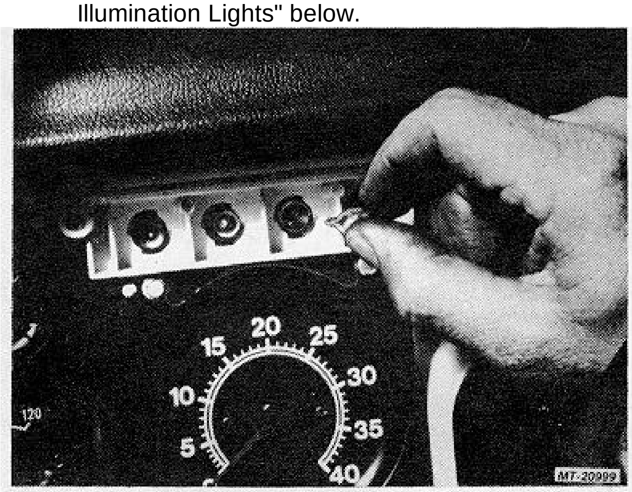

Fig. 12 Removing Bulb from Face of Cluster

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).

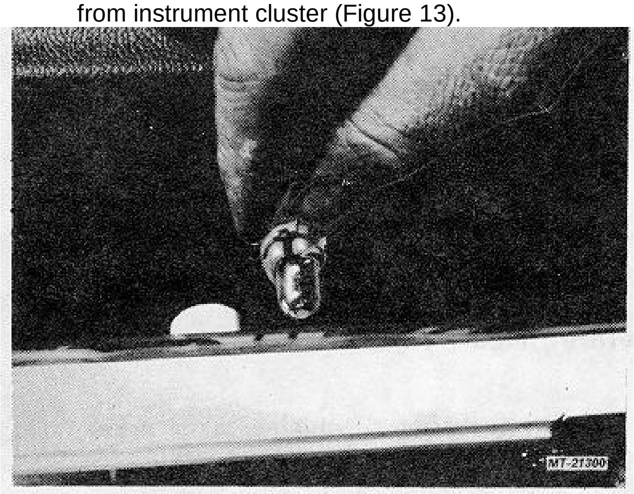

Fig. 13 Removing Bulb and Bulb Socket from Cluster

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.

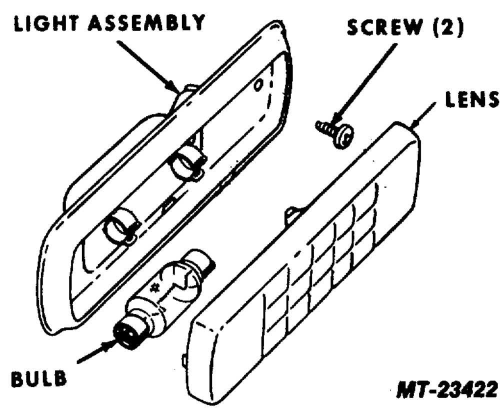

Fig. 14 Dome Light

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.

FLOOD (CARGO) LIGHT

BULB REPLACEMENT

(Refer to Figure 15)

1. Remove light mounting screws.

2. Pull light assembly away from mounting pad to expose wiring cable connector.

3. Disconnect wiring cable from light assembly. Remove light assembly.

4. Disengage bulb from terminals.

5. Position new bulb in terminals.

6. Connect wiring cable to light assembly.

7. Position light assembly on mounting pad and secure with mounting screws.

8. Check light operation.

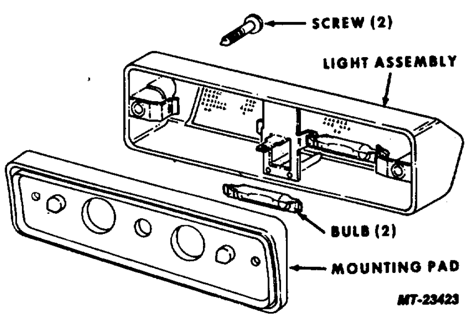

Fig. 15 Flood (Cargo) Light

LIGHT ASSEMBLY REPLACEMENT

1. Remove light mounting screws.

2. Pull light assembly away from mounting pad to expose wiring cable connector.

3. Disconnect wiring cable from light assembly. Remove light assembly.

4. Inspect light mounting pad and replace if damaged or deteriorated.

5. Connect wiring cable to new light assembly.

6. Position mounting pad and light assembly on cab 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 counter-clockwise 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.

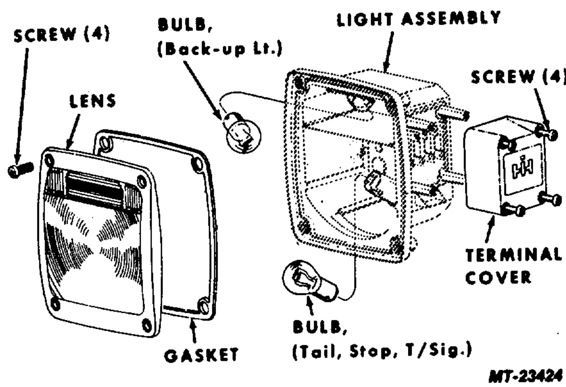

Fig. 16 Tail, Stop, Rear Turn Signal, Back-up Light

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.

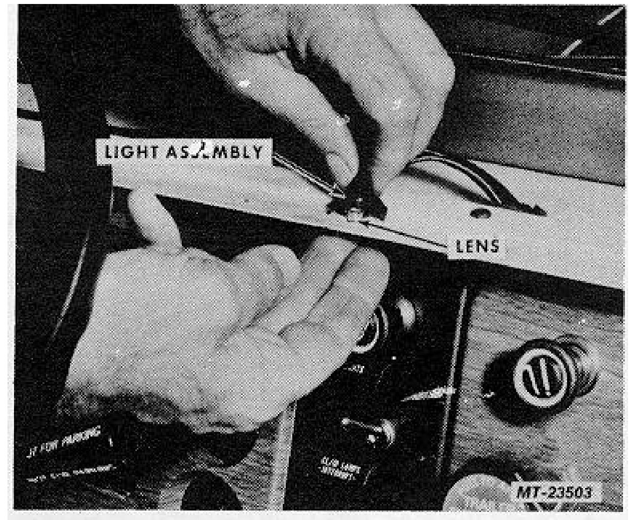

Fig. 17 Instrument Panel Control Light

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).

* without radio; 8 with radio. On 2200 series vehicles, 8 without radio, 10 with radio.

3. Turn 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.

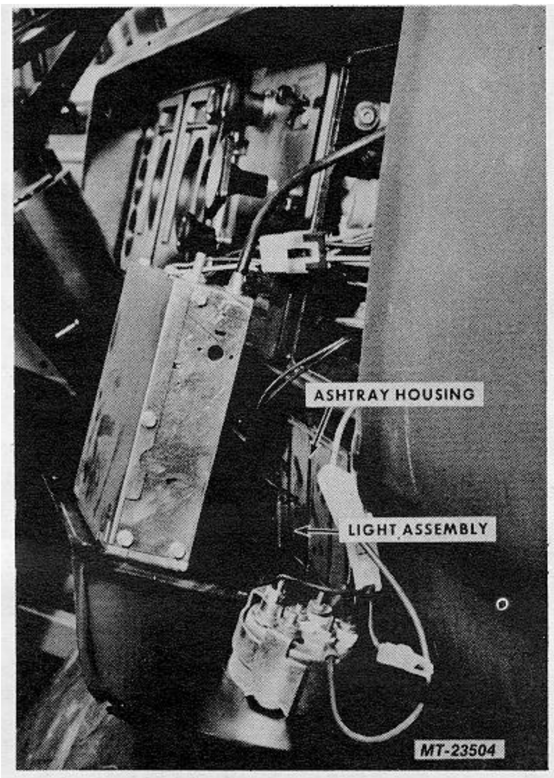

Fig. 18 Ashtray Light

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.

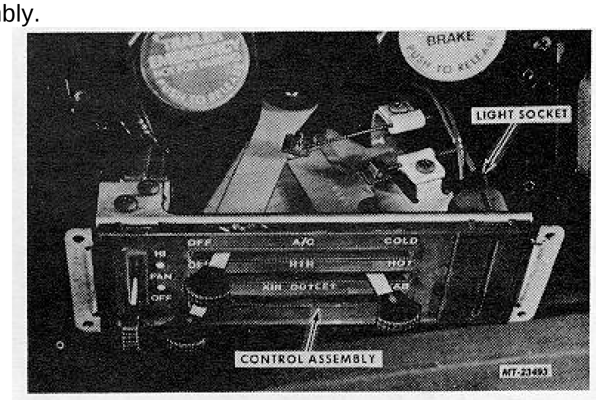

Fig. 19 Heater/Air Conditioning Control Light

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.

AUTOMATIC TRANSMISSION CONTROL LIGHT

BULB REPLACEMENT

1. Grasp light socket and disengage socket from hole in control housing. DO NOT pull on wire to remove socket. (See Figure 20).

In some cases it may be necessary to loosen control assembly left support bracket bolts to permit removal of light socket.

2. Press bulb in lightly and turn counterclockwise to disengage retaining pins.

3. Pull bulb from socket.

4. 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.

5. Insert light socket into hole in control housing and push inward until retaining clips "snap" into position securing socket.

6. Tighten support bracket bolts (if loosened to permit light removal).

7. Check light operation.

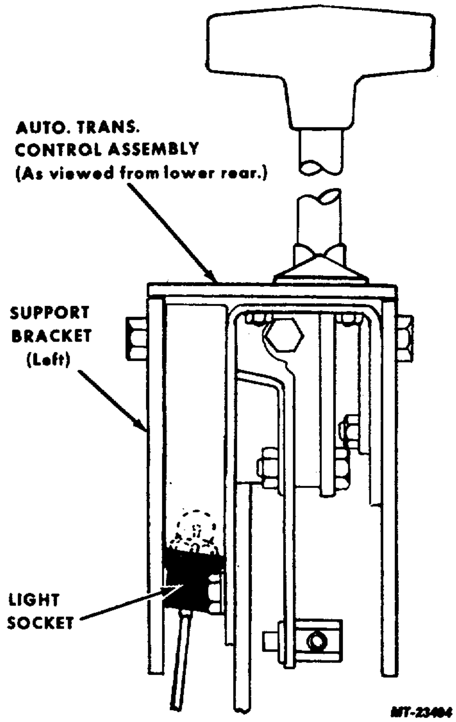

Fig. 20 Automatic Transmission Control Light

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)

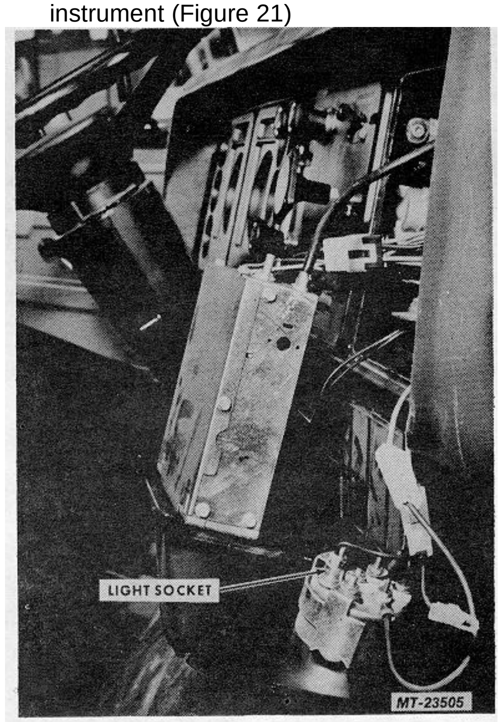

Fig. 21 Auxiliary Gauge Illumination Light (Typical)

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.
   and gauge(s), on instrument panel and
   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
Clearance Identification	3	168
Instrument Cluster	2	194
Dome	12	211
Flood (Cargo)	12	561
Tail Stop Turn License	32/3	1157
Back-Up	32	1156
Instrument Panel Controls	0.5	*
Ashtray	0.5	*
Heater/A.C. Control	3	168
Auto. Trans. Control	3	168
Control Identification or Warning Lights	0.5	*
Auxiliary Gauge Illumination	1	53

* Replace light assembly.

FUSE AND CIRCUIT BREAKER PANELS

CONTENTS

DESCRIPTION

All chassis incorporate safety devices to protect electrical wiring and equipment from short circuits or electrical overloads. These protective devices may be fuses, circuit breakers or fusible links.

Fuses

Fuses are designed to pass a given amount of current. The current flow limit is indicated by the rating or "Size" of the fuse (10 ampere, 14 ampere, etc.). Exceeding this limit will cause the fuse to "blow" opening the circuit.

After the cause of the overload is determined and corrected, a new fuse must be installed in the circuit. Do not replace a "blown" fuse with a fuse of higher capacity. To do so may result in damage to electrical components or wiring. Where fuse failure is encountered, correct the cause of the overload and install a new fuse of the originally specified rating.

Fuses for most vehicle wiring circuits are grouped together in a fuse panel (Figure 1). Some fuse panels have removable fuse terminals which can be replaced if damaged. Most fuse panels provide space to install additional fuse terminals if needed for installation of accessory circuits.

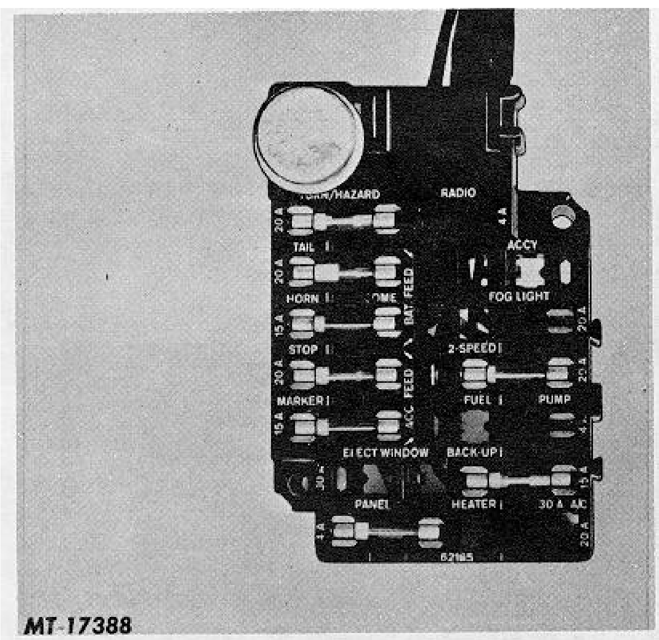

Figure 1 Fuse Panel (Typical)

Locations of fuse panels on various vehicle models are shown in this section.

Circuit Breakers

Circuit breakers are designed to open the circuit any time current demand exceeds the capacity of the breaker. In the event of short or overload, the circuit breaker will open due to excessive heat developed by the higher amperage passing through it. When the heat dissipates, the breaker will close allowing current flow again.

If the cause of the short or overload has not been removed, the circuit breaker will open again to protect the circuit. The current flow limit is indicated by the rating (capacity) of the circuit breaker--15 amperes, 20 amperes, etc. Do not replace a circuit breaker with one of a higher capacity.

Circuit breakers for vehicle wiring circuits are generally grouped together in a circuit breaker panel. Most circuit breaker panels provide space for installing additional circuit breakers if needed for installation of accessory circuits.

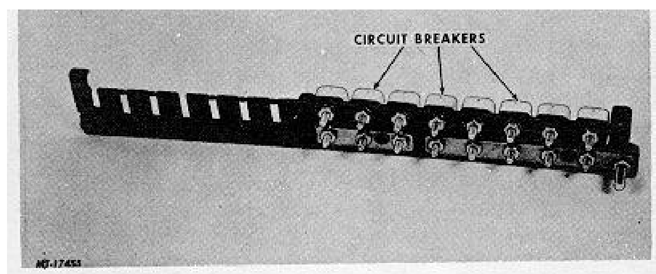

Figure 2 Circuit Breaker Panel (Typical)

Figure 2 illustrates the type of circuit breakers used in heavy duty vehicles equipped with circuit breaker panels. Figure 3 shows another type of circuit breaker which can be used to replace fuses on vehicles equipped with a fuse, panel.

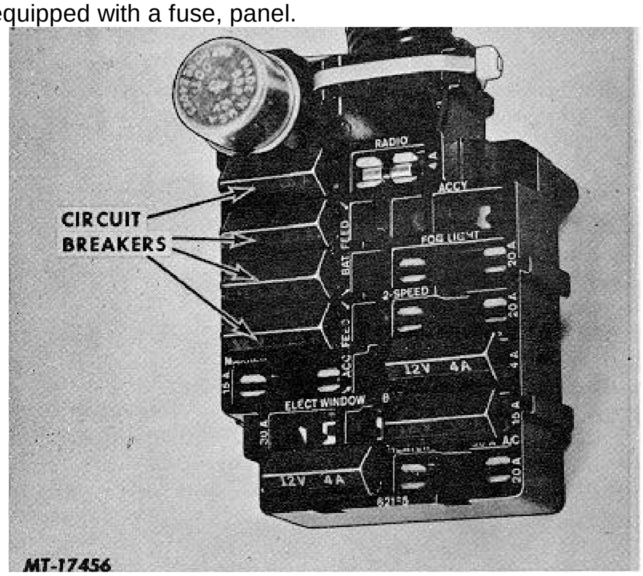

Figure 3 Fuse Panel with Fuse Replacement Type Circuit Breakers Installed

Locations of circuit breaker panels on various model vehicles are shown in this section.

Fusible Links

A third type of protective device is the fusible link. Fusible links are used to protect the wiring harness in the event of a short in an unfused circuit.

The fusible link consists of a length of light gauge wire. In case of a short or overload, the fusible link opens ("burns out") to protect the rest of the circuit. Repair consists of splicing a new fusible link into the circuit.

Locations of fusible links, where used, are shown on the wiring circuit diagram covering the vehicle involved.

FUSE PANEL AND CIRCUIT BREAKER PANEL LOCATIONS

Illustrated below are locations of fuse panels or circuit breaker panels on various vehicle models. Some heavy duty vehicles are equipped with both a fuse panel and a circuit breaker panel.

Vehicles may have additional secondary or accessory circuits not routed through the fuse or circuit breaker panel. Such circuits are protected by "in line" fuses or remote mounted circuit breakers in the current feed wiring. Refer to vehicle circuit diagrams for fuse or circuit breaker locations.

Scout II

The fuse panel on Scout II vehicles is located at the lower edge of the instrument panel to the left of the steering column as shown in

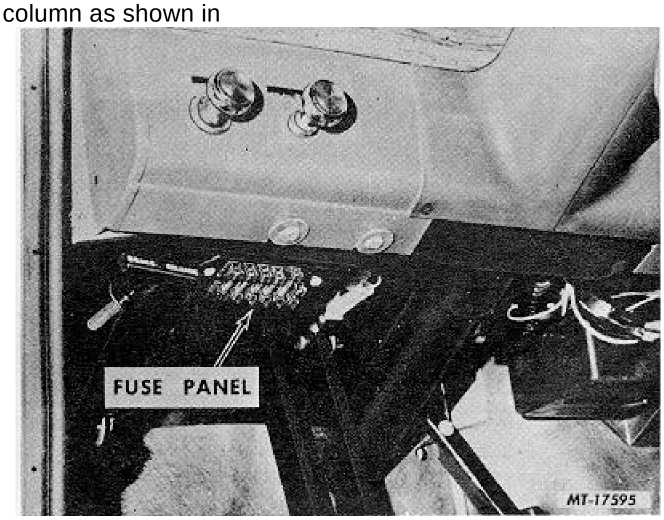

Figure 4 Figure 4 Fuse Panel Location Scout II Vehicles

100, 150, 200, 500 Series and 1600 Thru 1850 Loadstar Series

These vehicles have the fuse panel located to the left of the glove compartment and covered by the glove compartment door (see Figure 5).

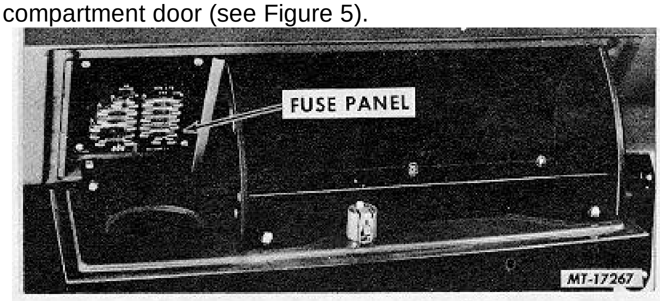

Figure 5 Fuse Panel Location 100, 150, 200, 500 and 1600 Thru 1850 Loadstar Vehicles

1610 Thru 1950 Cargostar Series

The fuse panel is located behind an access door at the right side of the instrument panel on Cargostar vehicles as shown in Figure 6.

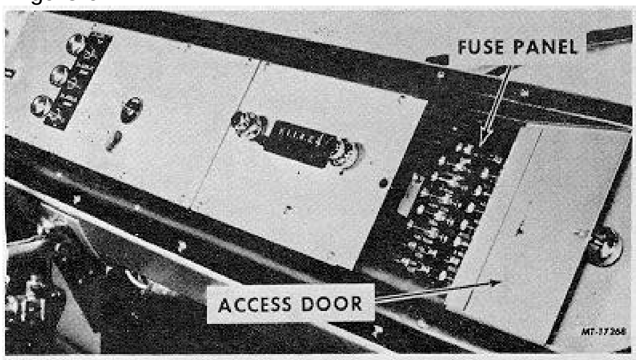

Figure 6 Fuse Panel Location 1610 Thru 1950 Cargostar Vehicles

1900 Thru 2100 Fleetstar Series

The fuse panel is located to the left of the glove compartment and covered by the glove compartment door as illustrated in Figure 7.

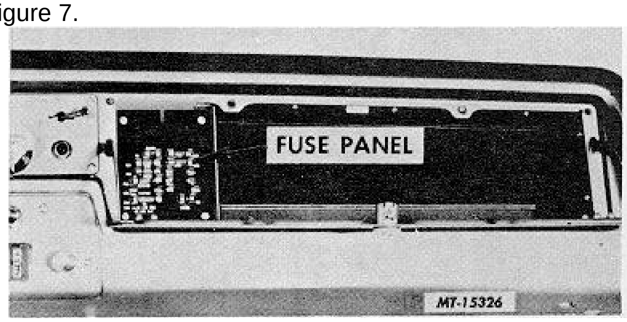

Figure 7 Fuse Panel Location 1900 Thru 2100 Fleetstar Vehicles

Fleetstar vehicles equipped with semitrailer wiring connections also have a trailer wiring fuse panel located behind the driver's seat at the left rear corner of the cab (Figure 8).

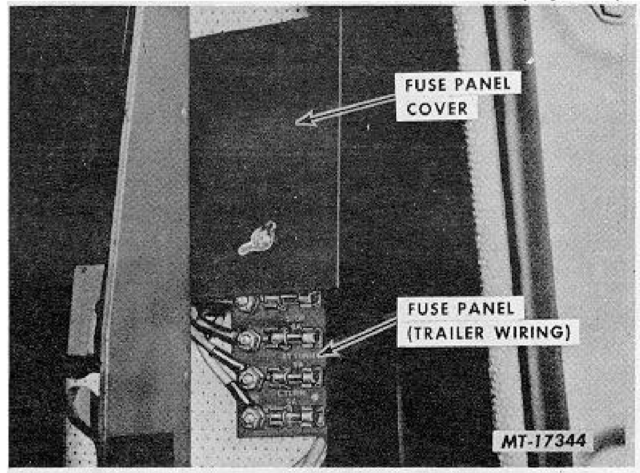

Figure 8 Trailer Wiring Fuse Panel 1900 Thru 2100 Fleetstar Vehicles

4070B Transtar II Series

These vehicles are equipped with both a fuse panel and a circuit breaker panel. Both panels are located beneath a hinged access cover at the top center of the instrument panel (see Figure 9 and Figure 10).

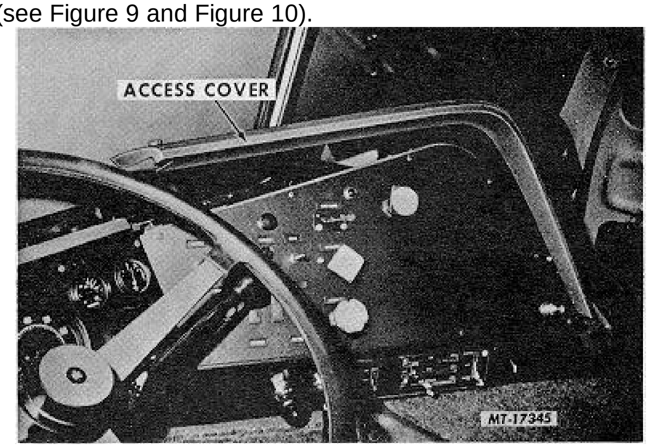

Figure 9 Fuse and Circuit Breaker Panel Access Cover CO-4070B Transtar II Vehicles

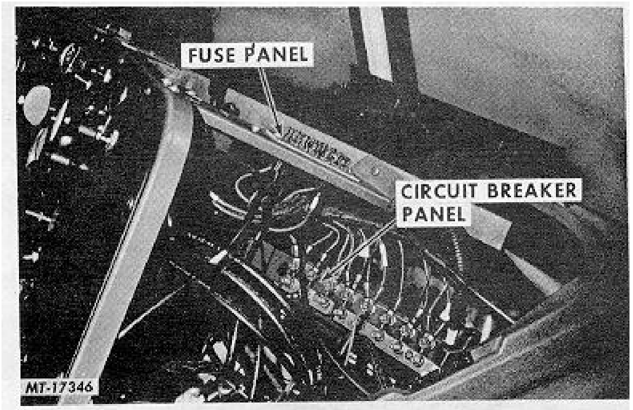

Fig. 10 Fuse Panel and Circuit Breaker Panel Locations CO-4070B Transtar II Vehicles (Access Cover Removed for Illustration)

4200, 4300 Transtar Conventional Series and 5000 Paystar Series

On these vehicles, the fuse panel and circuit breaker panel are located beneath a hinged access cover at the right side of the instrument panel (Fig. 11).

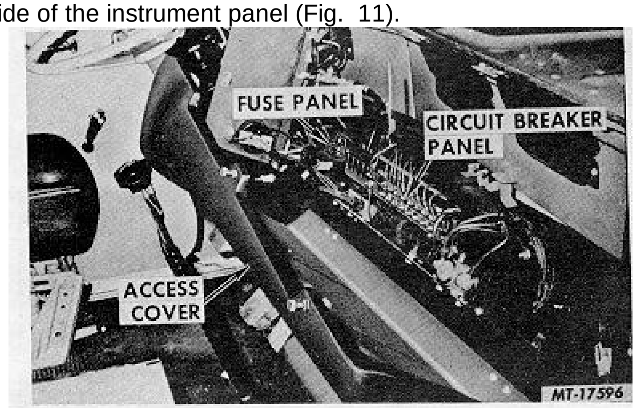

Fig. 11 Fuse Panel and Circuit Breaker Panel Locations 4200, 4300 Transtar Conventional and 5000 Paystar Vehicles.

CO-5370 Series

The fuse and circuit breaker panels on these vehicles are located behind an access door at the right center of the instrument panel (Fig. 12).

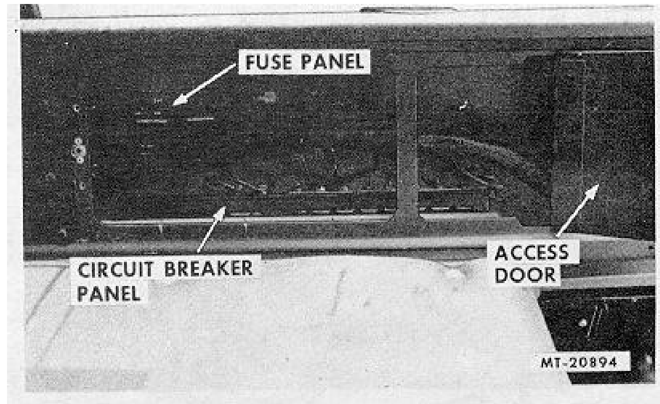

Fig. 12 Fuse Panel and Circuit Breaker Panel Locations CO-5370 Vehicles

S-Series

The fuse panel is located at the upper left corner of the dash panel (above the clutch pedal) on S-Series vehicles (Fig. 13).

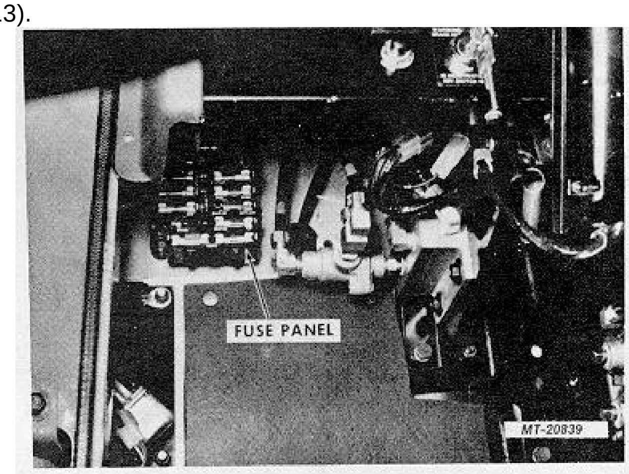

Fig. 13 Fuse Panel Location S-Series Vehicles

S-Series vehicles equipped with trailer wiring connections also have a trailer wiring fuse panel located behind the driver's seat at the left rear corner of the cab (Fig. 14).

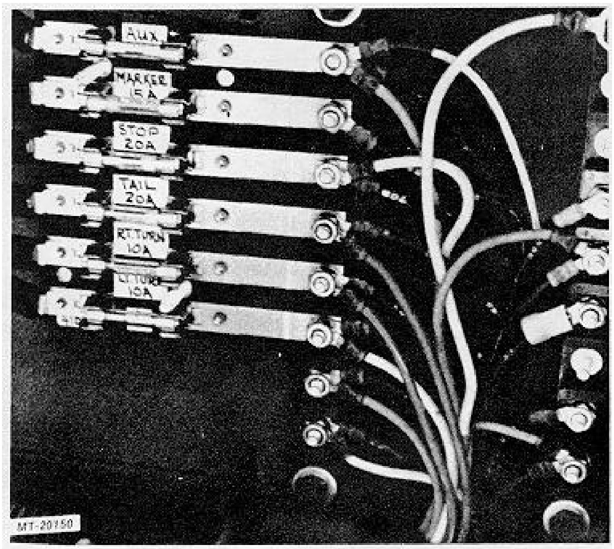

Fig. 14 Trailer Wiring Fuse Panel - S-Series Vehicles

SPARK PLUGS

INDEX

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REMOVAL

When removing the spark plugs from the engine, certain items should be remembered:

1. When disconnecting ignition cables from spark plugs, do not pull on cables but grasp the cable boot and carefully pull. To pull on cable may break the conductor in the resistor-type cable.
2. Observe location and routing of cables to avoid incorrect installation. Special attention should be given in routing spark plug cables, as cross fire (carburetor spit-back), rough operating engine, or short plug life will result if incorrect wire routing is encountered. If an engine is suspected of incorrect wire routing, compare wires with an engine which is known to be correct.

NOTE:

Cross fire is most likely to occur on a V8 engine between consecutively firing cylinders when these cylinders are located on the same bank.

3. After loosening each plug about two turns, blow out any accumulation of dirt around the base of plugs with compressed air. This prevents debris falling into cylinder combustion chambers when plugs are removed.

INSPECTION

Discussed in the following paragraphs are various instructions pertaining to different spark plug appearances and possible causes of their defects.

Preliminary Examination

If spark plugs in question reveal cracks, worn electrodes or other obviously unsatisfactory conditions, they should not be used again.

Gaskets

If the spark plug gaskets are not compressed, Fig. 1, it is an indication that the plugs have not been properly tightened to prevent blow-by between the spark plug and cylinder head. This condition results in excessive burning of the electrodes and overheats the insulator tip, which may cause preignition.

If the gaskets are flattened or compressed to a point where they have become distorted (out of round) or torn, Fig. 2, it is an indication that the spark plugs have been tightened to the extent that damage may have been inflicted on the plug itself.

Excessive torque will cause strain on the steel shell of the spark plug and result in cracked insulators, distortion of metal shell and gap setting, as well as blow-by between the component parts of the plug.

If the gasket is properly compressed (approximately one-half of the original thickness) showing a flat, clean, even surface, Fig. 3, it indicates that the spark plugs were properly installed.

Spark Plug Appearances

Deposits normally occur in distinct bands on insulator. The tip deposits near the electrodes are the ones which may affect spark operation. If they become conductive, their "shunt resistance" is said to drop, and the plug is short circuited.

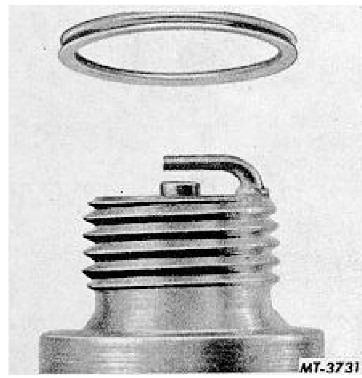


Fig. 1 Not Properly Tightened (Gasket Not Compressed)

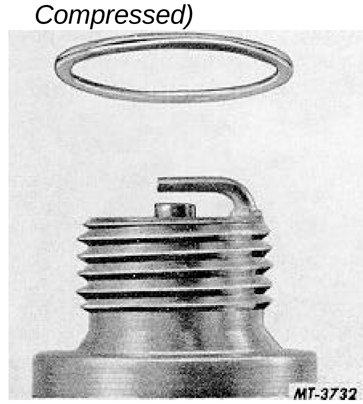


Fig. 2 Overtightened (Gasket Distorted)

Fig. 3 Properly Torqued

Normal Conditions

Normal conditions are shown in Fig. 4. The plug shown has been running at the correct temperature. The deposits present will be light tan or gray in color with most regular grades of commercial gasoline; if LPG is used, the color will be predominately brown.

Fig. 4 Normal Spark Plug Appearance

Core Bridging

Core bridging, Fig. 5, will be encountered only rarely in automotive engines. Deposits accumulated after a long period of misfiring may be suddenly loosened when normal combustion temperatures are restored upon installing new spark plugs. During a high-speed run these materials shedding off the piston are thrown against the hot insulator surface.

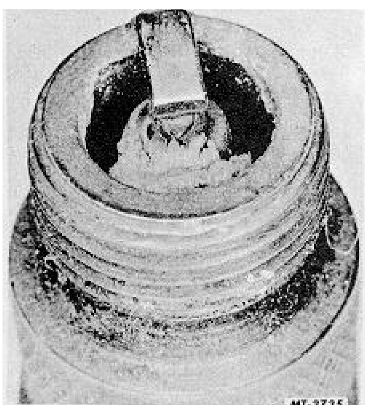


Fig. 5 Core Bridging

This action forms a bridge between the insulator and shell, resulting in a "dead short." Such evidence of excessive combustion chamber deposits will be most common where oil control is poor or where vehicles are usually driven in slow speed, start-stop service. In such instances it usually pays to physically remove accumulated deposits from the engine.

Cold Fouling

Cold fouling or carbon deposits are illustrated in Fig. 6. This dry, black appearance usually means that the next hotter plug should be substituted. However, if only one or two plugs in a set are fouled, check for sticking valves or bad ignition leads. Fouling of the entire set may be caused by a clogged air cleaner, a sticking heat riser or a faulty choke.

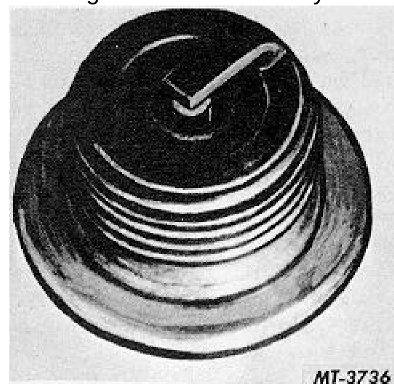


Fig. 6 Cold Fouling

Overheating

Overheating, illustrated in Fig. 7, is indicated by a dead white or gray insulator which appears "blistered." Electrode gap will be considerably worn. This suggests that a cooler heat range should be used; however, overadvanced ignition timing, detonation and cooling system stoppages can also overheat the correct spark plug heat ranges.

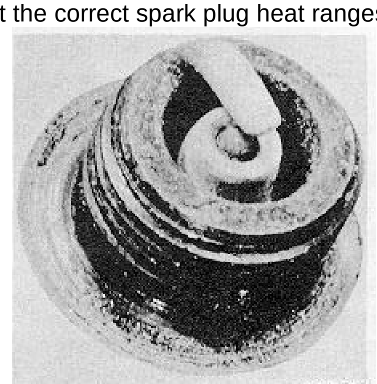


Fig. 7 Overheating

Turbulence Burning

Turbulence burning, shown in Fig. 8, causes electrodes to wear away on one side. This is the result of normal turbulence patterns in the combustion chambers of certain engines. It can be ignored if normal plug life is being obtained. If gap growth appears excessive, review the corrective measures suggested under "Overheating."

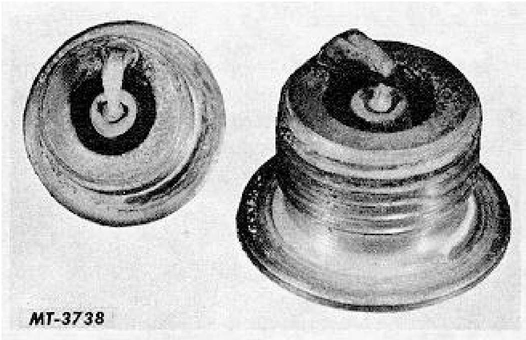


Fig. 8 Effects of Turbulence Burning

Wet Fouling

Wet fouling,shown in Fig. 9, illustrates that the plug has drowned in excess oil. In an old engine, suspect worn rings or excessive cylinder wear. In OHV engines too much oil may be coming in past the valve guides. Also, depending on cylinder location, this fouling can suggest a leaking vacuum booster pump diaphragm. Use of a hotter plug may relieve such fouling, but plugs can't take the place of needed engine overhaul. Remember that plug fouling in new engines may occur before normal oil control is achieved. In new or recently overhauled engines such fouled plugs can be cleaned and reinstalled.

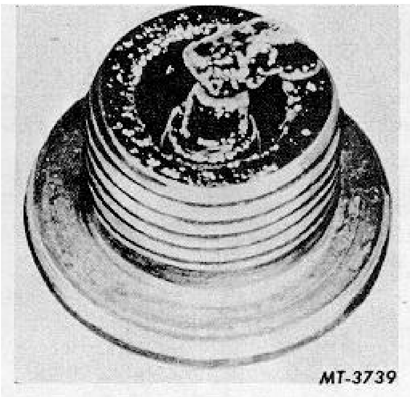


Fig. 9 Wet Fouling

Silica Deposits

Silica deposits, illustrated in Fig. 10, are hard and scratchy. This material is largely lead silicate formed when fine sand particles (silicate) combine with the anti-knock compounds in the fuel. It's most common in trucks operating in dusty areas or in sand loading operations. Such plugs cannot be cleaned. Always check for intake manifold leaks and see that the air cleaner on the engine is in good condition.

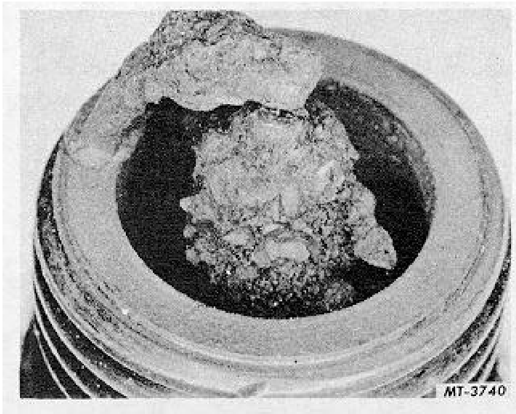


Fig. 10 Silica Deposits

Fuel Scavenger Deposits

Fuel scavenger deposits shown in Fig. 11 may be white or yellow in color. They may appear to be bad, but this is a normal appearance with certain brand fuels. Such materials are designed to change the chemical nature of deposits to lessen misfire tendencies. Notice that accumulation on the ground electrode and shell areas may be unusually heavy, but the material is easily flaked off. Such plugs can be considered normal in condition and can be cleaned with standard procedures.

Fig. 11 Fuel Scavenger Deposits

Sustained Preignition Damage

Sustained preignition damage, illustrated in Fig. 12, usually involves melting of the ceramic firing tip. Since this requires temperatures about 2700°F, other components of the engine may also have been damaged by preignition. This is another sure sign that a careful inspection of the engine and its adjust ments is required.

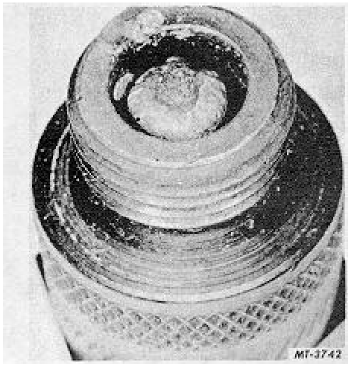


Fig. 12 Sustained Preignition Damage

Chipped Insulator

The chipped insulator shown in Fig. 13 results from bending the center electrode during regapping of the plug. Under certain conditions severe detonation can also split insulator firing ends. Obviously, the plug must be replaced.

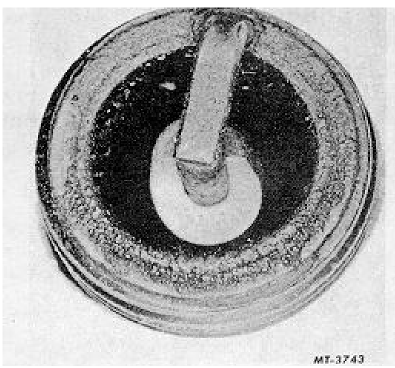


Fig. 13 Chipped Insulator

Mechanical Damage

Mechanical damage to plug shown in Fig. 14 is caused by a foreign object in the combustion chamber. Small objects can travel from one cylinder to another (because of valve overlap). Be sure to check the other cylinders to prevent recurrence of damage. When working on an engine, be certain the carburetor throat and spark plug holes are kept covered.

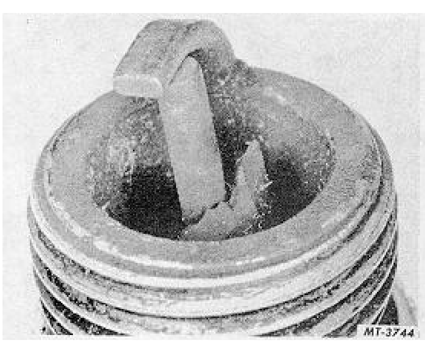


Fig. 14 Results of Mechanical Damage

Reversed Coil Polarity

Reversed coil polarity can often be detected by "dishing" of the ground electrode. Note in Fig. 15 that the center electrode is usually not worn badly. This source of misfiring and rough idle can be corrected by reversing the primary coil leads.

Fig. 15 Reversed Coil Polarity

Spark Plug Gap Tools

Pressure-type (plier) gap tools, if improperly used, impose a tremendously high unit pressure on the center electrode (Fig. 16). This is because of compression being exerted between the end of the center electrode and the top of the shell. If too much force is applied through leverage multiplication, the center electrode seal on any type or brand of spark plug is likely to be damaged. The conventional type gap tool, which should only contact the ground electrode, is less likely to damage the plug.

Fig. 16 Damage to Spark Plug from Pressure (Plier) Type Gap Tools

Condition of Electrodes

The extent of service and mileage to which a spark plug has been subjected is generally best indicated by the degree of wear of the electrodes, Fig. 17. When the center electrode has become worn away or the ground electrode has become so badly eroded at the sparking area that resetting of the gap is either difficult or impossible, the spark plug is not fit for further efficient engine service--even if cleaned.

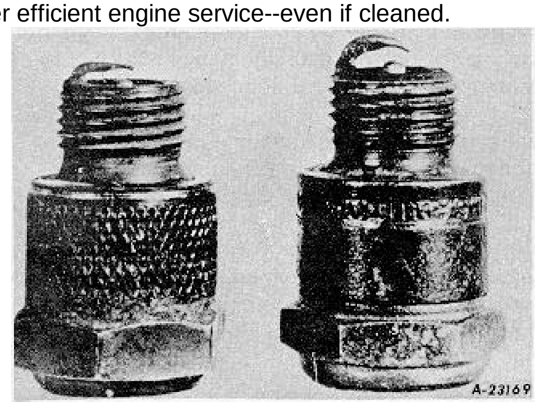


Fig. 17 Condition of Electrodes

CLEANING AND SETTING

Remove spark plug gaskets if plugs are to be cleaned.

Remove oily deposits from both firing end and outside surface of plug using a commercial cleaning solvent which dries quickly. Failure to remove oil from spark plugs will result in cleaner abrasive packing inside the firing end of spark plug if an abrasive type cleaner is used.

Use the instructions provided with the liquid spark plug cleaner and tester (SE-2190) and be sure the plugs are thoroughly dry before testing.

If an abrasive type plug cleaner is used, be sure the spark plugs are free of abrasive material before testing.

Pass a thin point file between center and ground electrodes to smooth up both surfaces.

Reset gap by moving ground side electrode only. Do not touch center electrode, as insulator tip fracture may result. Bend ground electrode toward center electrode.

Using a wire feeler gauge, gap plugs to specifications. A very slight drag should be felt when feeler gauge passes between electrodes.

Use the instructions provided with the tester to check spark plugs.

NOTE:
Never assume you are simulating cranking compression when using the tester. Air pressure in a bench tester has no direct relation to engine compression for the following reasons:

1. There are no temperature effects in the bench test. Heated electrodes within warm cylinders in an engine require less voltage than under a cold bench test.

2. There is no fuel/air charge in the bench tester.

3. Since spark plug firing is dependent on engine timing, firing of the spark plugs is not always at the point of maximum compress ion.

4. There is no cylinder turbulence in the tester pressure chamber.

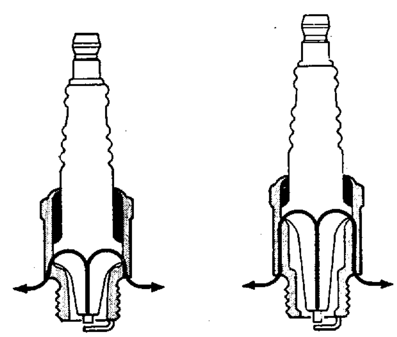
Because of these variables, the bench test, while useful, cannot be measured by any specific psi readings.

HEAT RANGE

Spark plug heat range is the primary factor governing spark plug performance under various service conditions. The term "heat range simply refers to the classification of spark plugs according to their ability to transfer heat from the firing end of the plug to the cooling system of the engine.

The rate of heat transfer, or heat range, is controlled basically by the distance between the inside gasket seat and the insulator tip.

A "cold" type plug, Fig. 18, has a relatively short insulator nose and transfers heat very rapidly into the engine's cooling system. Such a plug is used in heavy-duty or continuous high speed operation to avoid overheating.



MT-3754

Fig. 18 Construction and Heat Flow of "Hot" and "Cold" Plugs

The "hot" type plug, Fig. 18, has a much longer insulator nose and transfers heat more slowly away from its firing end. Thus, it runs hotter and burns off combustion deposits which tend to foul the plug during prolonged idle or low-speed operation.

INSTALLATION

When installing spark plugs, always be sure gasket seats and threads are clean.

Using a torque wrench, tighten plugs to 2830 ft. lbs.

BOOSTER GAP PLUG

For the past several years auxiliary gap (Booster Gap) spark plugs have been used in certain IH engines,

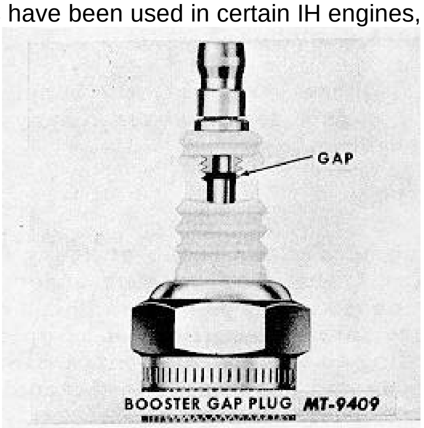


Fig. 19

Prior to IH approval, the Booster Gap design was thoroughly tested and evaluated, at which time their anti-fouling characteristics were firmly established.

<u>What is a Booster Gap plug?</u>

This plug has an internal <u>air gap</u> between the center electrode and the terminal stud.

<u>How do they work?</u>

Most servicemen know that misfire will occur when a conventional spark plug is fouled. As the coil attempts to build up voltage on the "dirty" firing end, it "sees" an easier path to ground over the deposits. This short circuit prevents normal voltage buildup. The Booster Gap, however, <u>isolates</u> the coil from the fouling deposits, allowing near normal voltage build-up. The instant the Booster Gap sparks, sufficient voltage appears across the firing gap and normal ignition results. When you remove a plug wire from a fouled plug and let the spark jump from the cable to the plug terminal to make the plug fire, you are using this same Booster Gap principle.

<u>Where are Booster Gap plugs used?</u>

Maximum benefit from this design is obtained in engines that operate over a wide load and speed range. For example, a heat range cool enough for highway service will have better fouling protection during stop-start city delivery service with the Booster Gap.

Furthermore, the Booster Gap has been instrumental in reducing the complaints of "break-in fouling" in new engines.

In many cases misfire due to oil fouling in older engines can be relieved simply by using the recommended heat range plug incorporating a Booster Gap.

<u>A cure-all?</u>

Not at all. Booster Gap plugs used where recommended and applicable to help solve fouling problems will give excellent results. However, the need for the correct selection of plugs in the proper heat range based on type of vehicle operation is important.

Where more severe conditions of fouling as a result of light service application or break-in fouling on engines occurs, the alternate recommended hotter type plug with Booster Gap should be used.

<u>Voltage Requirements</u>

While nominal in amount, the Booster Gap does require more voltage <u>initially</u> than conventional spark plugs. This higher requirement diminishes, however, after several thousand miles of use.

Most any ignition system has more than adequate reserve to supply the bit of extra voltage requirement; if you experience misfiring with Booster Gap plugs and not with conventional plugs, chances are the ignition system is marginal.

It should also be pointed out that Booster Gap plugs are <u>not</u> resistor plugs. If radio interference is a problem on older vehicles having nonresistor ignition cables, it may be necessary to install resistance leads (cables). Booster Gap plugs may be used in conjunction with resistance-type ignition cables to obtain interference suppression and still obtain the added benefits of the Booster Gap. This is the combination that is recommended on all gasoline powered motor truck engines.

STARTING MOTOR

ENCLOSED SHIFT LEVER TYPE
STANDARD DUTY

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

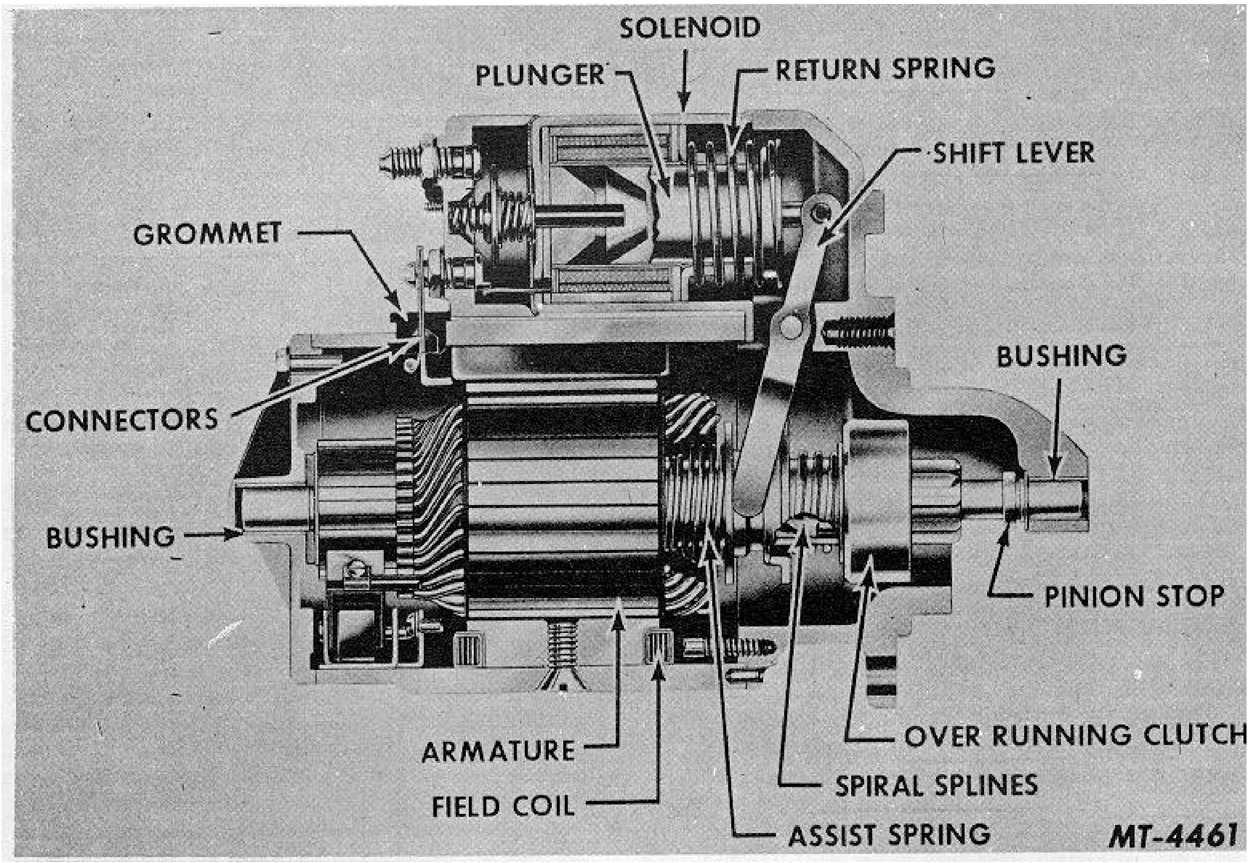


Fig. 1 Sectional View of Enclosed Shift Lever Type Starting Motor

DESCRIPTION

The enclosed shift lever type starting motor is equipped with a drive end housing which encloses the entire shifting mechanism and solenoid plunger, protecting them from road dirt, splash and icing conditions.

The solenoid is mounted on the flange of the drive end housing and operates the overrunning clutch drive by means of a linkage and shift lever. When the control switch closes the starting circuit the solenoid is energized shifting the pinion into mesh with the ring gear on the engine flywheel and closing the main contacts inside the solenoid. When the contacts inside the solenoid close, battery current is then supplied to the motor causing the armature to rotate. Torque is then transmitted by the clutch from the starting motor armature to the flywheel. To protect the armature from excessive speeds when the engine starts the clutch is designed to "overrun" or turn faster than the armature which permits the pinion to disengage itself.

LUBRICATION

Some starting motors require no lubrication except at overhaul, while other motors are equipped with lubrication fittings. The motor should be lubricated every 8000 km (5000 miles) or 300 hours of operation if a means of lubrication is provided.

1. Hinge cap oilers or oil tubes sealed with pipe plugs should have 8 to 10 drops of medium grade engine oil.

2. Grease cups should be turned down one turn or refilled if necessary.

If the motor is disassembled for any reason lubricate as follows:

1. Oil wicks should be resaturated if equipped.

2. Bushings should be coated with a medium grade of engine oil.

3. The armature shaft should be coated lightly with a medium grade of engine oil.

4. The drive assembly should be wiped clean.

CAUTION:

Do not clean in any degreasing tank or with grease dissolving solvents, this will dissolve the lubricant in the clutch mechanism.

5. Relubricate the sprag clutch with a medium grade of engine oil.

CAUTION:

Avoid excessive lubrication.

TROUBLE SHOOTING THE STARTING MOTOR 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. Failure of the motor to perform according to the specifications will require removal of starter and disassembly and further checks or adjustments made.

NOTE:

All starting motor tests should be made with engine and battery at room temperature (not cold).

Regardless of the construction, never operate the starting motor more than 30 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 tester (SE2283) will be used in performing the starter tests and the instruction manual supplied with the tester will provide 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 selector 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 voltage is available to operate ignition system when starter is in operation.

Connect voltmeter leads at the starter observing the polarity, Fig. 2. 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 tests.

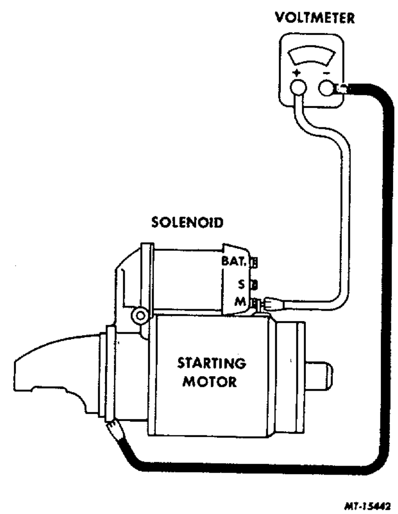


Fig. 2 Cranking Voltage Test

Test No. 2 -Battery Capacity Test

The battery capacity test is performed to determine if the battery is in satisfactory condition. See "Battery" Section. 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. 3.

In the cranking circuit we also have a cranking control circuit, Fig. 3. 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.

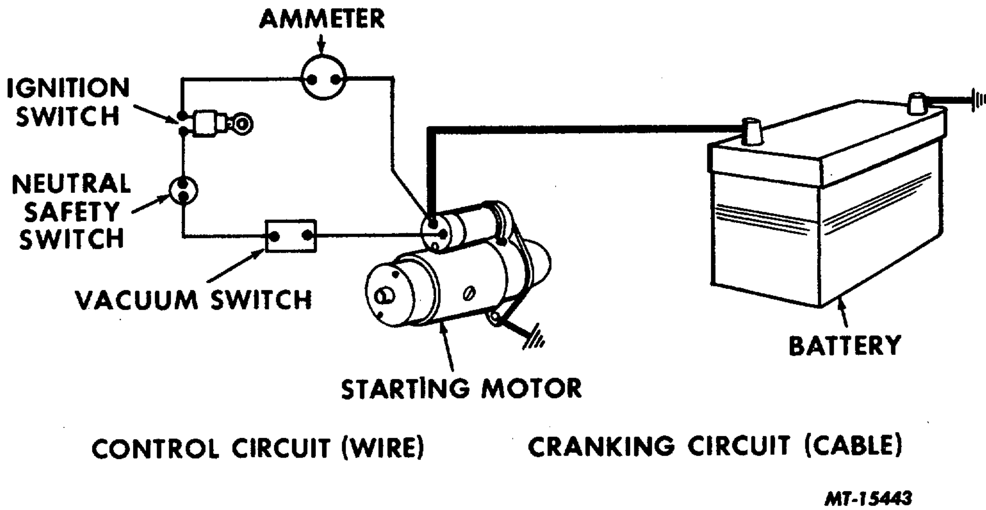


Fig. 3 Starting Motor Circuit

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. 4. Prevent engine from starting during test. Crank engine and observe voltmeter reading.

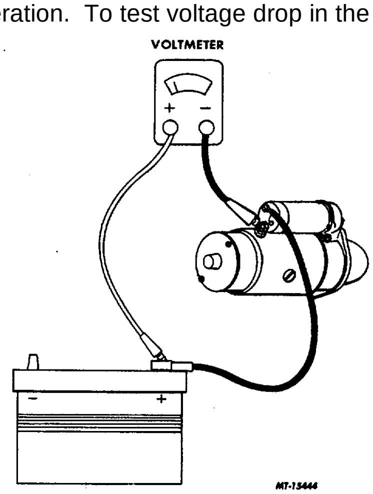


Fig. 4 Cranking Circuit Test

Values of maximum voltage drops for a standard 12-volt cranking circuit are as follows:

Cable under three (3) feet......................	.1 volt
Cable over three (3) to six (6) feet	.2 volt
Mechanical Switch	.1 volt
Solenoid Switch	.2 volt
Magnetic Switch	.3 volt
Each Connection....................................	.0 volt

Add these values together on the particular chassis being inspected. For example, if your total of the values from the chart is .5 volt and you have less than .5 volt drop on the chassis, continue to grounded side test.

However, if there is more than .5 volt drop you have an excessive voltage drop and this must be located by moving test lead from starting motor and working toward the battery. Crank engine with 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 Side: 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 present, 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.

Control Circuit: High resistance in the control circuit will reduce the current 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. 5. 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. However, with experience, slightly higher voltage loss will be found and will be normal.

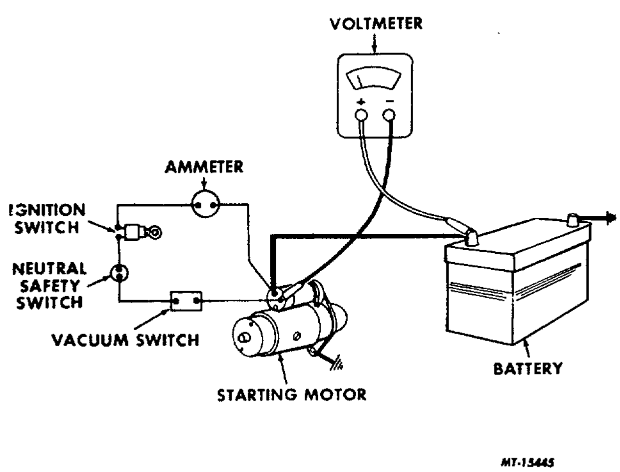


Fig. 5 Control Circuit Test

Isolate the point of high resistance by placing the voltmeter leads across each component in the circuit in turn. A reading of more than. volt across any one wire or switch is usually an indication of the trouble.

Test No. 4 -- No Load Test

After completing the cranking voltage test, battery capacity test and 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 a particular order to make certain the starting motor circuit is in good condition before needless starting motor removal.

Before performing "No Load Test, T" 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 screw 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. 6 from the motor terminal to the motor frame. An RPM indicator is necessary to measure armature speed. Obtain the specified voltage by varying the resistance unit; then read the current draw and the armature speed and compare these readings with the values listed in the specifications.

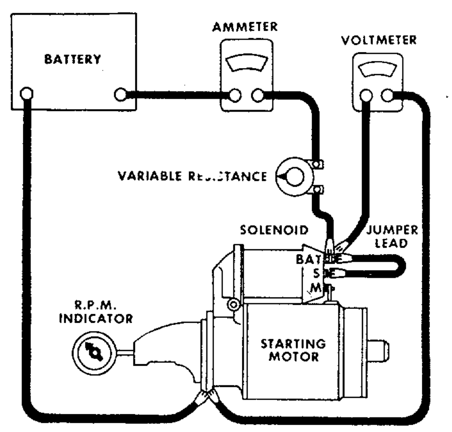


Fig. 6 No Load Test Hookup

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.

1. Disconnect the field coil connections from the solenoid motor terminal.

2. Remove the thru-bolts.

3. Remove the commutator end frame and field frame assembly.

4. Remove the armature assembly from the drive housing. On some models it will be necessary to remove the solenoid and shift lever assembly from the drive housing before removing the armature assembly.

5. Remove the thrust collar from the armature shaft.

6. Remove the pinion from the armature by sliding a metal cylinder onto the shaft; with a hammer striking the metal cylinder against the retainer, drive the retainer toward the armature core and off the snap ring, Fig. 7.

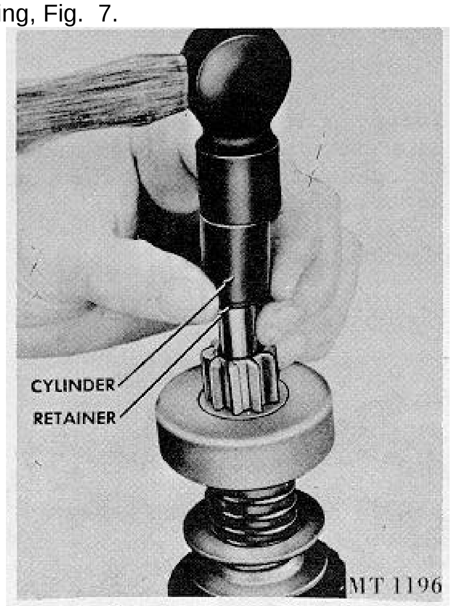


Fig. 7 Removing Retainer from Snap Ring

7. Remove the snap ring from the groove in the armature shaft.

8. Roll type clutches are designed to be services as a complete unit; therefore, do not disassemble. If the condition of the clutch assembly is questionable, replace it.

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 the proper spring tension (see specifications) 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, opens, 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, Fig. 8.

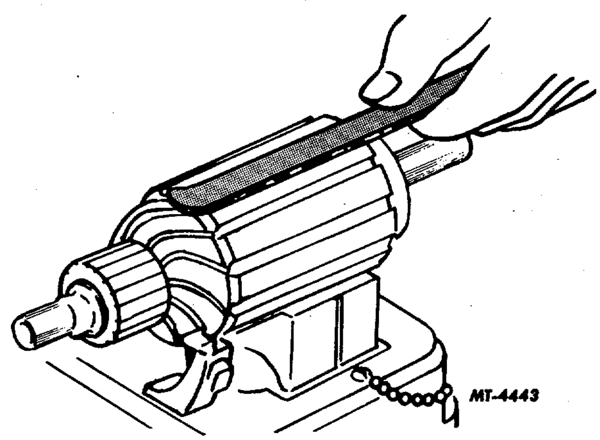


Fig. 8 Testing Armature for Short Circuits

   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, resoled 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, Fig. 9. 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.

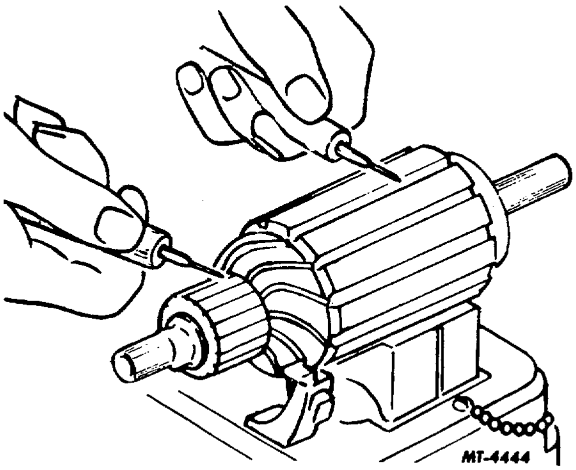


Fig. 9 Testing Armature for Grounds

If the commutator is worn, dirty, out-of-round or the insulation is high, the commutator should be turned down and under cut.

3. Field Coils: Check field coils for grounds 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 the coil leads, 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.

REASSEMBLY

1. Place the clutch assembly on the armature shaft.

2. To aid in reinstalling the snap ring and retainer on the armature shaft, proceed as follows.

   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. 10; then slide the ring down into the groove.

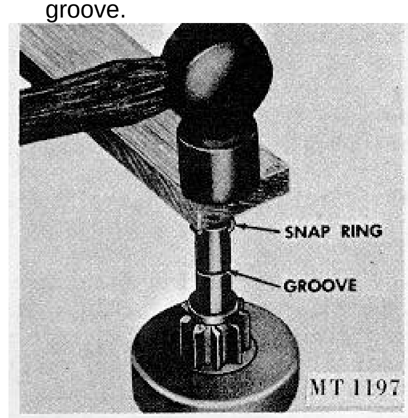


Fig. 10 Installing Snap Ring

   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. 11.

   d. Remove the washer.

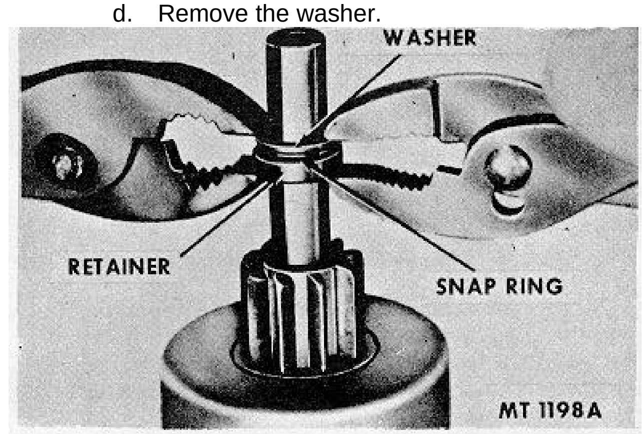


Fig. 11 Installation of Retainer And Thrust Collar

3. The remaining portion of the starting motor reassembly procedure is the reverse of the disassembly.

4. When installing the solenoid, apply sealing compound between field frame and solenoid flange.

PINION CLEARANCE

Pinion clearance should be inspected after reassembly of the motor to insure proper adjustment. Check pinion clearance following the steps listed below.

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. 12.

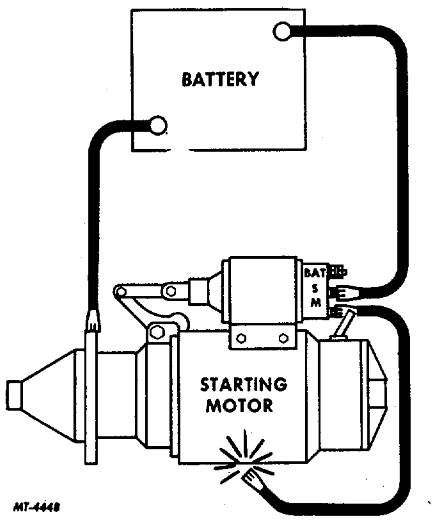


Fig. 12 Pinion Drive Clearance Check Hookup

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 remain until the battery is disconnected.

   CAUTION: Do not keep the jumper wire connected too long as overheating of the solenoid may result.

4. Push the pinion back towards commutator end to eliminate any overtravel. Then measure the distance between the pinion stop and pinion. The clearance should be .01 to .14, Fig. 13.

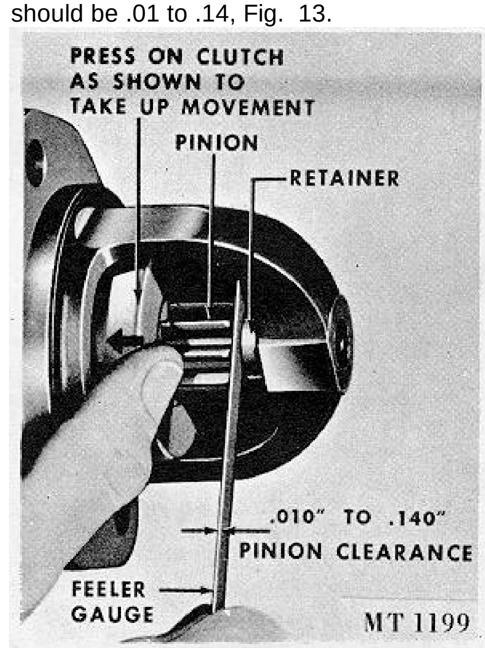


Fig. 13 Checking Pinion Clearance

There are no provisions for adjusting the pinion clearance on the enclosed shift lever type starting motors. Therefore, if the pinion clearance does not fall within the specified limits (.01 to .14), inspect the solenoid linkage or shift lever yoke buttons for excessive wear.

SPECIFICATIONS

Model Numbers	Type System (Voltage)	NO LOAD TEST				
		Volts	Minimum Amps. *	Maximum Amps. *	Minimum RPM	Maximum RPM
1107220	12	9	55	80	3500	6000
1107678	12	9	50	80	5500	10500
1107679	12	9	55	80	3500	6000
1107680	12	9	50	80	5500	10500
1107709	12	9	50	80	5500	10500
1107710	12	9	55	80	3500	6000
1107742	12	9	40	105	3500	6500
1108233	24	20	20	30	2250	2750
1108238	24	20	40	75	3300	5600
1108278	12	9	50	80	5500	10500
1108341	12	9	50	80	5500	10500
1108384	12	9	50	80	5500	10500
1108478	12	9	50	80	5500	10500
1108515	12	9	50	80	5500	10500
1108769	12	9	65	95	7500	10500
1109256	12	9	50	80	5500	9000
1109356	12	9	60	85	6800	10300
1109358	12	9	60	85	6800	10300
1109369	12	9	65	95	7500	10500
1109437	12	9	60	85	6800	10300

* Includes Solenoid

ELECTRICAL

LIGHTING SWITCHES

INDEX

LIGHTING SWITCH (LESS PROTECTION FUSE BUT EQUIPPED WITH A CIRCUIT BREAKER).

Description And Operation

The lighting switch illustrated in Figure 1 does not incorporate fuses in the switch assembly, but is protected by a circuit breaker.

When the lighting switch knob is pulled out to the first position, the parking lights, tail lights and instrument lights are on. When the lighting switch knob is pulled out to the last position, all lights are on.

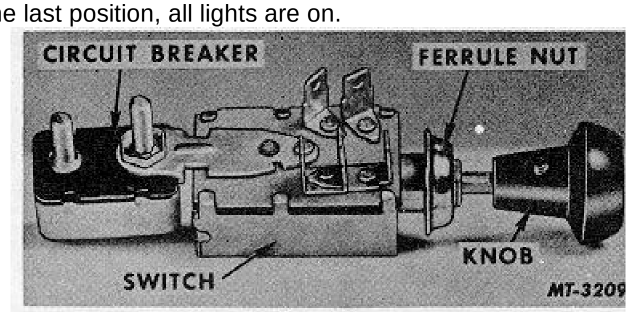


Fig. 1.

Removal

1. Pull light switch knob outward to headlight position.
2. Loosen Allen screw in knob and remove knob from shaft.
3. Remove furrule nut.
4. Disconnect all wires from the switch. Tag wires for proper installation.

LIGHTING SWITCH (LESS PROTECTION FUSE AND CIRCUIT BREAKER).

Description and Operation

This type lighting switch, Fig. 2, does not incorporate a circuit breaker or fuses as the lighting system is protected by a fuse panel.

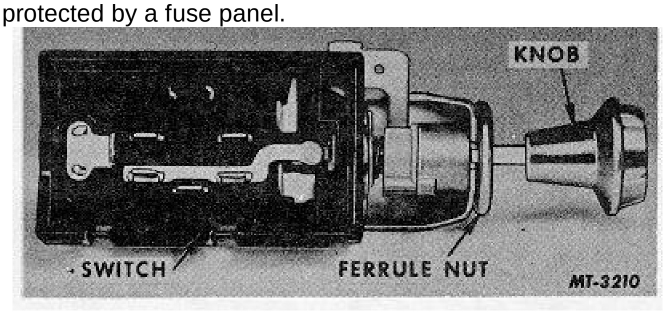


Fig. 2.

The lighting switch on the instrument panel controls the headlights, parking lights, instrument panel lights, cab interior light and tail lights. When the lighting switch is pulled out halfway, both parking and tail lights are "on". To light the instrument panel, turn the light switch control to the left; a built-in rheostat controls the intensity of the panel light from "off" to full "on". To turn the cab interior light on, turn the lighting switch control counterclockwise to the extreme left position.

Removal

1. Pull light switch outward to headlight position.
2. Depress shaft release button, Fig. 3, on switch body and pull knob and shaft out of switch body.
3. Remove ferrule nut by positioning a screw driver in the end, turn nut in a counterclockwise direction.
4. Disconnect all wires from the lighting switch and either tag them for correct installation or note the relation of each wire to its proper terminal.

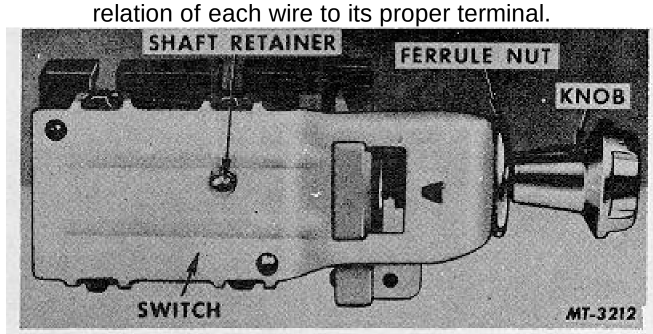


Fig. 3.

LIGHTING SWITCH (WITH PROTECTION FUSE AND CIRCUIT BREAKER).

Description and Operation

This type lighting switch, Fig. 4, incorporates 15 amperes dual thermal circuit breakers and a fuse to protect the entire lighting system. One circuit breaker protects the headlights and parking lights, while all other lights on the vehicle are directed through the remaining circuit breaker. In addition, the panel lights are also protected by a (4 amp) fuse. This type of circuit permits the use of the headlights to be retained if an overload or short develops in another part of the system. A current flow of more than 15 amperes will cause the points of this current limit relay to open and close as they warm and cool. Thus the current to the affected circuit is rapidly interrupted and restored until the short is located and corrected. Protection against destruction of the wiring is thereby provided and possible rapid discharge of the battery averted.

When the switch control knob is pulled out to the first position, an internal circuit is established to the switch terminals for the parking lights, instrument lights and taillights. When the knob is pulled out to the last position, a circuit is established to the switch terminals for the headlight s, instrument lights and tail lights. The current for the instrument lights passes through a rheostat which is regulated by the light switch knob. By turning the switch knob clockwise, the instrument lights can be dimmer or turned off completely. The cab interior light (except CO and VCQ models) may be turned on while retaining use of the instrument panel lights by rotating the lighting switch knob to the extreme counter clockwise position (through the detent or "click").

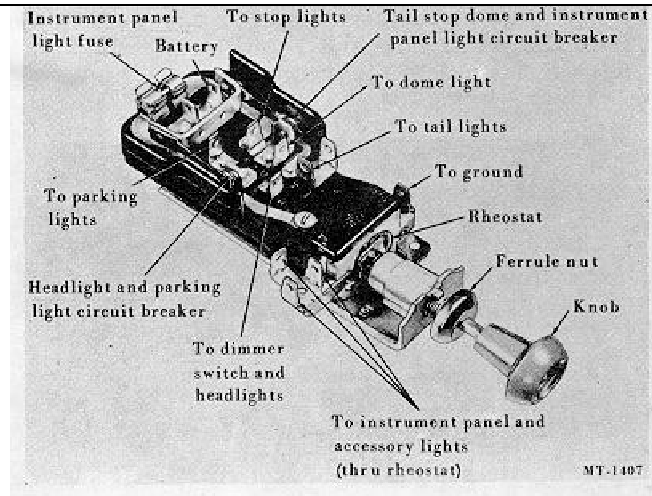


Fig. 4

<u>Removal</u>

1. Pull light switch knob outward to headlight position.
2. Depress shaft release button, on switch body and pull switch knob and shaft out of switch body.
3. Remove ferrule nut by positioning a screw driver in the end, turn nut in a counterclockwise direction.
4. Disconnect all wires from the lighting switch and either tag them for correct installation or note the relation of each wire to its proper terminal.

ENGINE

MODELS: MV---404, MV-446

CONTENTS

*For complete engine tune-up specifications and troubleshooting guide, refer to Emission Control Systems for Gasoline Engines Service Manual; 1976 CTS-2694, 1977 CTS-2721, 1978 CTS-2733 and 1979 CGES-135.

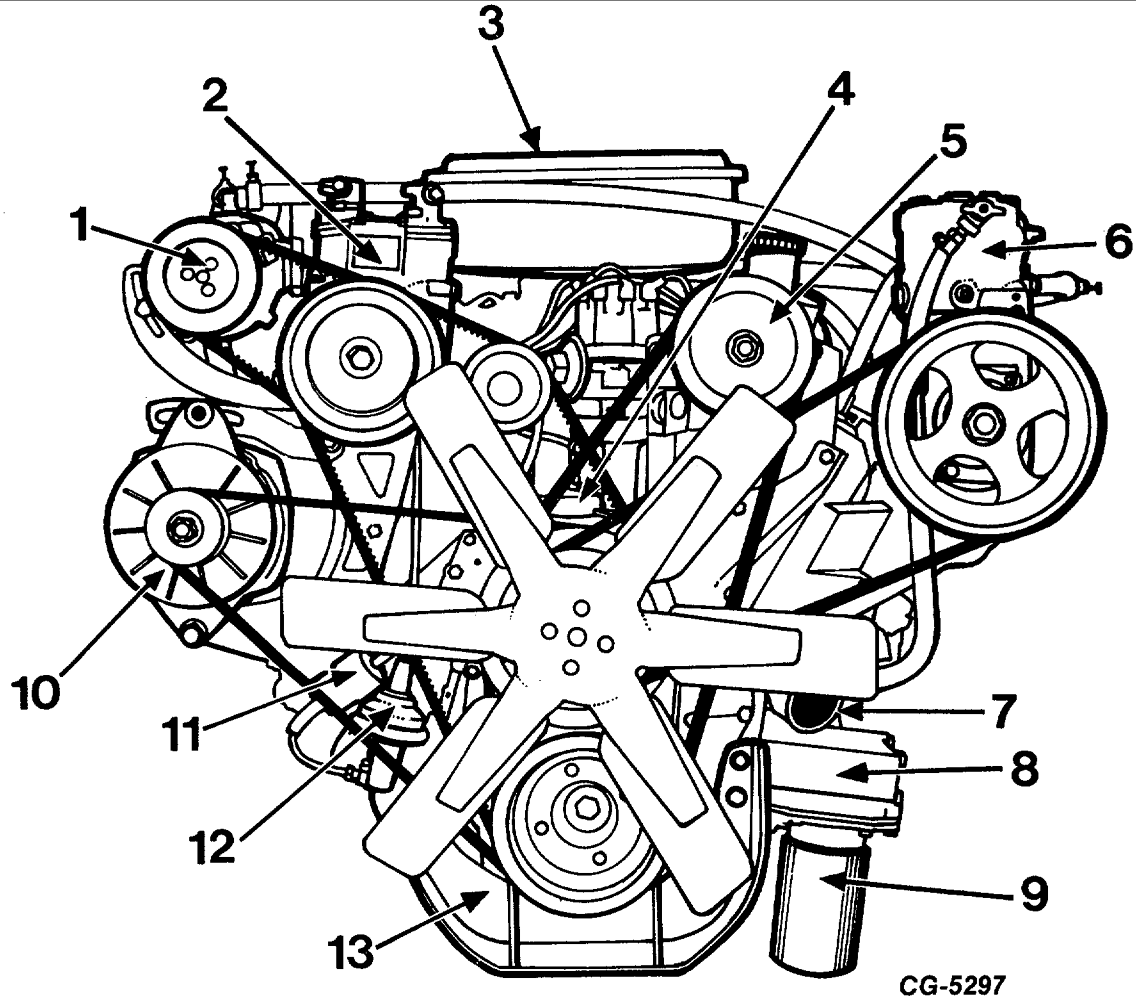


Fig. 1 Front View of Engine

1. Air pump
2. Freon compressor
3. Air cleaner
4. Engine water inlet
5. Power steering pump
6. Air compressor
7. Engine water outlet
8. Oil Cooler
9. Oil filter
10. Alternator
11. Gasoline filter
12. Fuel pump
13. Engine mounting bracket

ENGINE DESCRIPTION

The V-Series engines covered in this section are 8-cylinder, overhead valve, 900 type. Dimensional specifications of the various models are listed under "Specifications." Figures 1, 2 and 3 illustrate the complete engine assembly.

The basic unit of the engine, the cylinder block and upper crankcase, is cast in one piece and is of extremely rigid construction. It provides full-length water jackets surrounding each of the cylinders. This unit forms the major section of the engine as it is fitted with the crankshaft, camshaft, pistons and various related parts.

The forged alloy steel crankshaft is supported by five insert-type main bearings. Crankshaft end thrust is controlled by the flanges of the No. 3 main bearing.

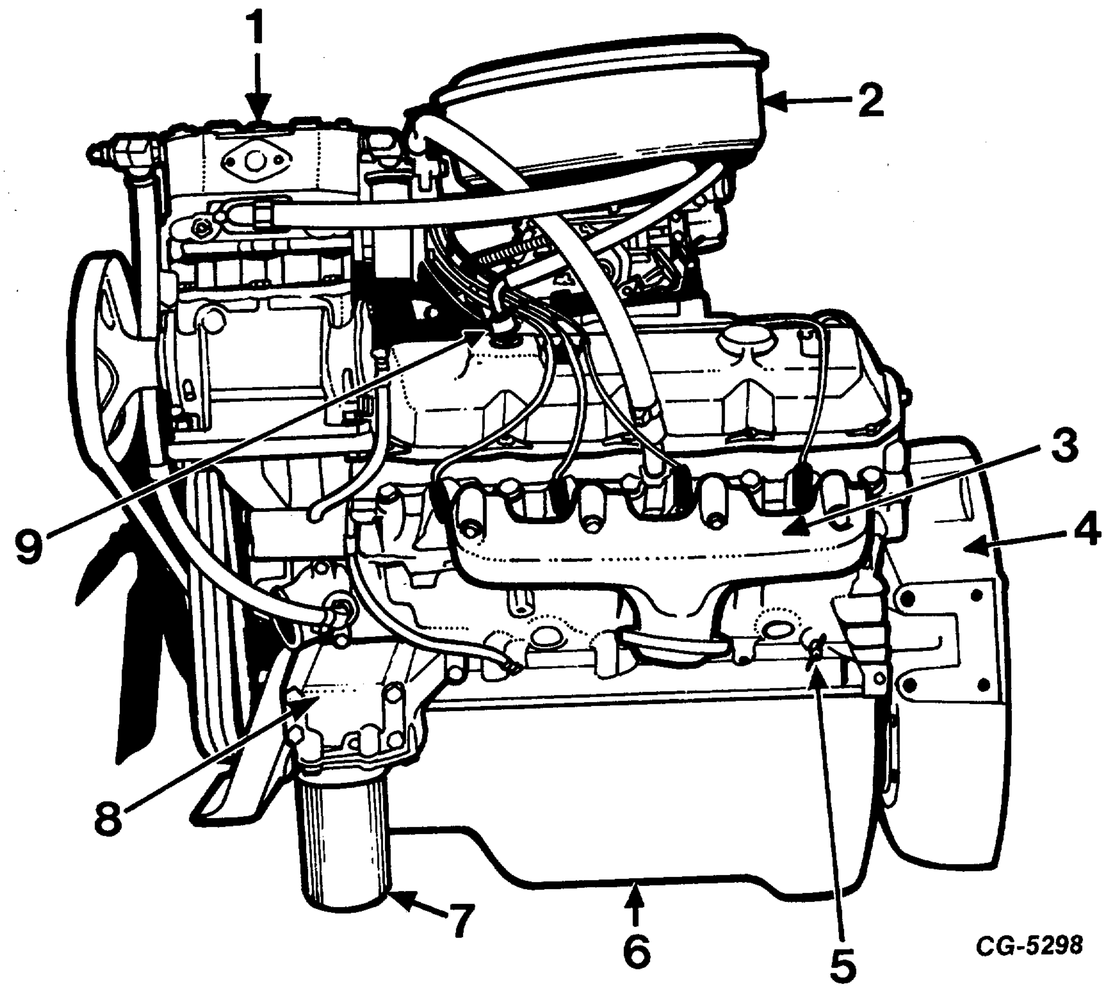


Fig. 2 Left Side View of Engine

1. Air compressor
2. Air cleaner
3. Exhaust manifold
4. Flywheel housing
5. Drain cock
6. Oil pan
7. Oil filter
8. Oil cooler
9. Flame arrestor

The camshaft is supported by five insert-type bearings pressed into the block and is driven by a drive gear keyed to the crankshaft. The end thrust of the camshaft is controlled by a thrust flange located between the front camshaft journal and the distributor drive gear.

The aluminum-alloy pistons are fitted with compression rings and an oil ring and are used in the engine with forged steel connecting rods. The full-floating type piston pins are held in place in the pistons at the ends of the pins by snap rings. The lower end of the connecting rod and cap contain locking type bearing inserts. The rods and caps are numbered for identification and reassembly.

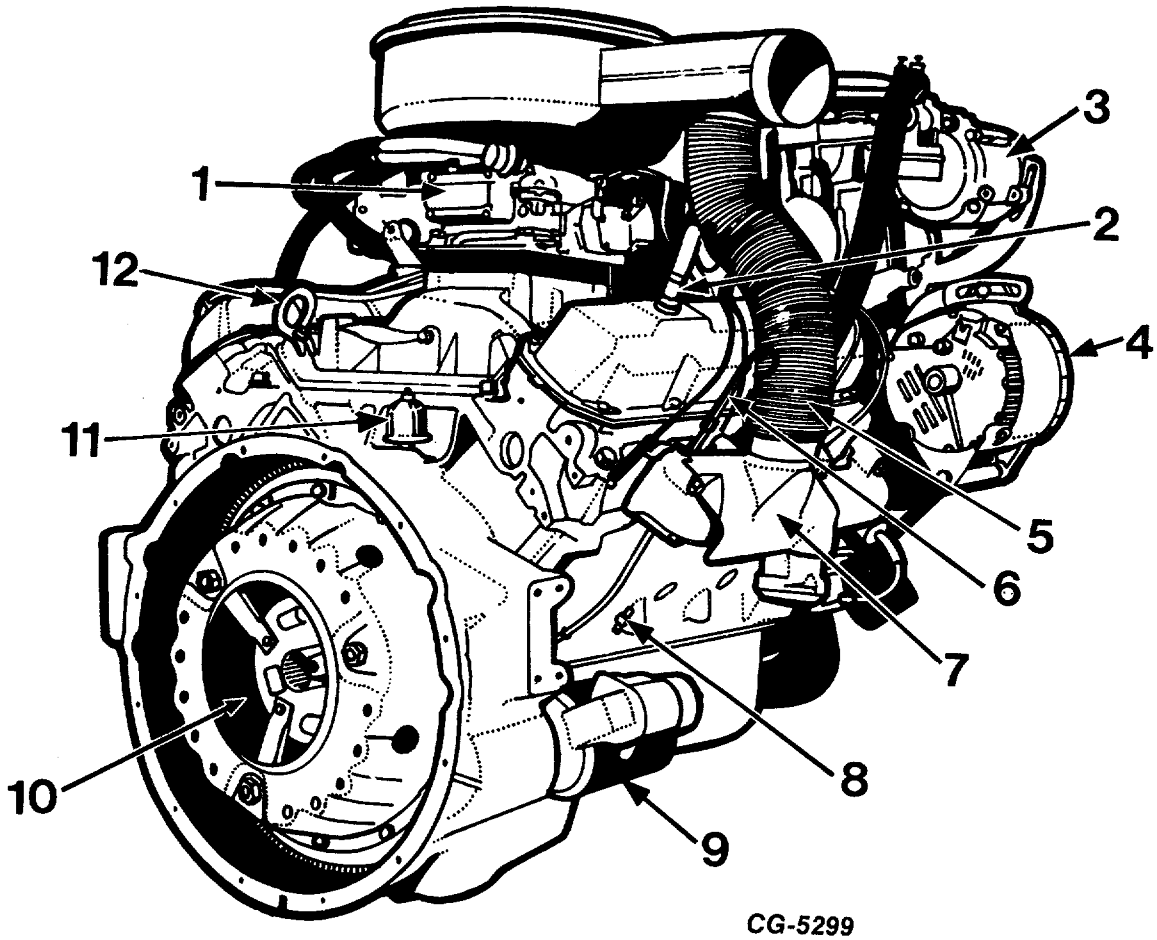


Fig. 3 Right Rear View of Engine

1. Carburetor
2. PCV valve
3. Air pump
4. Alternator
5. Shroud hose
6. Dipstick
7. Manifold shroud
8. Drain cock
9. Starting motor
10. Clutch
11. Oil pressure sending unit
12. Lifting eye

The hydraulic valve lifters minimize engine noise and maintain zero valve lash or tappet clearance. This eliminates the need for periodic adjustment.

The cylinder head assemblies feature a high turbulence-type of combustion chamber which provides superior combustion characteristics to produce very high volumetric and thermal efficiencies. The cylinder heads used on the engines are equipped with a positive valve rotating mechanism on the exhaust valve only. This device is called a "Roto Coil" and is located at the base of each exhaust valve spring. The cylinder heads also incorporate an integral air manifold.

Another important feature of the cylinder heads is that they are completely interchangeable from one cylinder bank to the other bank. The cylinder head gaskets are made of composition material which prevents compression leakage between the cylinder block and cylinder head. The gaskets also prevent leakage of water from the water jackets into the cylinders. The gaskets are also interchangeable from one bank to another.

When viewing the engine from the driver's seat, the cylinders on the left bank are numbered 2, 4, 6 and 8 with No. 2 being at the front. Similarly, the cylinders on the right bank are numbered

1, 3, 5 and 7 with No. 1 being at the front. The right and left sides of "V" engines with cylinders numbered in the foregoing manner are sometimes referred to as "even bank" and "odd bank." The "odd" or "even" refers to the numbers of the cylinders. For easy reference each cylinder number is cast on the intake manifold directly over its respective. cylinder. The firing order is 1-2-7-3-4-5-6-8. This information is also cast on the top surface of the intake manifold.

Two "V" type fan belts driven by a pulley on the crankshaft drive the water pump-fan combination and alternator while another "V" type belt driven by the water pump pulley drives the air compressor.

The water pump is mounted on the front of the engine and supplies both cylinder banks. The alternator is mounted on the right side of the engine with an adjustable strap to set the proper belt tension.

A gear-type oil pump is internally mounted to the bottom of the crankcase and is driven by a tang on the end of the distributor shaft. The distributor, mounted in the front end of the cylinder block assembly, is gear driven directly by the camshaft resulting in reduced spark fanning.

NOTE: When timing the engine, attach the timing light to the No. 1 spark plug and adjust distributor to obtain proper initial timing; see specifications and Figure 4.

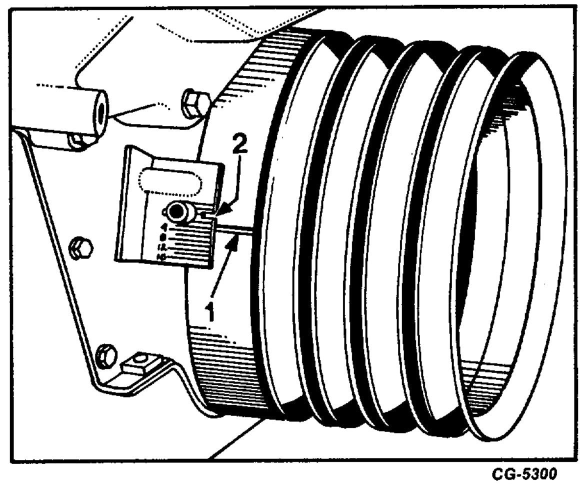


Fig. 4 Illustrating Timing Marks on Crankshaft Pulley Hub and Engine Front Cover

1. Timing mark
2. T.D.C.

ENGINE LUBRICATION SYSTEM

The oil pump is located in the left front corner of the oil pan. The pump is driven from an extension on the distributor which is gear driven from the camshaft. It draws oil from the oil pan sump through a screen and tube assembly. The oil pump contains an internal bypass set at 50 psig. The oil is filtered only, or cooled and filtered, before entering the crankcase. Filter and cooler contain bypass systems which allow oil to bypass them in the event that either or both become plugged.

From the filter, oil feeds the main oil gallery which is cross-drilled five places. The cross-drilling intersects vertical drilling which feeds the main bearings and camshaft bearings. The front cross-drilling intersects two additional vertical drillings to provide full-main oil gallery pressure to the individual tappet gallery. Oil is metered through the tappets, up the push rods, across the rocker arms and onto the valve tips. A front cam shaft thrust plate meters oil forward to lubricate the camshaft drive gear, distributor gear and fuel pump cam. Oil returns to the oil pan through drilled holes at the front and rear of the cylinder head. These holes match with holes in the crankcase to provide passage through the crankcase into the oil pan.

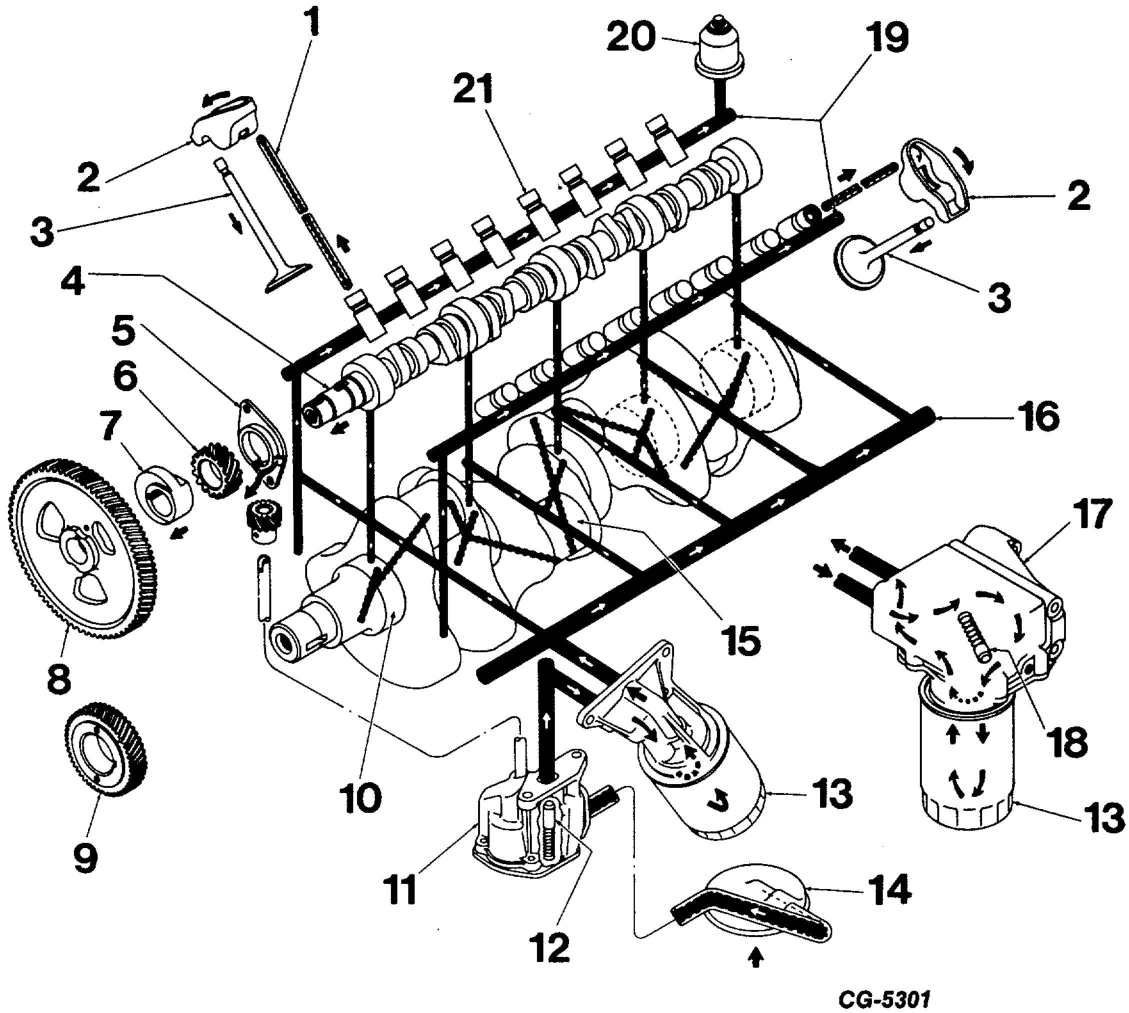


Fig. 5 Diagrammatic View of Lubricating System

1. Push rod
2. Rocker arm
3. Valve
4. Camshaft
5. Camshaft thrust flange
6. Distributor drive gear
7. Fuel pump cam
8. Camshaft gear
9. Crankshaft gear
10. Main Bearing
11. Oil pump
12. Pressure control valve
13. Oil filter
14. Oil pump float
15. Connecting rod bearings
16. Main oil gallery
17. Oil cooler
18. Cooler by-pass valve
19. Valve lifter (tappet) oil gallery
20. Oil pressure sender unit
21. Hydraulic valve lifter (tappet)

ENGINE LUBRICATION PRIMING

When assembling the overhauled engine, it is necessary to thoroughly lubricate the various running parts with clean engine oil to assure initial lubrication when engine is first started. However, to further make certain that complete initial lubrication is available, the engine lubricating system should be pressure primed or charged with oil. The oil leak detector, SE-1632, can be used for this purpose. Attach the line from the oil leak detector to a suitable fitting such as the main oil gallery plug located on the left side of the crankcase. Inject sufficient oil into the engine to fill the oil filter and charge the entire system. Use only clean engine oil of the grade to be used for engine break-in. New or overhauled engines that have been in storage over an extended period should also be primed in a similar manner. In addition to priming engines that have been stored, the engines should be turned over a few times while being primed.

NOTE: Disconnect the coil primary wire when performing this operation to prevent the engine from starting.

When the priming procedure is used, make certain the oil level is checked before the engine is put into service. Caution should be taken so as not to overfill or have insufficient oil as a result of using the pressure priming procedure.

Priming the engine will minimize the possibility of scuffing or heat buildup in the areas of friction, which could lead to immediate or eventual failures.

OIL FILTER (Spin-On Type)

Replace the oil filter by using the following procedure:

1. Remove oil filter assembly by turning counterclockwise with the hands or a suitable tool. Clean the filter mounting pad.
2. Coat the gasket on the new filter with a film of grease.
3. Place the new filter in position on the center tube. Hand tighten 1/2 to 3/4 turn after the gasket first contacts the base of the mounting pad.
4. Start engine and run for at least five minutes to warm oil and check for leaks. Also check engine oil level.

ENGINE MOUNTINGS

Engine mountings may vary between vehicle models. The mountings illustrated are both of the two-piece insulator type.

Front Mountings

The engine front mounting shown in Figure 6 utilizes a two-piece insulator with sleeves. When assembling, position component parts as shown and tighten hex head bolt to 75 to 85 ft. lbs.

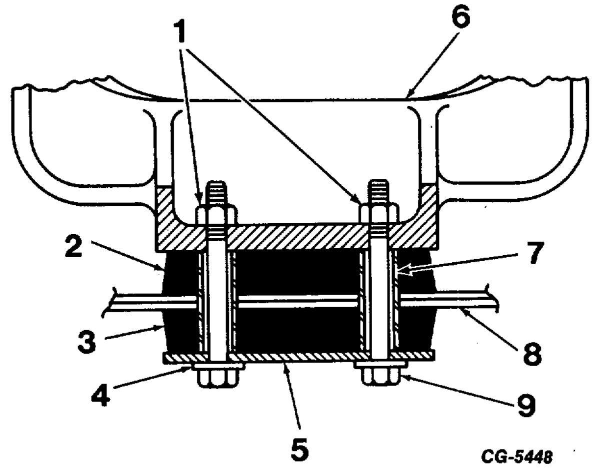


Fig. 6 Engine Front Mounting with Two-Piece Insulator

1. Tighten to 75 - 85 ft. lbs. torque (threads lubricated)
2. Insulator- upper
3. Insulator - lower
4. Hardened washer
5. Retainer
6. Engine mounting bracket
7. Sleeve
8. Crossmember
9. Bolt

Rear Mountings

The engine rear mountings shown in Figure 7 also utilizes a two-piece insulator. When assembling, position component parts as shown and tighten nuts to 160 to 175 ft. lbs.

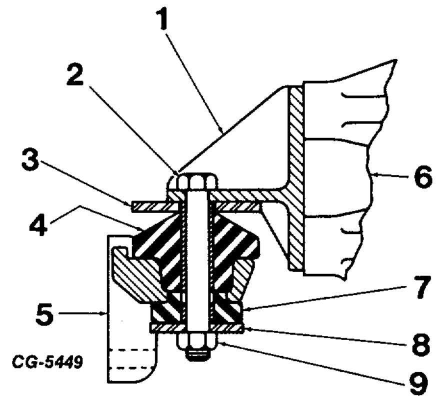


Fig. 7 Engine Rear Mounting with Two-Piece Insulator

1. Bracket
2. Bolt-torque to 160-175 ft. lbs.
3. Washer
4. Upper insulator
5. Bracket to frame rail
6. Flywheel housing
7. Lower insulator
8. Washer
9. Locknut

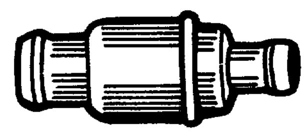
CRANKCASE VENTILATION SYSTEM

The purpose of this system is to prevent crankcase vapors from entering the atmosphere by drawing the vapors into the intake manifold and burning them with the normal fuel mixture. The system utilizes the vacuum created in the intake manifold to draw clean air through the crankcase and valve chamber. Fresh air enters the cylinder head cover through the flame arrestor by route of the connecting hose from the air cleaner. The flame arrestor must be serviced at intervals according to the "Operator's Manual."

The crankcase ventilator valve, Figure 8 located in the right cylinder head cover varies the air flow through the crankcase to meet changing conditions at all engine speeds and loads. The system will work effectively as long as all component parts are clean and free from sludge and foreign material.

The valve should be serviced and the system inspected and cleaned at intervals set forth in the "Operator's Manual." It may be necessary to inspect and clean the system more frequently under adverse driving or weather conditions.

To check the operation of the system, first remove the valve from the cylinder head cover; then with the engine operating, a vacuum should be felt at the end of the valve. If no vacuum is present, the valve, hose and fitting should be removed and cause of the restriction determined. The inner chamber of the valve should be checked by inserting a stiff wire into the valve body to see that it can be moved freely. Upon reinstallation, the crankcase ventilation valve should be installed as indicated on the valve by an arrow.



CG-5450

Fig. 8 Crankcase Ventilator Valve of One-Piece Construction

The oil filter cap is non-vented, and therefore, requires no service.

ENGINE REMOVAL

Engine removal procedures will vary between vehicle models and also between individual chassis because of various equipment and accessories. The following outline covers, in general, the engine disconnect points and lifting instructions.

Preliminary Instructions

1. Remove front bumper, if equipped with steel hood.
2. Raise hood.
3. Disconnect battery cable from battery.
4. Drain radiator and engine block. See Figures 2 & 3 for location of engine coolant drain cocks.
5. Drain oil from engine oil pan.
6. Remove hood assembly.
7. Disconnect shutter cylinder air line, if so equipped.
8. Disconnect radiator hoses.
9. Remove radiator support and core assembly (fiberglass hood only). If equipped with steel hood, disconnect headlamp, etc., wiring at cowl and remove radiator support and core assembly with fenders and splash panels as an assembly.

10. Remove air cleaner.
11. Disconnect heater hoses.
12. Disconnect wires from alternator, coil, distributor, heat sender unit and oil sender unit.
13. Remove engine ground strap.
14. Remove choke and throttle wire.
15. Disconnect tachometer cable, if so equipped.
16. Remove accelerator linkage at carburetor.
17. Remove fuel line at fuel pump.
18. Disconnect exhaust pipe at manifold.
19. Disconnect wires at starting motor.
20. Disconnect canister vent and purge lines at carburetor, if so equipped.
21. Disconnect the freon compressor wire at connector.
22. Remove the freon compressor lines at compressor.
23. On chassis equipped with air brakes, disconnect the main air supply line and the flexible air line at the compressor.
24. On chassis equipped with hydraulic brakes having a hydrovac, disconnect the vacuum air cleaner hose at rear of intake manifold.
25. Install lifting sling, Figure 9.
26. Connect hoist to lifting sling.
27. Place a support under the transmission.
28. Remove the 12 bolts securing the bell housing to flywheel housing.
29. Remove the engine front mounting bolts and insulators.
30. Remove the engine rear mounting bolts and insulators.
31. The engine must be pulled forward to clear the transmission main drive gear and clutch driven disc; then, raise and lift out of chassis.

NOTE: Extreme care must be exercised during removal of the power plant to avoid damage to the clutch driven disc and wiring harness.

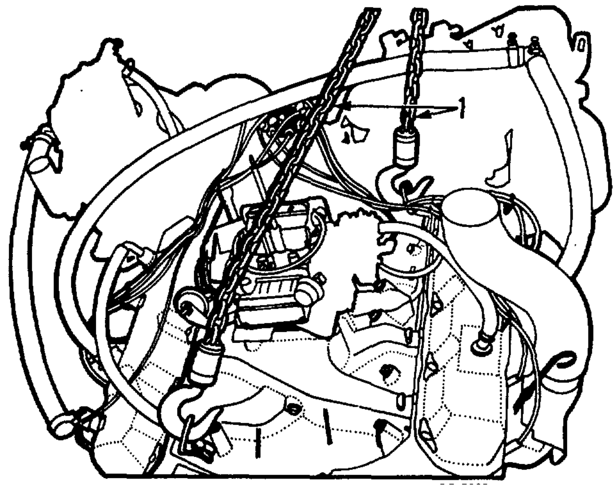


Fig. 9 Engine Lifting Sling

1. Lifting sling

ENGINE INSTALLATION

Prior to installation check to be sure that all lines, cables and parts are installed on the engine assembly that were connected to and removed with the engine If maintenance was performed, be sure all adjustments affected are made correctly. If any components of the engine were removed and installed, check all connections and related parts to insure the installations were accomplished correctly.

In general, the installation of the engine is performed in the reverse order of the removal. When positioning the engine in the chassis, special care must be exercised during installation to avoid pinching of the wiring harness between the engine and frame assembly.

Lower the engine to align the transmission main drive gear spline with the clutch driven disc. The weight of the engine assembly must be supported until the twelve bolts securing the bell housing are installed Connect the wiring harness, lines and linkages that were disconnected during removal.

Install the radiator assembly and shroud and connect the upper and lower radiator hoses on the conventional chassis.

On conventional chassis, install the front end sheet metal and stay rods.

Install the hood assembly

Connect the battery ground strap and fill the cooling system to the specified level. Fill the engine crankcase with specified engine oil to the proper level. Refer to the Operator's Manual for this information. However, if equipped to prime the lubricating system, refer to "Lubrication System Priming" and follow the procedure described.

Check accessory and pulley drive belts and adjust if necessary.

Start engine and operate all controls through their full range to check for proper adjustment.

Inspect all hose connections for coolant leaks and air connections for air leaks.

ENGINE DISASSEMBLY

Install the engine in the SE-1962 Overhaul Stand with mounting plate, Figure 10.

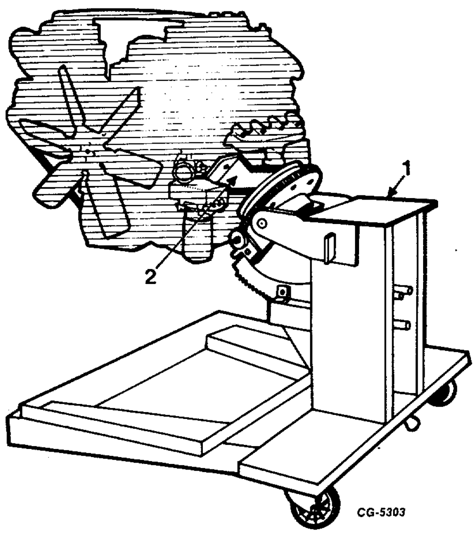


Fig. 10 Engine Installed in SE-1962 Overhaul Stand With Mounting Plate

1. Engine stand
2. Mounting plate

NOTE: Use of this overhaul stand permits raising or lowering (vertical to horizontal position) the engine as required to permit rotating the engine 360° and is held securely in any of the eight positions provided. However, before engine rotation is performed, it is recommended the engine be stripped of as many components as possible to eliminate excessive weight and provide clearance. The engine can be raised in a vertical position over the pedestal of the stand and the pin released and crankcase rotated and locked in any one of the eight positions.

1. Make sure all oil and water have been drained from the cylinder block.

2. Remove fan blade with spacer and front engine mount.

3. Disconnect water inlet, water outlet, air inlet and oil feed lines from air compressor, Figure 11.

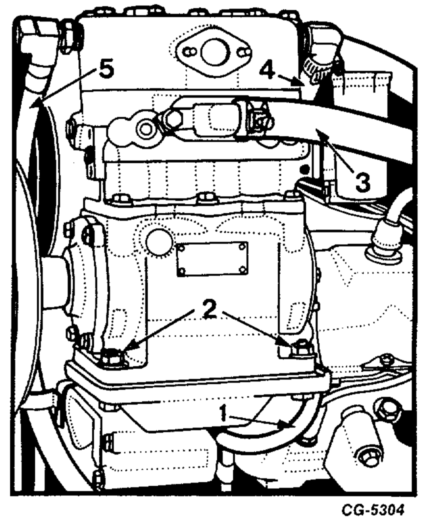


Fig. 11 Air Compressor Removal

1. Oil feed line
2. Nuts
3. Air inlet line
4. Water inlet line
5. Water return line

4. Loosen four nuts on bracket and slide compressor inward, Figure 11. Remove V-belt and water pump front pulley.

5. Remove nuts, bolts and flat washers from bracket and remove air compressor with gasket. Remove water inlet and outlet hoses.

6. Remove bolts and lockwashers securing air compressor bracket to the engine, Figure 12. Remove bracket with "O" ring.

7. Loosen alternator adjusting strap bolt and mounting bolt, Figure 13. Remove two V-belts.

8. Remove alternator adjusting strap bolt and mounting bolt with flat washers. Remove alternator from bracket.

9. Remove alternator bracket and adjusting bracket by removing bolts and flat washers, Figure 14.

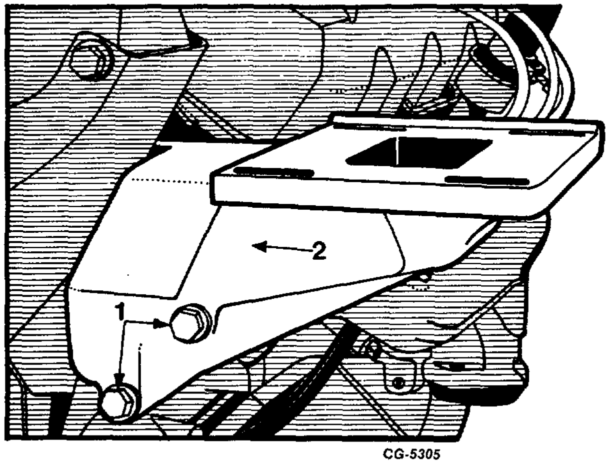


Fig. 12 Removing Air Compressor Bracket

1. Bolts
2. Bracket

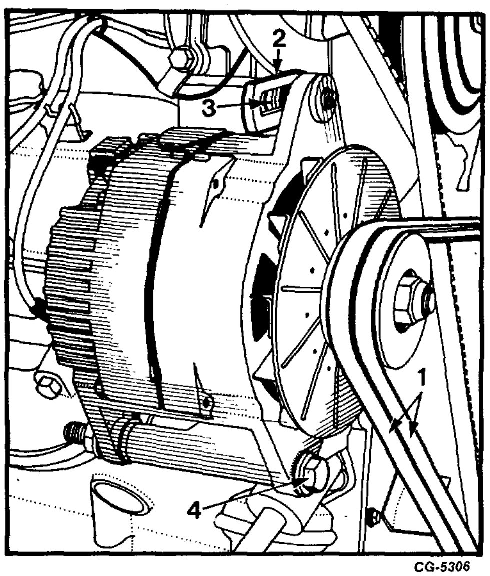


Fig. 13 Removing Alternator V-Belts

1. V-belts
2. Adjusting strap
3. Bolts
4. Mounting bolt

10. Loosen bolts on freon compressor idler pulley and remove V-belt, Figure 15. Remove bolts and remove idler pulley.

11. Remove hoses to left and right cylinder head check valves from the air pump, if so equipped. Remove air pump adjusting strap bolt and flat washer and air pump mounting bracket bolt, nut and flat washer, Figure 16 Remove air pump.

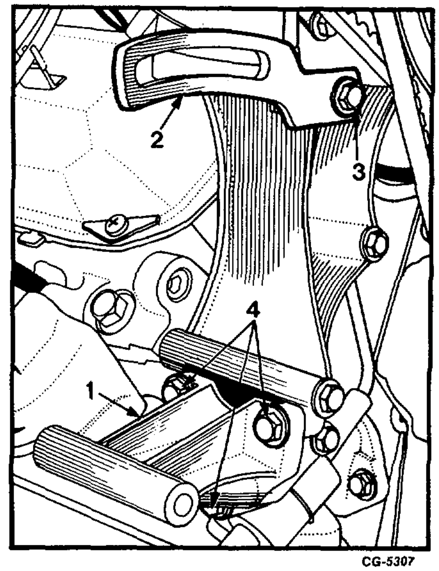


Fig. 14 Removing Alternator Brackets

1. Bracket
2. Adjusting Strap
3. Bolt
4. Bolts

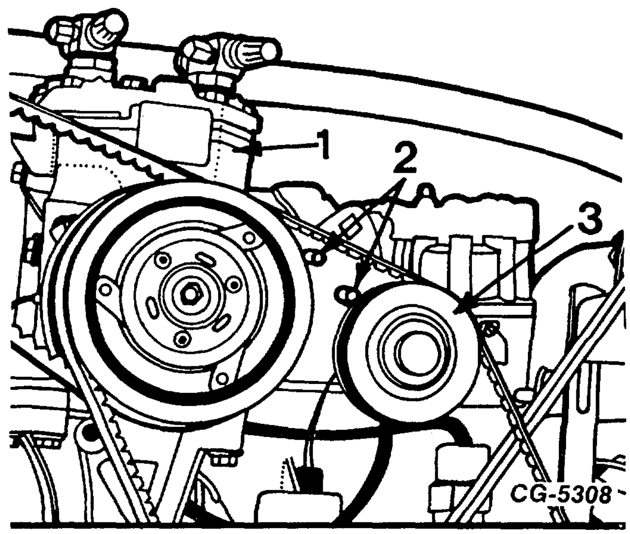


Fig. 15 Removing Freon Compressor V-Belt

1. Freon compressor
2. Bolts
3. Idler Pulley

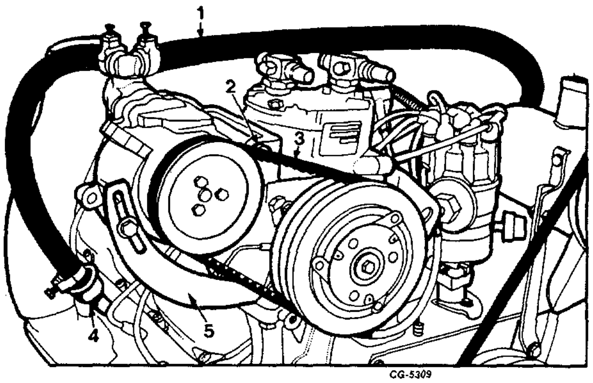


Fig. 16 Air Pump Removal

1. Hose to left head check valve
2. Mounting bolt
3. V-belt
4. Right head check valve
5. Adjusting strap

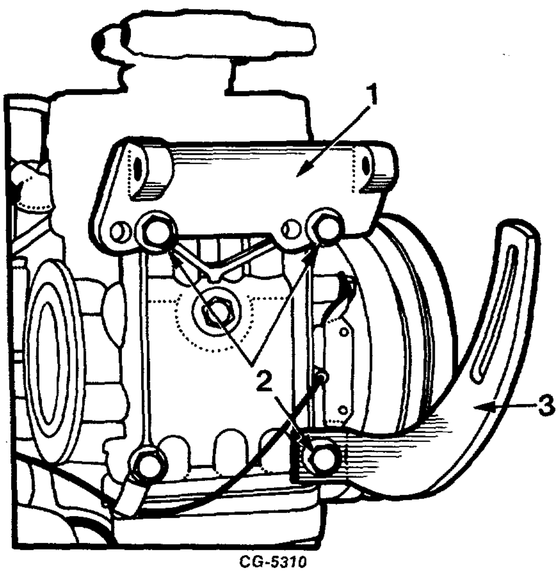


Fig. 17 Removing Air Pump Brackets

1. Bracket
2. Bolts
3. Adjusting Strap

12. Remove air pump mounting brackets by removing bolts and flat washers Remove adjusting strap and spacer by removing bolt and flat washer, Figure 17.

13. Remove idler pulley bracket from freon compressor by removing bolts and flat washers, Figure 18.

NOTE: Bottom bolts have two hardened flat washers each.

14. Remove shroud hose from exhaust manifold, Figure 18.

15. Remove freon compressor from bracket by removing four bolts and lockwashers, Figure 19.

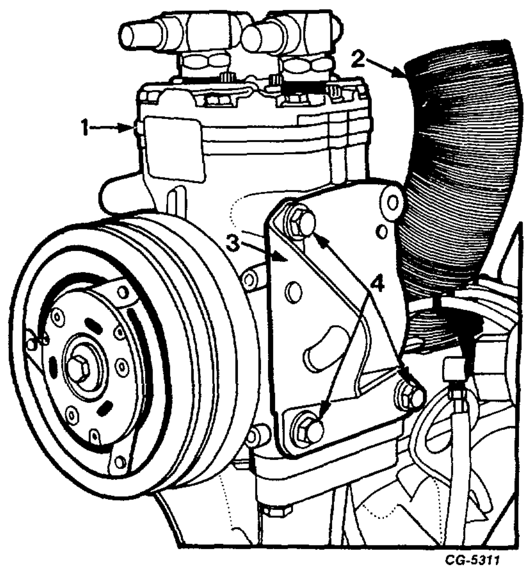


Fig. 18 Removing Freon Compressor Idler Pulley Bracket

1. Freon compressor
2. Shroud hose
3. Bracket
4. Bolts

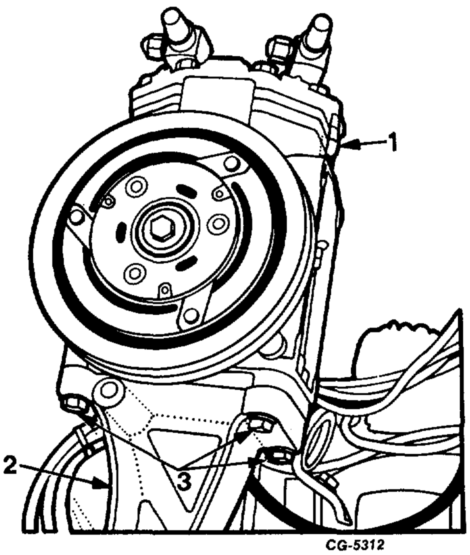


Fig. 19 Freon Compressor Removal

1. Freon compressor
2. Bracket
3. Bolts

16. Remove freon compressor bracket, Figure 20.

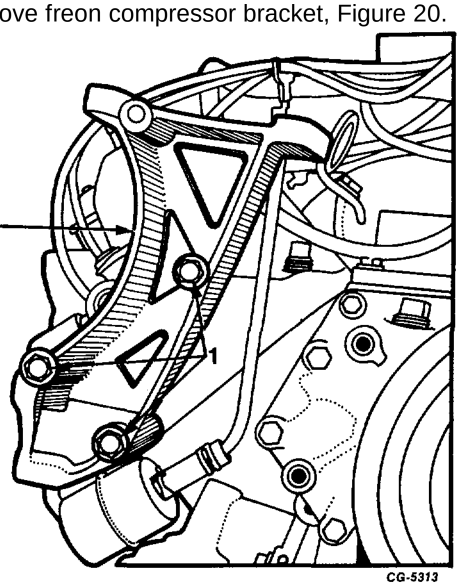


Fig. 20 Freon Compressor Bracket Removal

1. Bolts
2. Bracket

17. Loosen power steering adjusting strap bolt and two bracket bolts to facilitate removing V-belt, Figure 21.

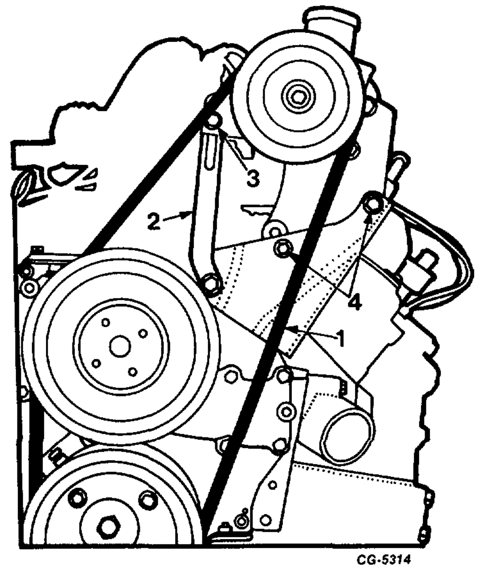


Fig. 21 Removing Power Steering V-Belt

1. V-Belt
2. Adjusting strap
3. Bolt
4. Bolts

18. Remove power steering pump pulley mounting bolt and flat washers, Figure 22

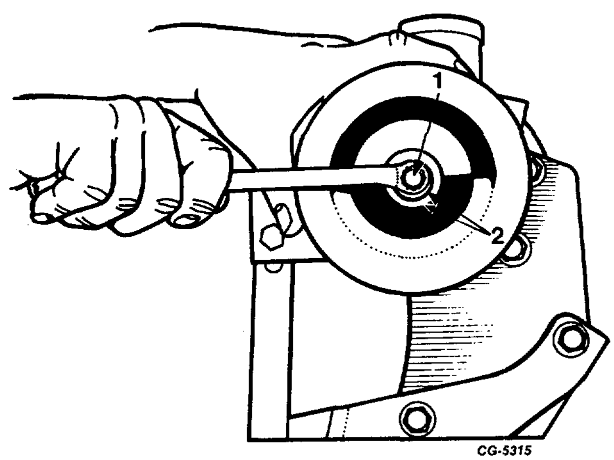


Fig. 22 Removing Power Steering Pump Pulley Bolt

1. Mounting Bolt
2. Flatwashers

19. Use SE-2420 Puller and wrench to remove power steering pulley, Figure 23.

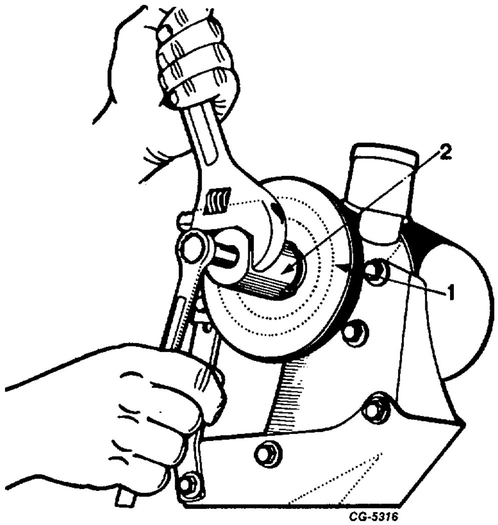


Fig. 23 Using SE-2420 Puller to Remove Power Steering Pump Pulley

1. Pulley
2. Puller

20. Remove bolts and flat washers securing power steering pump to bracket, Figure 24. Remove adjusting strap bolt and remove power steering pump with side bracket.

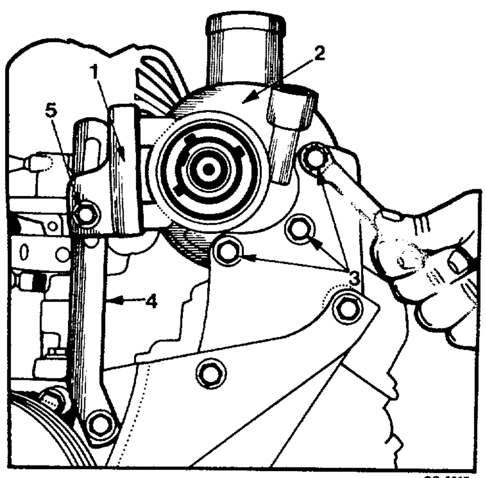


Fig. 24 Removing Power Steering Pump

1. Side bracket
2. Pump
3. Bolts
4. Adjusting Strap
5. Adjusting Bolt

21. Remove power steering bracket with adjusting strap, Figure 25.

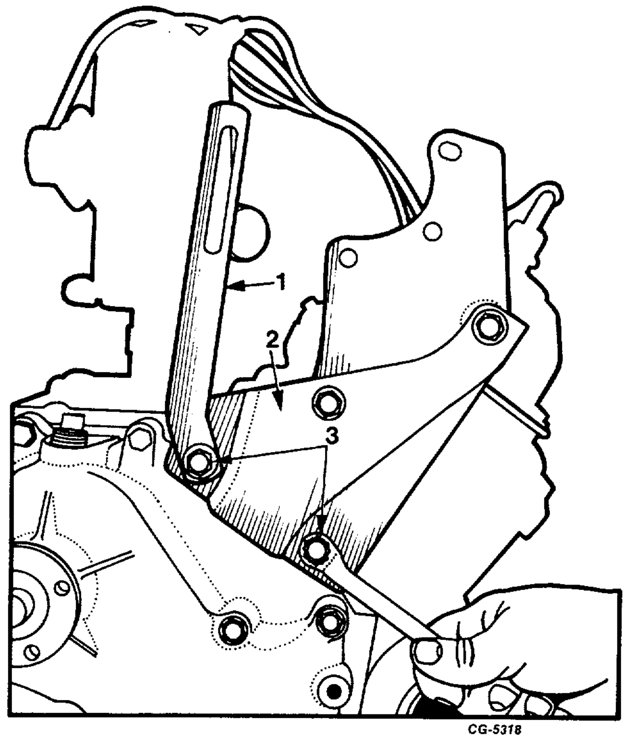


Fig. 25 Removing Power Steering Bracket and Strap

1. Adjusting strap
2. Bracket
3. Bolts

22. Remove starting motor bolts and lockwashers, Figure 26. Remove starting motor.

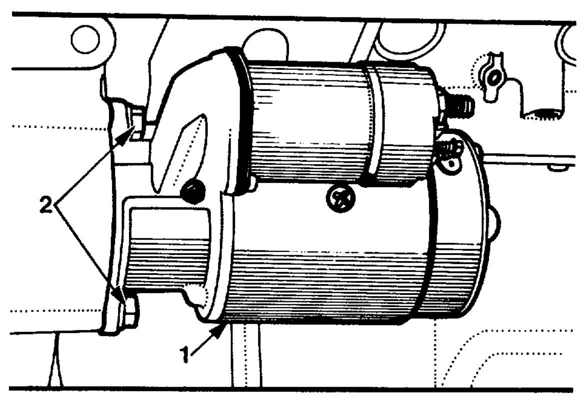


Fig. 26 Starting Motor Removal

1. Starting motor
2. Bolts

23. Remove bolts and flat washers securing oil filter and cooler (if so equipped) to the crankcase, Figure 27. Remove oil filter, cooler and gasket.

NOTE: If the vehicle is not equipped with an oil cooler, the filter and filter base may be removed by removing three bolts and flat washers.

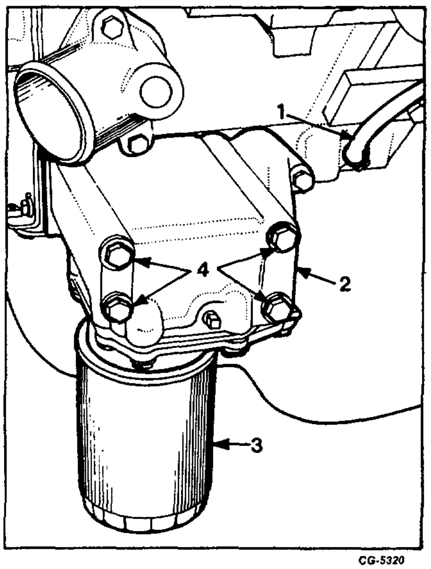


Fig. 27 Oil Cooler and Filter Removal

1. Oil feed to air compressor
2. Oil cooler
3. Oil filter
4. Mounting bolts

24. Remove oil feed line to air compressor, Figure 27.

25. Remove low temperature vacuum control valve, exhaust gas recirculating valve, gasket and hoses, if so equipped. Cap or plug all openings.

26. Disconnect the distributor high tension wires at the coil and spark plugs. Always grasp spark plug boat and use a twisting motion when removing spark plug cables so as not to destroy resistance wire termination. Remove the wires with the slideout brackets on both cylinder head covers and remove the distributor cap and wires as an assembly, Figure 28.

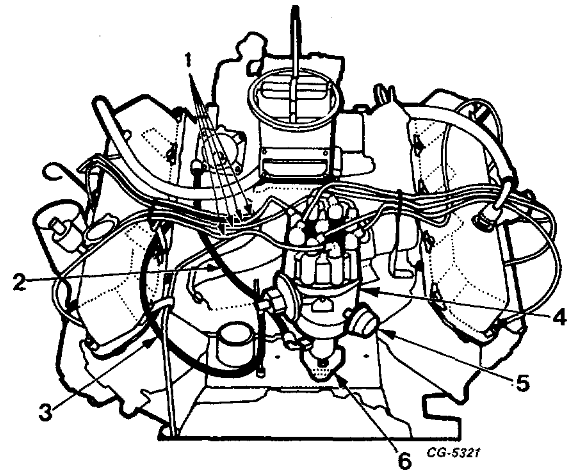


Fig. 28 Distributor and Wiring Removal

1. High tension wires
2. Governor line
3. Vacuum line
4. Distributor
5. Filter
6. Hold down bracket

27. Loosen the distributor hold-down bolt at the crankcase, Figure 28. Disconnect the vacuum line and governor line at the carburetor. Remove the distributor, governor line, vacuum line and "O" - ring.

28. Remove carburetor return spring and bracket from intake manifold, Figure 29.

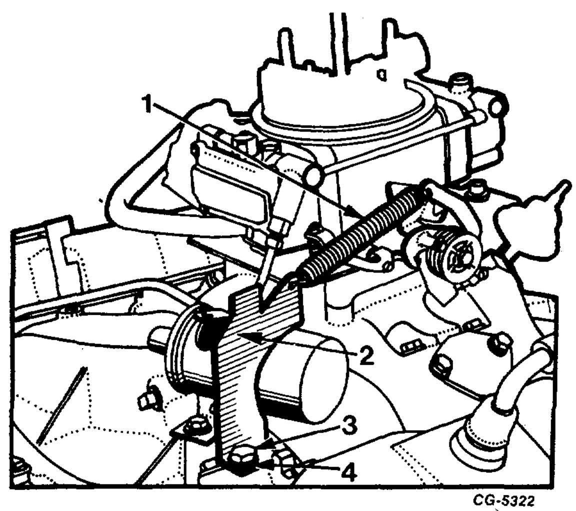


Fig. 29 Removing Return Spring and Bracket

1. Return spring
2. Bracket
3. Bolt
4. Lockwasher

29. Remove coil and bracket from intake manifold, Figure 30. Also, remove flame arrestor and hose from left cylinder head cover.

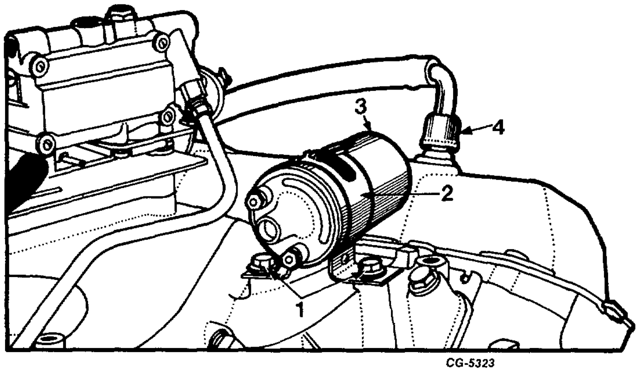


Fig. 30 Coil Removal

1. Mounting bolts
2. Bracket
3. Coil
4. Flame arrestor

30. Remove fuel line with bracket, reinforcement washer and fuel filter, Figure 31. Remove PCV valve and hose.

NOTE: Cap or plug all openings or fittings.

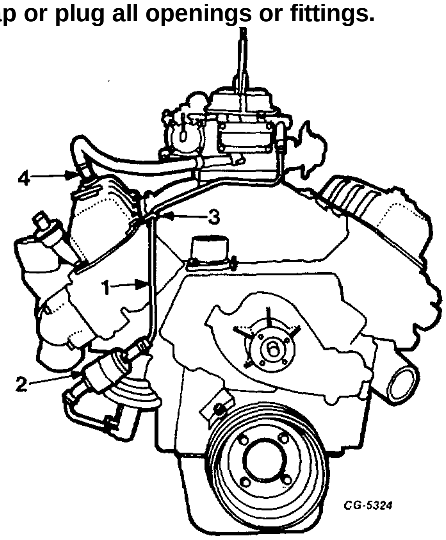


Fig. 31 Fuel Line Removal

1. Fuel line
2. Filter
3. Bracket
4. PCV valve

31. Remove carburetor nuts and washers, Figure 32 Remove carburetor, two gaskets and spacer plate

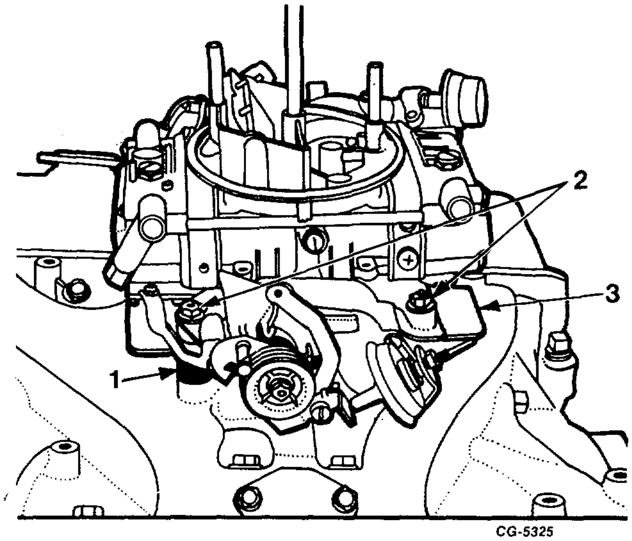


Fig. 32 Removing Carburetor

1. Spacer
2. Nuts
3. Gasket

32. Remove bolts and hardened washers securing fuel pump to the crankcase, Figure 33 Remove fuel pump and gasket

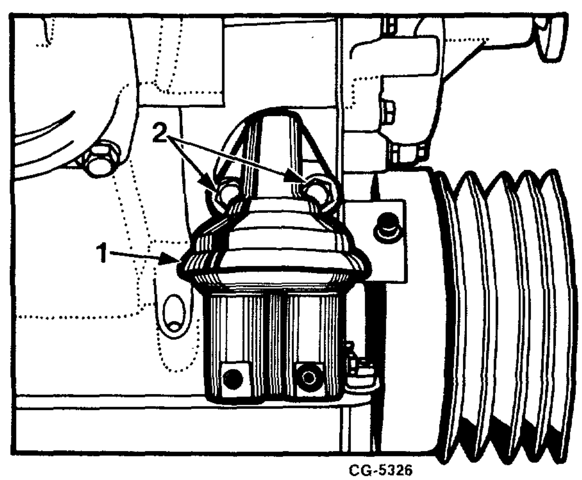


Fig. 33 Fuel Pump Removal

1. Fuel pump
2. Bolts

33. Remove two bolts and flat washers from engine water outlet, Figure 34. Remove engine water outlet, thermostat and gasket from engine.

34. Remove water temperature sender unit Figure 34.

35. Remove water inlet housing and gasket by removing bolts and washers securing them to the crankcase, Figure 35.

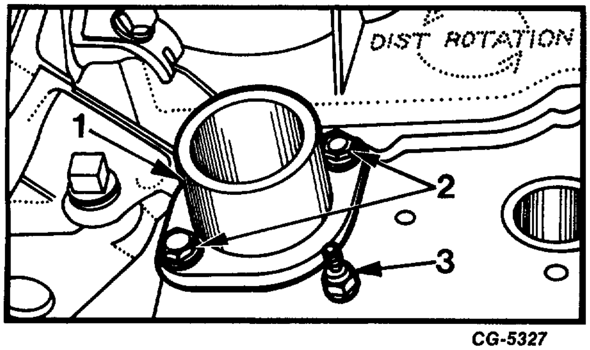


Fig. 34 Thermostat and Sender Unit Removal

1. Engine water outlet
2. Bolts
3. Water temp. sender unit

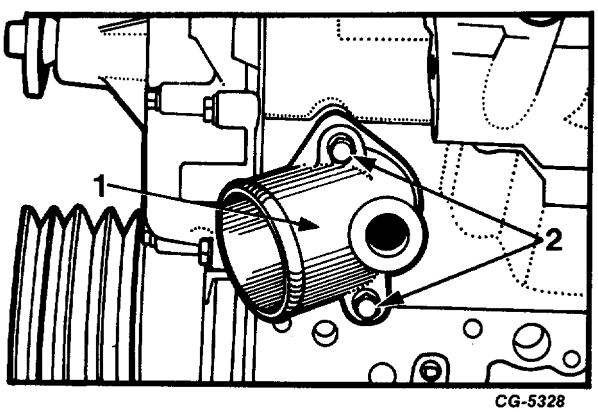


Fig. 35. Water Inlet Housing Removal

1. Water inlet housing
2. Bolts

36. Remove twelve mounting bolts and flat washers securing intake manifold to cylinder heads, Figure 36 Remove intake manifold.

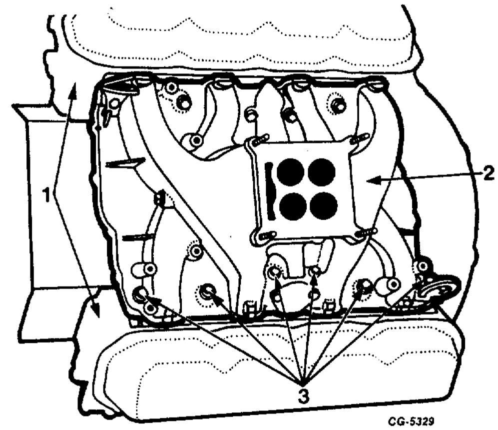


Fig. 36 Intake Manifold Removal

1. Cylinder heads
2. Intake manifold
3. Mounting bolts

37. Remove any dirt or foreign matter that may have accumulated around the top edge of the tappet cover; then remove tappet cover and intake manifold gasket assembly, Figure 37.

NOTE: The tappet cover and intake manifold gaskets are serviced as one unit.

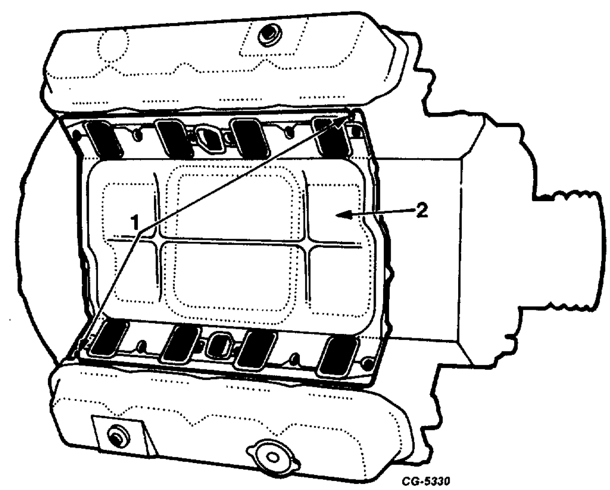


Fig. 37 Removing Tappet Cover and Intake Manifold Gasket Assembly

1. Roll pins
2. Tappet cover and intake manifold gasket assembly.

38. Remove intake manifold seals, Figure 38.

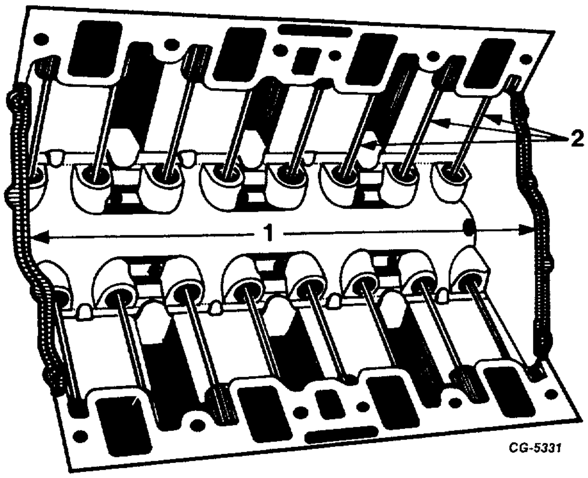


Fig. 38 Intake Manifold Seals

1. Intake manifold seals
2. Push rods

39. Remove manifold heat shroud from right exhaust manifold, Figure 39.

40. Remove oil level gauge from tube, Figure 39.

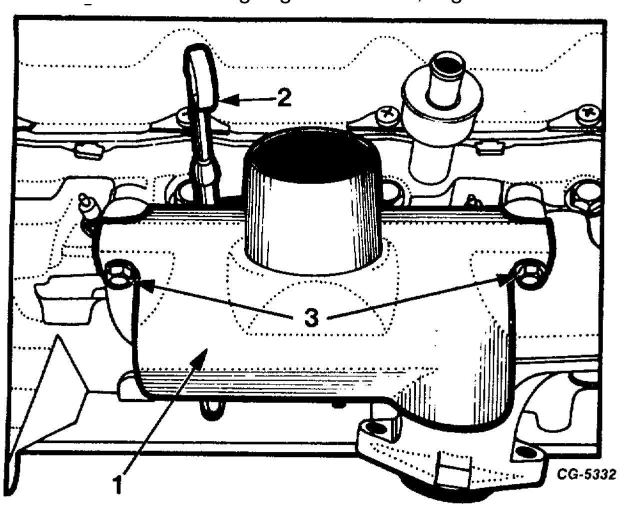


Fig. 39 Head Shroud Removal

1. Heat shroud
2. Mounting bolts
3. Oil level gauge

41. Remove right exhaust manifold and gasket by removing remaining six manifold bolts, Figure 40. Remove air manifold check valve.

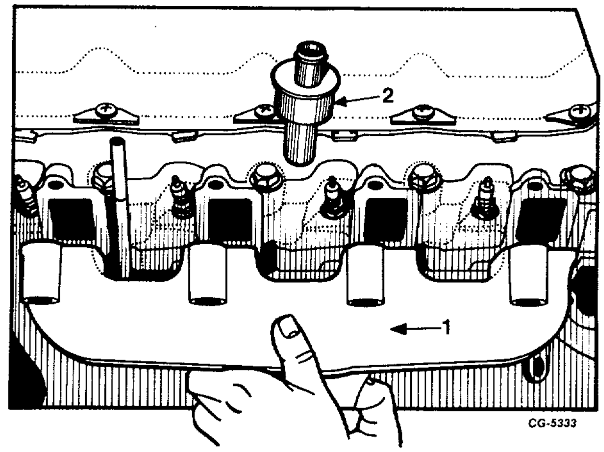


Fig. 40 Removing Right Exhaust Manifold

1. Exhaust manifold
2. Air manifold check valve

42. Repeat Step 41 and remove manifold and gasket from opposite cylinder head and opposite air manifold check valve.

43. Remove cylinder head cover bolts on both banks and remove covers and gaskets from both heads, Figure 41.

NOTE: The cylinder head covers use oil deflector baffles to direct the path of the oil from the push rods.

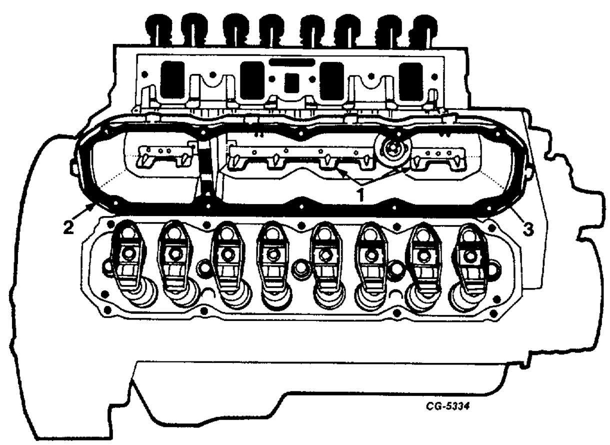


Fig. 41 Removing Cylinder Head Covers

1. Oil deflector baffles
2. Cylinder head cover
3. Gasket

44. Remove flange head bolts securing rocker arms to cylinder heads, Figure 42 Remove rocker arms and pivots from cylinder heads.

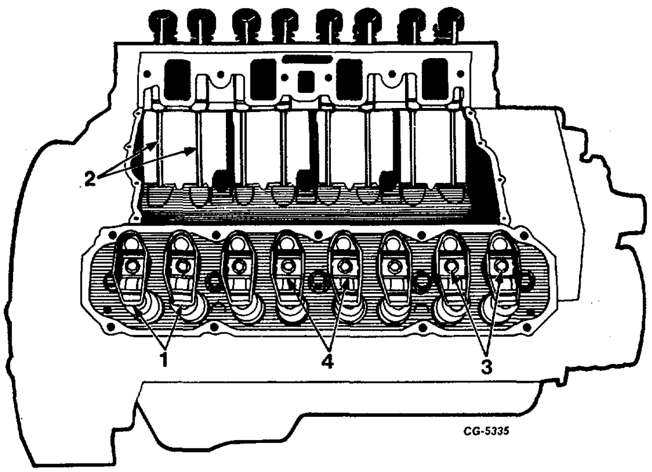


Fig. 42 Rocker Arm Removal

1. Rocker arms
2. Push rods
3. Bolts
4. Pivots

45. Remove push rods from engine.

46. Repeat Steps 44 and 45 on opposite cylinder head.

47. Lift out all hydraulic valve lifters or tappets from the crankcase assem-, bly, Figure 43. This can be accomplished by rotating the camshaft so the tappets are resting on the high side of the camshaft lobes Keep the tappets in order in storage box, SE-1894, to assure cleanliness and reinstallation in their original bores.

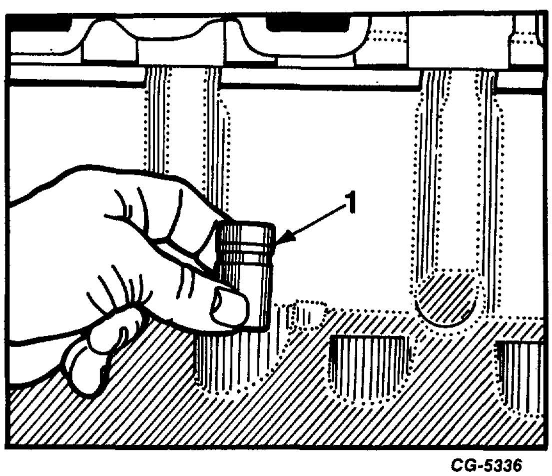


Fig. 43 Hydraulic Tappet Removal

1. Hydraulic tappet

48. Remove cylinder head bolts and lift cylinder heads off the two locating dowel sleeves, Figure 44 Remove the cylinder head gasket

CAUTION: Use extreme care when handling to prevent damage to gasket surfaces. Never pry between the cylinder heads and the block as their have a finished surface and must not be damaged.

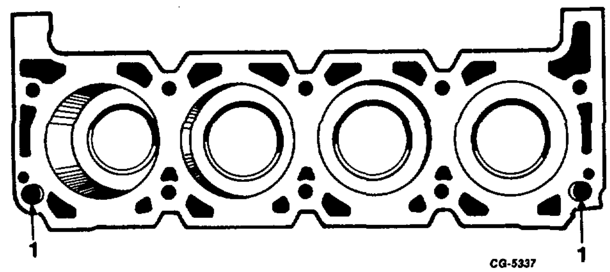


Fig. 44 Dowel Sleeves in Block for Cylinder Head

1. Dowel sleeves

49. Repeat Step 48 and remove opposite cylinder head.

50. Remove bolts and lockwashers securing water pump to engine, Figure 45. Remove water pump and gasket.

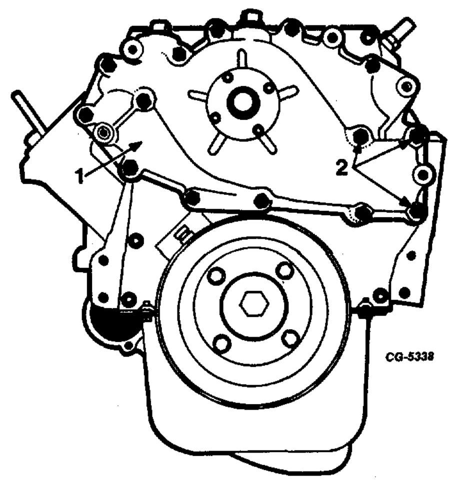


Fig. 45 Water Pump Removal

1. Water pump
2. Mounting bolts

51. Remove bolts and lockwashers securing crankshaft pulley to damper, Figure 46. Remove crankshaft pulley.

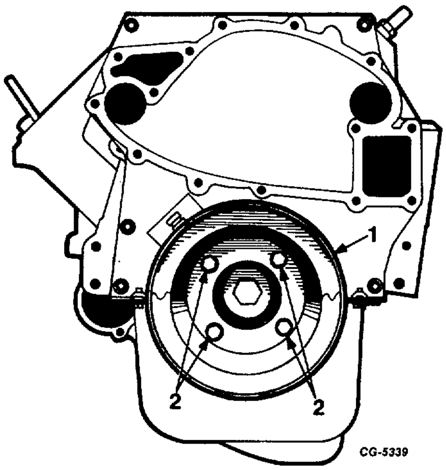


Fig. 46 Crankshaft Pulley Removal

1. Crankshaft Pulley 2. Mounting bolts

52. Remove crankshaft damper bolt and washer Figure 47.

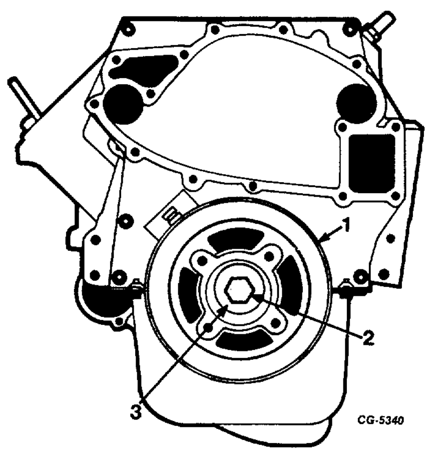


Fig. 47

1. Crankshaft damper 3. Washer
2. Bolt

53. Remove crankshaft damper using SE1368 Puller, Figure 48.

54. The clutch plate should be compressed with three bolts "A" (3/8" 16 x 2") prior to removing the mounting capscrews, Figure 49. This is done to prevent distortion of the clutch cover. Then loosen the clutch back plate-to flywheel retaining capscrews and remove the clutch assembly. Remove main drive gear pilot bearing.

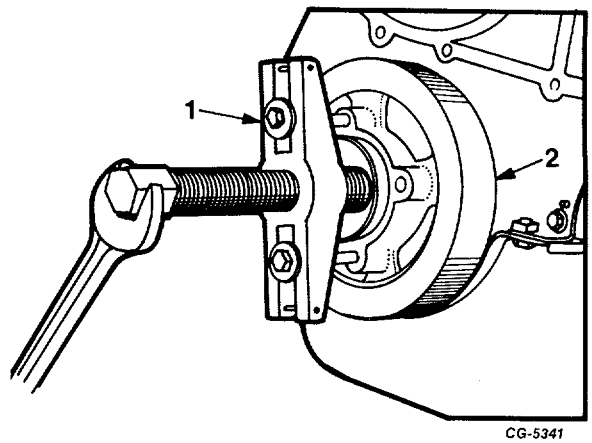


Fig. 48 Using SE-1368 Puller to Pull Crankshaft Damper

1. Puller 2. Pulley damper

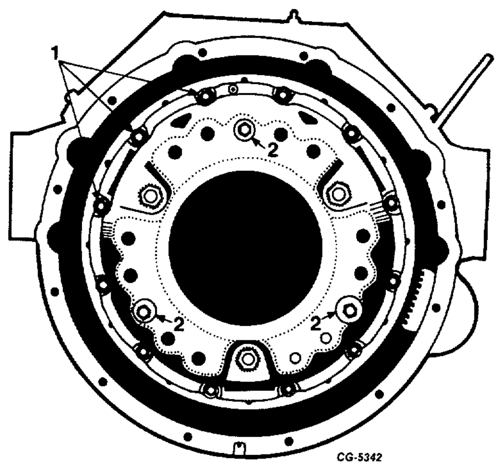


Fig. 49 Clutch Removal

1. Cover Retainer Bolts
2. Bolts "A" for Removal or Assembly Procedures

55. Remove ten mounting bolts and remove the flywheel assembly from the crankshaft flange, Figure 50.

56. Remove oil pan from engine.

57. Remove the engine front cover mounting bolts and lift the cover from the crankcase, Figure 51.

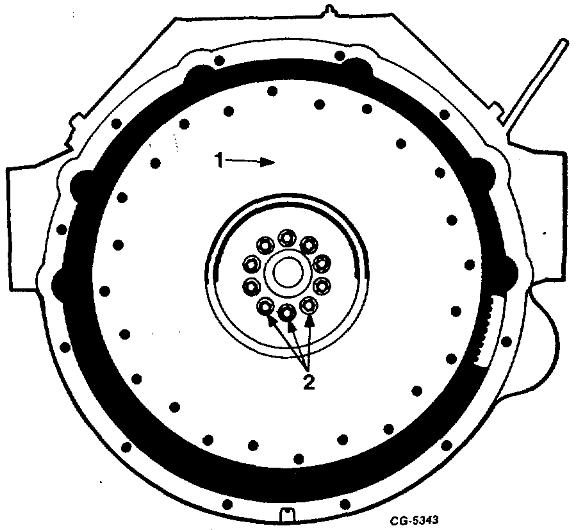


Fig. 50 Flywheel Removal

1. Flywheel
2. Mounting bolts

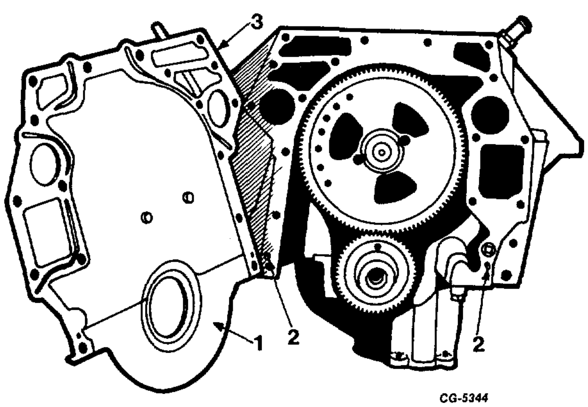


Fig. 51 Removal of Engine Front Cover

1. Front Cover
2. Dowel pins
3. Gasket

58. Press front cover oil seal from front cover using a 3-1/4" O.D. flat disc from the SE-1905 Set, Figure 52.

NOTE: Where it is the desire to replace the engine front cover oil seal while the engine is in the chassis, it will be necessary to remove the hood, radiator shell, radiator and crankshaft pulley. Then using puller, SE-2091, remove seal as shown in Figure 53. To reinstall the seal, follow note under Step 15 outlined under "Engine Assembly."

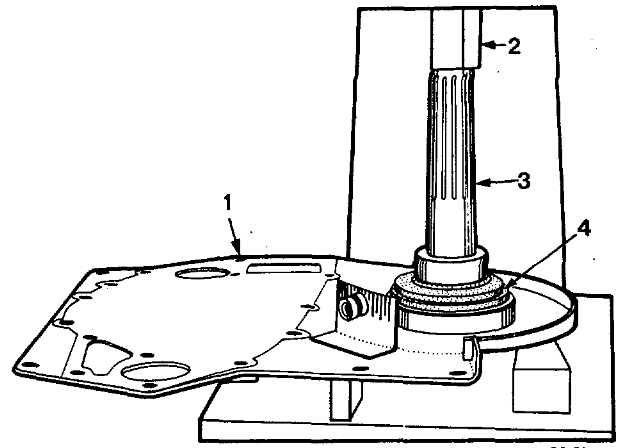


Fig. 52 Front Cover Oil Seal Removal with Cover Removed Using SE-1905 Handle and 3-1/4" O.D. Disc

1. Front cover
2. Press ram
3. Handle
4. Disc

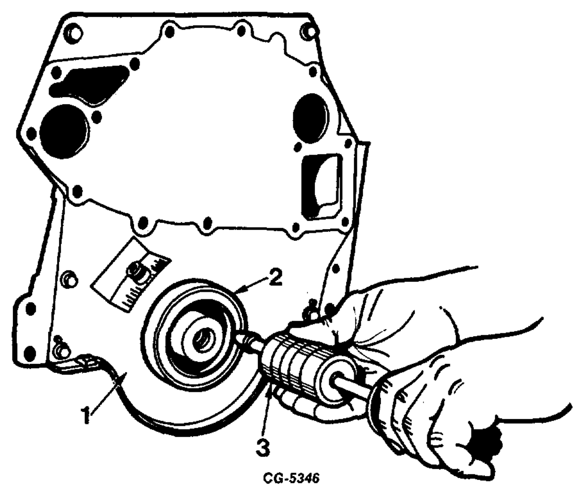


Fig. 53 Front Cover Oil Seal Removal with Cover Installed. Using SE-2091 Puller

1. Front cover
2. Seal
3. Puller

59. Remove retainer plate bolts and remove retainer plate with rear oil seal and gasket, Figure 54.

60. Remove bolts from flywheel housing and remove flywheel housing, Figure 55.

NOTE: Use extreme care when removing flywheel housing to prevent damaging the dowel pins.

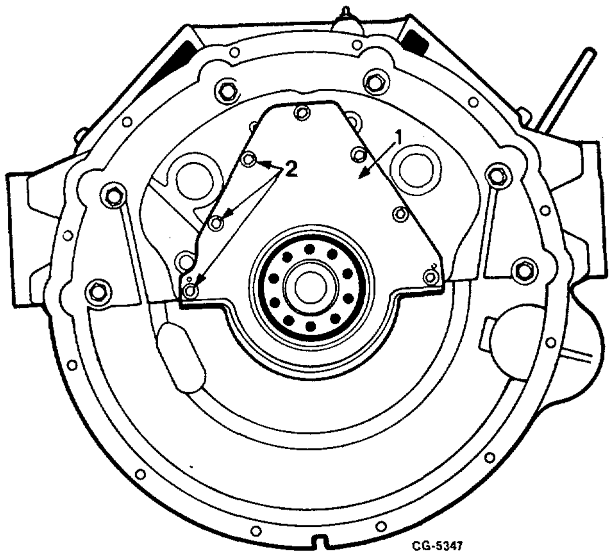


Fig. 54 Rear Oil Seal Retainer Plate Removal

1. Retainer plate
2. Bolts

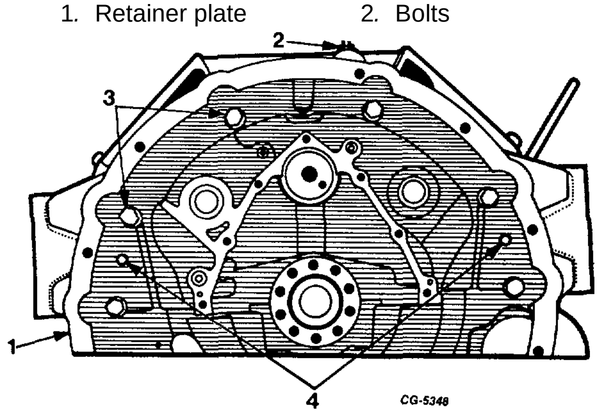


Fig. 55 Flywheel Housing Removal

1. Flywheel housing
2. Oil pressure sending unit
3. Mounting bolts
4. Dowel pins

61. Remove oil pressure sending unit from rear of engine, Figure 55.

62. Press rear oil seal from retainer plate using handle from SE-1905 and 4-1/8" disc, Figure 56.

63. Remove oil pump and pick up tube mounting bolts and nut, Figure 57. Lift oil pump and withdraw pump drive shaft from cylinder block.

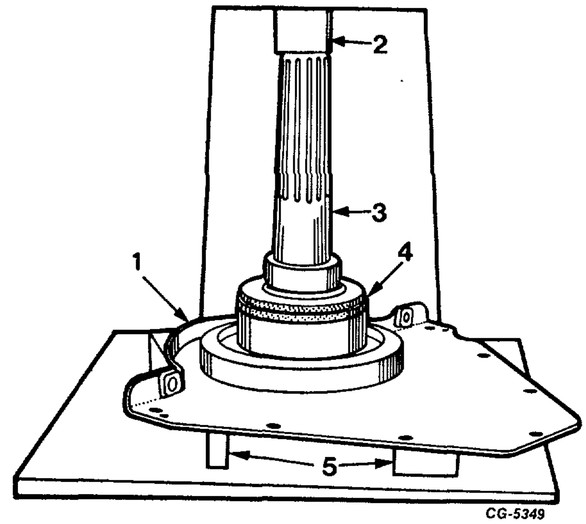


Fig. 56 Rear Oil Seal Removal

1. Retainer plate
2. Press ram
3. Handle
4. Disc

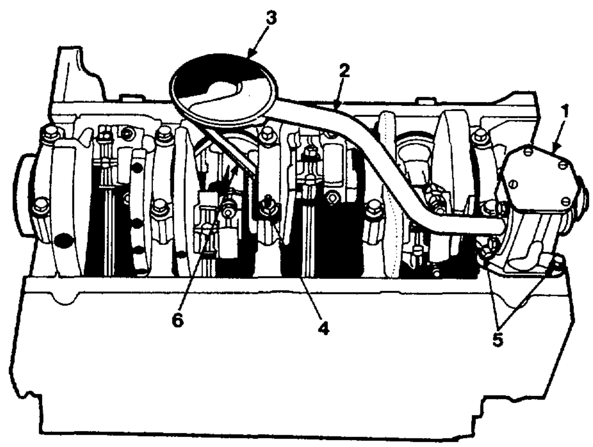


Fig. 57 Oil Pump Removal

1. Pump
2. Tube
3. Screen
4. Mounting nut
5. Mounting bolts
6. Bracket

64. Remove oil level gauge tube.

65. Rotate the crankshaft to position the journals for removal of the connecting rod assemblies, Figure 58.

NOTE: Before removing the piston assemblies, always remove the ridge from the top of the cylinder bore.

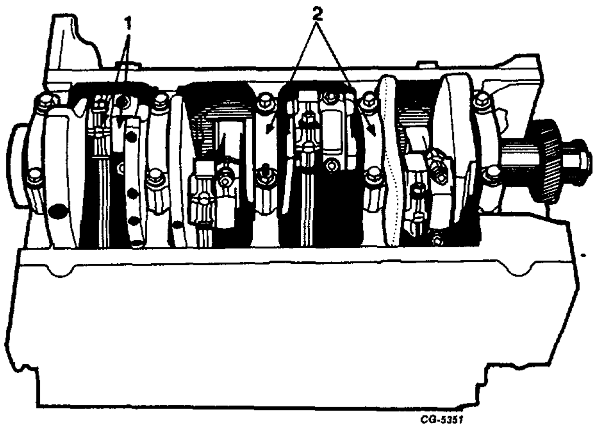


Fig. 58 Positioning Connecting Rods for Removal

1. Connecting rod caps
2. Main bearing caps

66. Remove the cap and push the connecting rod and piston assemblies from the cylinder bore, Figures 59 and 60. Replace the cap and the bearing inserts on the rod so the numbered sides match The connecting rod and piston assemblies are numbered so they can be reinstalled in their respective cylinders.

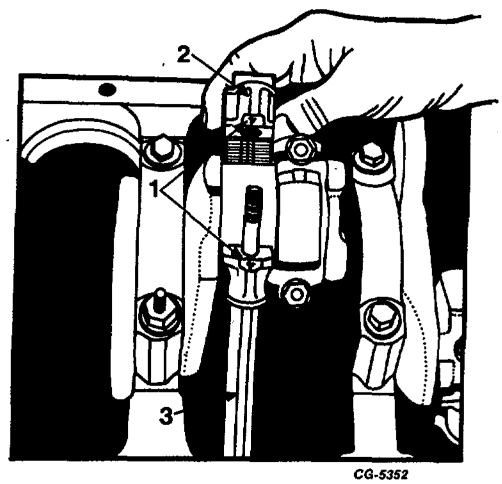


Fig. 59 Connecting Rod Cap Removal

1. Cap and rod identification
2. Cap
3. Connecting rod

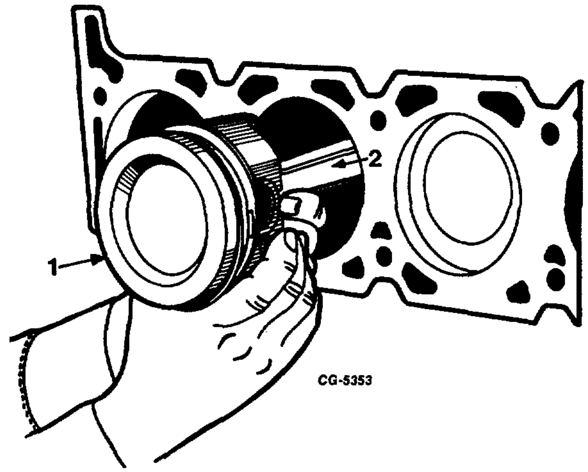


Fig. 60 Connecting Rod and Piston Removal

1. Piston
2. Connecting Rod

67. Remove the two bolts and lockwashers securing the camshaft thrust flange to the crankcase, Figure 61.

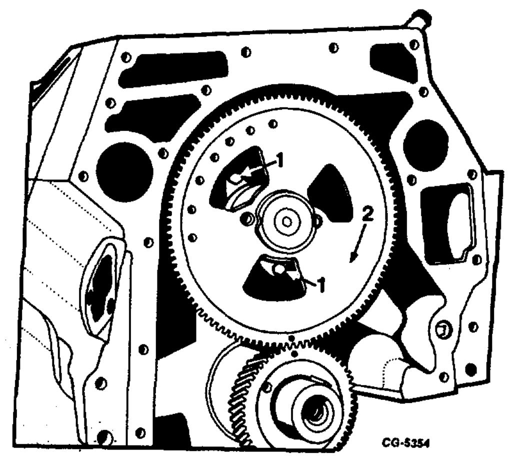


Fig. 61 Thrust Flange Bolt Removal

1. Thrust flange bolts
2. Camshaft gear

68. Remove the camshaft assembly, Figure 62.

IMPORTANT: Use extreme caution when handling the camshaft assembly to prevent chipping the distributor gear teeth.

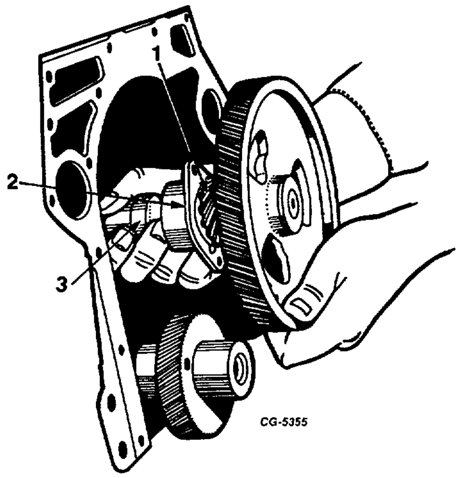


Fig. 62 Camshaft Removal

1. Distributor gear
2. Camshaft thrust flange
3. Camshaft

NOTE: Fuel pump cam located forward of distributor gear.

NOTE: The camshaft gear, distributor gear and fuel pump cam can be removed without complete engine disassembly. This can be accomplished using the following procedure:

a. Remove camshaft allen screw, Fig. 63.

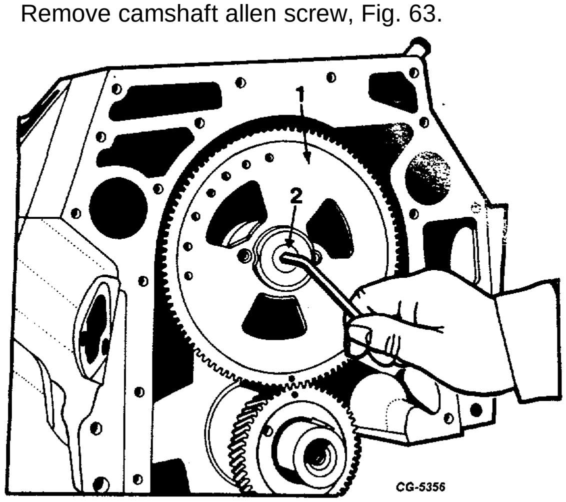


Fig. 63

1. Gear
2. Allen screw

b. Remove camshaft gear using SE-1368 Puller, Figure 64.

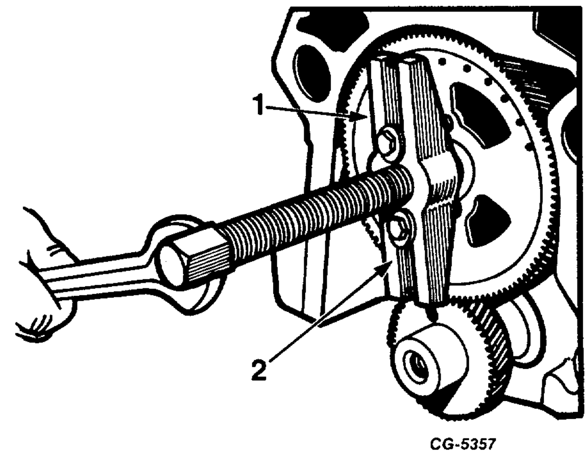


Fig. 64

1. Camshaft gear
2. Puller

c. Remove fuel pump cam using SE1368 Puller and SE-1368-3 Fingers, Figure 65.

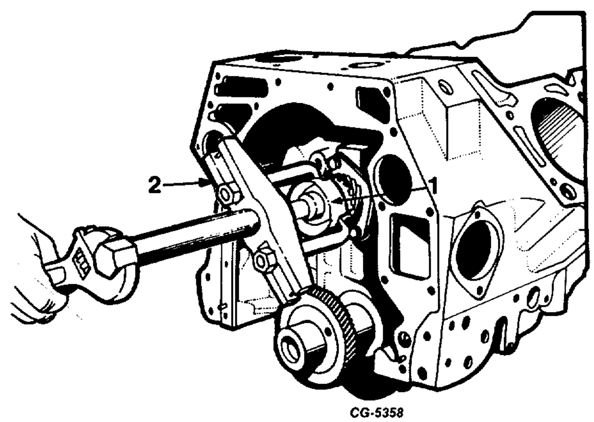


Fig. 65

1. Fuel pump cam
2. Puller

d. Remove distributor gear using SE-1368 Puller and SE-1368-5 Fingers, Figure 66.

IMPORTANT: Use extreme caution so as not to chip the distributor gear teeth.

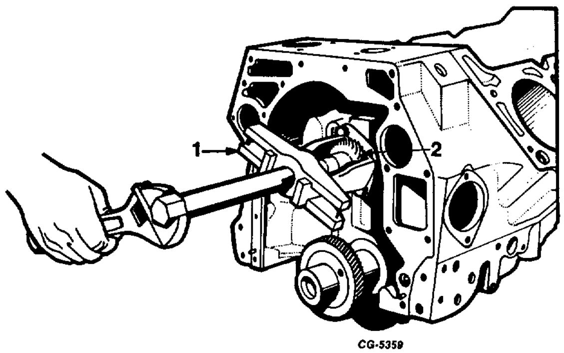


Fig. 66

1. Puller 2. Distributor Gear

69. Use SE-1368 Puller to remove the crankshaft gear, Figure 67. If necessary, use an adapter or heavy flat washer between the crankshaft and puller screw to prevent damage to the internal threads.

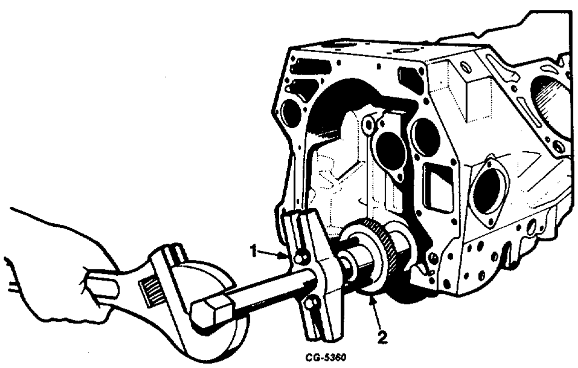


Fig. 67 Using SE-1368 Puller to Remove Crankshaft Gear

1. Puller 2. Crankshaft gear

70. The crankshaft bearing caps are numbered and arrowed to the front to identify their respective positions for reinstallation. The number three bearing cap accommodates a thrust flange to limit crankshaft end play, Figure 68. Remove bolts from bearing caps and remove all main bearing caps.

71. Lift the crankshaft straight up and out of the cylinder block. Remove upper bearing inserts.

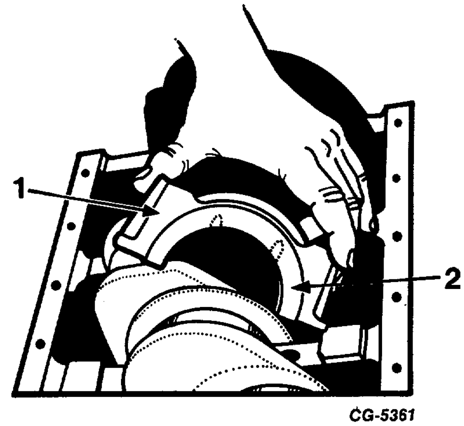


Fig. 68 Main Bearing Cap Removal

1. Number 3 main bearing cap
2. Thrust flange

ENGINE OVERHAUL

Cylinder Block

One of the most important phases of engine reconditioning is the thorough cleaning and inspection of the cylinder block.

Each machined surface of the cylinder block should be cleaned of all old gasket material. The pipe plugs which seal the oil passages should be removed and all passages thoroughly cleaned.

Remove the main oil gallery plug and use SE-2334-2 Brush (3/8" diameter) to clean the main oil gallery, Figure 69. Replace oil plug after coating with a suitable nonhardening sealing compound.

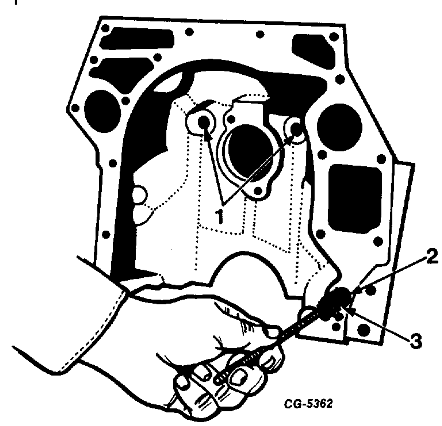


Fig. 69 Cleaning Main Oil Gallery with SE-2334-2 Brush

1. Tappet oil galleries 3. Brush
2. Main oil gallery

Remove the tappet oil gallery plugs by drilling a small hole in the plug and prying with a screwdriver or suitable tool. Clean the tappet oil galleries with SE-2334-1 Brush (5/16" diameter). Replace the tappet gallery plugs flush to .060" below crankcase surface using tool shown in Figure 70. The tool may be made locally from cold rolled steel to the dimensions shown in Figure 70.

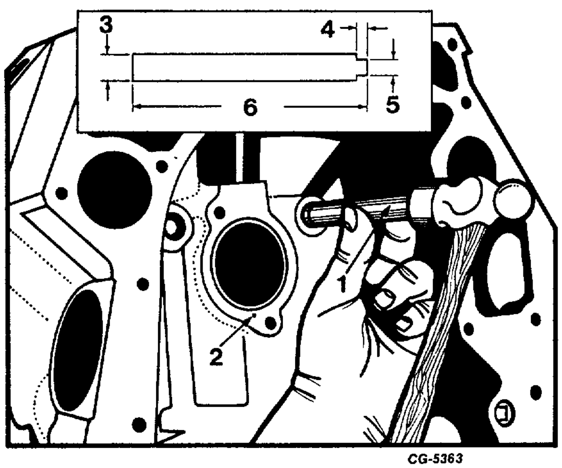


Fig. 70 Tappet Oil Gallery Plug Installation

1. Installer tool
2. Oil hole
3. .490
4. .200
5. .410
6. .450

NOTE: Coat the edges of the plugs with a suitable nonhardening sealing compound prior to installation.

If it becomes necessary to remove an expansion type plug due to water leaks, drill a 1/2" hole in the center of the plug and remove by prying with a screwdriver or suitable tool. When installing the expansion plug, the concave side of the plug must be installed on the interior of the cylinder block. Coat the edges of #he plug with a suitable nonhardening sealing compound and install using a 1" diameter brass drift and hammer.

Inspection of the cylinder block should be done carefully to detect any scoring of the cylinder bores, cracks or water leaks. Small cracks may be found by coating the suspected areas with a mixture of light motor oil and kerosene. After wiping the area dry, immediately apply a coat of quick drying liquid such as zinc oxide powder mixed with wood alcohol. Wherever cracks are present, a brown discoloration will appear in the white coating.

Check the top surface of the cylinder block for trueness with a straightedge. Test by attempting to insert a .006" feeler gauge ribbon between the straightedge and cylinder block. If this is possible, replace the cylinder block.

Each cylinder bore should be checked with an inside reading micrometer SE686 or dial bore gauge SE-2331 to determine taper, out-of-round or worn condition, Figure 71. Measure the diameter of the cylinder bore at the top of the piston ring travel at right angle "A", Figure 72, to the centerline of the crankshaft. Record the readings. Next, measure each bore so the gauge reading coincides with the centerline "B", Figure 72, of crankshaft. The difference between "A" reading and "B" reading is the out-of-round condition at the top of the cylinder bore. Repeat the same procedure at the bottom of the ring travel to check for out-of-round. The difference between the diameters measured at the top "A" and the bottom "B", Figure 73, of the bore (at right angles to centerline of the crankshaft) is the taper of the bore.

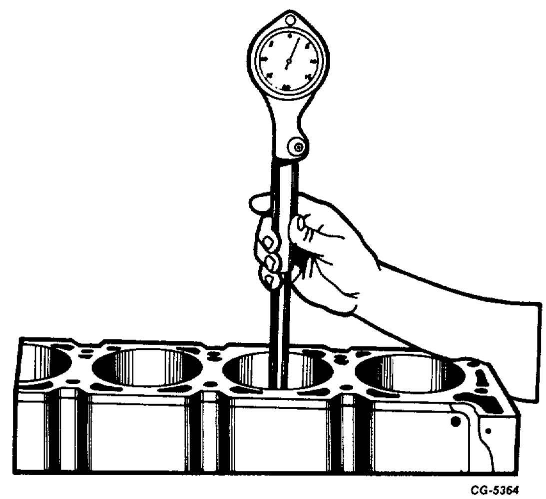


Fig. 71 Checking Cylinder Bore Using Dial bore Gauge SE-2331

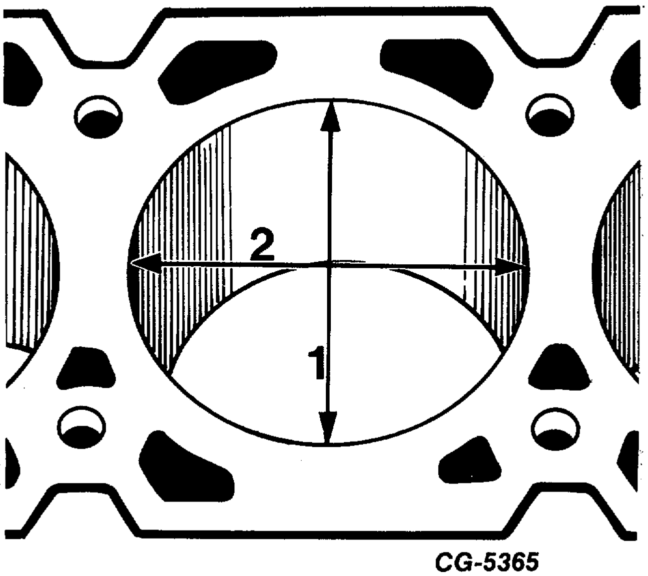


Fig. 72 Checking cylinder Bore Out-of-Round

1. "A" 2. "B"

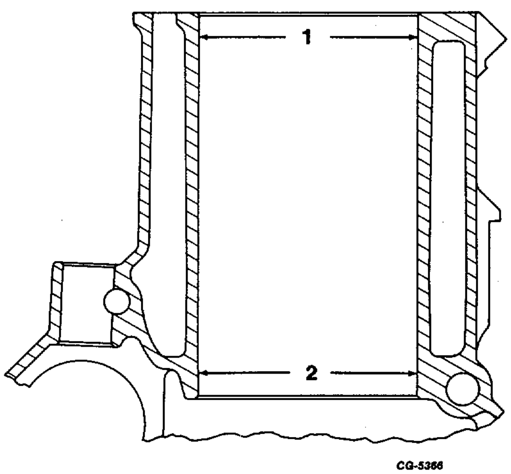


Fig. 73 Checking Cylinder Bore Taper

1. "A" 2. "B"

If the cylinder bore does not exceed the limits of .002" out-of-round and/or .005" taper, new standard size service piston rings will give satisfactory performance provided the piston clearance is not excessive.

Cylinder bore blocks can be deglazed by the use of SE-2314-5 glaze breaker brush, Figure 74 This silicon carbide tipped nylon flexible brush quickly deglazes cylinder walls and produces a crosshatch pattern on the cylinder wall surface in a single operation. The brush contours itself to the cylinder wall and conditions the wall surface without altering the cylinder bore.

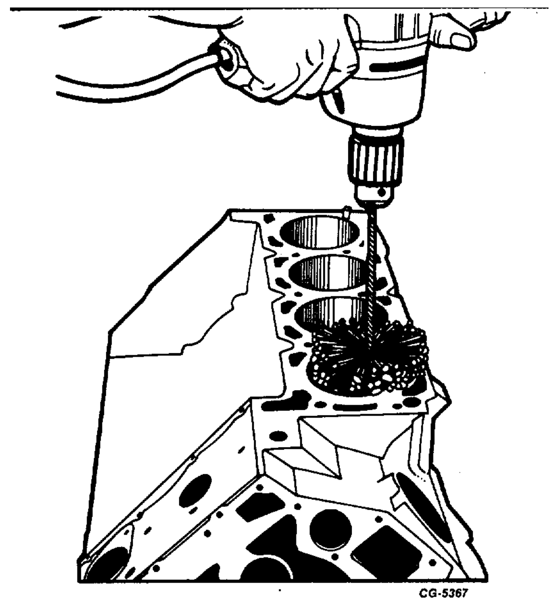


Fig. 74 Deglazing Cylinder Wall Surface Using SE-2314-5 Glaze Breaker Brush and Electric Drill

The SE-2314-5 brush is used in conjunction with an electric drill, Figure 74. A slow RPM drill is recommended. Most 3/8" capacity electric drills are satisfactory for driving the brushes. A drill speed of 350 - 500 RPM has been found to be a practical speed for deglazing IH cylinder block bores.

A lubricant should be used with the silicone carbide-tipped brush to produce a desirable finish on the wall surface A lightweight engine oil (SAE-30) provides adequate lubrication for deglazing cylinder block bores The lubricant also controls airborne particles which can be easily wiped from the cylinder bore with a cloth.

When conditioning cylinder block bores, stroke the brush up and down in the bore at a rate of 30 - 40 strokes per minute for a duration of 15 - 20 seconds per cylinder bore In most instances, 20 seconds is adequate time for the brush to break cylinder wall glaze and produce a crosshatch pattern on the cylinder wall surface.

Thoroughly clean cylinder bore walls after deglazing Wipe as much of the abrasive deposits from the wall as possible. Then swab out each abrasive-coated cylinder with SAE-10 oil and carefully wipe it out with a clean cloth One swabbing and wiping is not sufficient Three complete operations are usually required - <u>more may be necessary</u>. Continue cleaning until a clean, white cloth shows no evidence of discoloration when wiped through the cylinder bore. Never use gasoline, kerosene or commercial cleaners to clean cylinders. Solvents of this nature will not remove abrasives from the walls. Rapid engine wear and ring failure results from failing to properly clean abrasives from the cylinders.

However, if the wear exceeds the previously mentioned limits, it is recommended to rebore the cylinder of cylinders to within .003" of the required oversize diameter, Figure 75. This will allow enough stock for the final step of honing the bores, Figure 76, so that the exact clearance may be obtained for the selected oversize piston. When performing the honing operation, the hone should be stroked up and down to produce a crosshatch pattern on the cylinder wall as shown in Figure 77. The faster the hone rotates, the faster it must be stroked up and down to produce the desired crosshatch pattern.

NOTE: After the honing operation is completed. the sharp burred edge that develops at the bottom of a newly honed cylinder should be removed manually with emery cloth. Then thoroughly clean the block and cylinder bores.

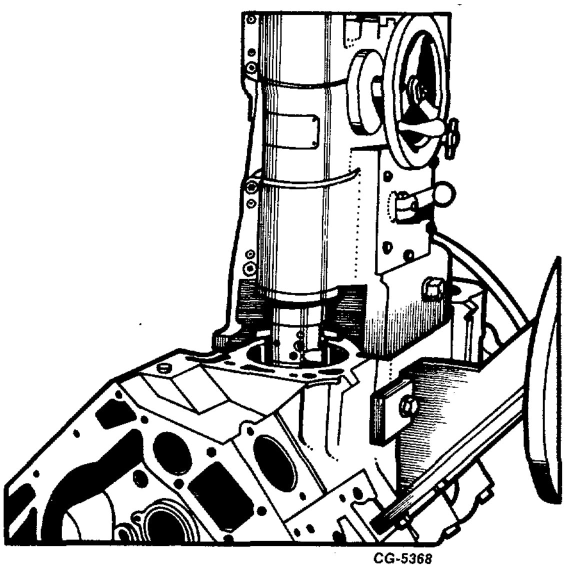


Fig. 75 Reboring Cylinder Using SE-1399 Boring Machine

Wipe as much of the abrasive deposits from the cylinder wall as possible. Then swab out each abrasive-coated cylinder with clean SAE-10 oil and carefully wipe it with a clean cloth. One swabbing and wiping is not sufficient Three complete operations are usually required - more may be necessary. Continue cleaning until a clean, white rag shows no evidence of discoloration when wiped through the cylinder bore. Never use gasoline, kerosene or commercial cleaners to clean cylinders after honing. Solvents of this nature will not remove abrasives from the walls. Rapid engine wear and ring failure result from failing to properly clean abrasives from the cylinders.

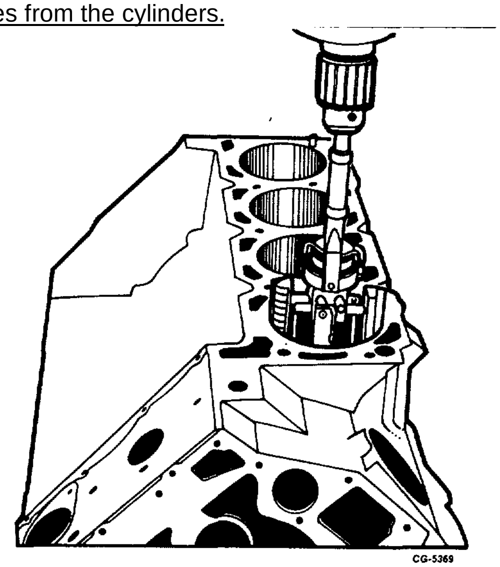


Fig. 76 Honing cylinder bore Using SE-784 Cylinder Grinder

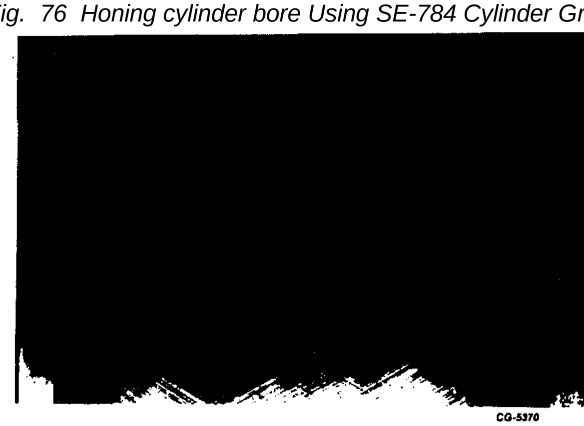


Fig. 77 Proper Honing Leaves a Crosshatch on the Cylinder Wall

Inspect the camshaft bearings for wear and proper running clearance. See "Specifications." If the limits are exceeded, replace the bearings This can be accomplished with the special camshaft bearing remover and installer SE-1897 with two SE-1897-7 adapters and the slide hammer and adapter from puller set SE-1879.

NOTE: Oil holes must be in alignment with holes in the crankcase.

1. Position one adapter SE-1897-7 in the second bearing with the flange to -ward the rear of the block, Fig 78.

2. Position another adapter SE-1897-7 in the third bearing with the flange toward the rear of the block, Figure 78.

3. Install the bar through the adapters and lock the third bearing adapter on the bar with a "C" washer SE1897-2.

4. Using the second bearing adapter as a pilot, pull the third bearing with the slide hammer, Figure 78.

NOTE:
Always hold the adapter firmly against the bearing being removed or installed to avoid damage.

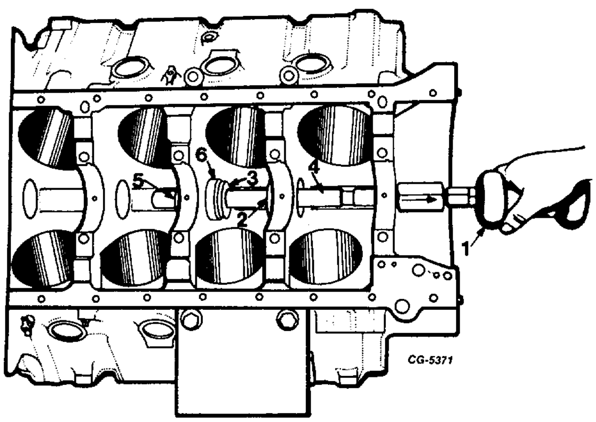


Fig. 78 Removing Third Bearing

1. Slide hammer	**4. Bar**
2. Second adapter	**5. C-washer**
3. Third adapter	**6. Bearing**

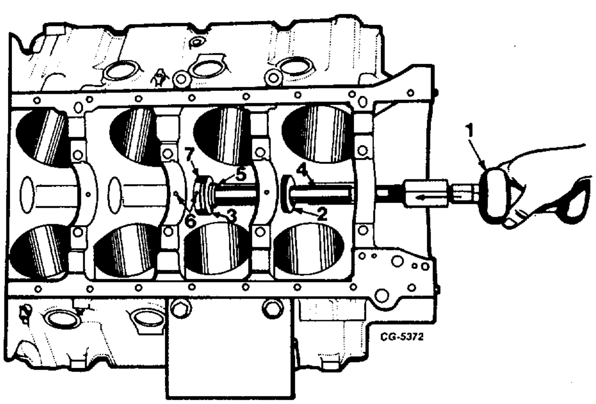


Fig. 79 Installing Third Bearing

1 Slide hammer	**4 Bar**
2. Second adapter	**5. C-washer**
3. Third adapter	**6. Align oil holes**
	7. Bearing

5. Position the new bearing on the third adapter and install adapter and bar with a "C" washer in front of the adapter, Figure 79. Align the oil hole and push in the third bearing.

6. Position the front adapter SE-1897-7 in the front bearing with the flange toward the front of the block, Figure 80.

7. With the second adapter still in position, install the bar through the adapters and lock the second adapter on the bar with "C" washer, Figure 80.

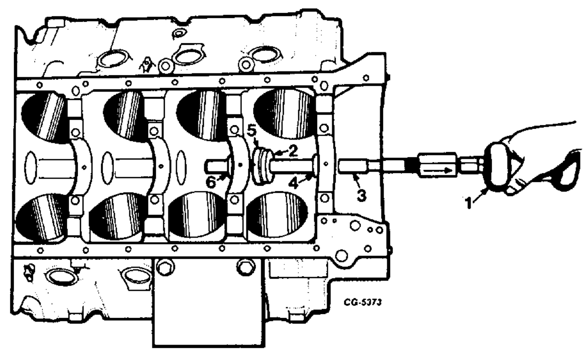


Fig. 80 Removing Second Bearing

1 Slide hammer	**4. Front adapter**
2. Second adapter	**5. Bearing**
3 Bar	**6. C-washer**

8. Using the front adapter as a pilot, pull the second bearing with a slide hammer, Figure 80.

NOTE:
Always hold the adapter firmly against the bearing being removed or installed to avoid damage.

9. Position the new bearing on the second adapter and with the adapter flange toward the front of the block, install the bar through the front and second adapter. Then install "C" washer in front of the second adaptor. Align the oil hole and push in second bearing, Figure 81.

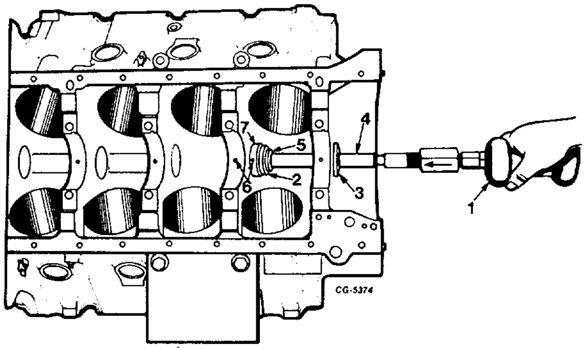


Fig. 81 Installing Second Bearing

1. **Slide hammer**
2. **Second adapter**
3. **Front adapter**
4. **Bar**
5. **C-washer**
6. **Index oil holes**
7. **Bearing**

10. Remove the "C" washer and use the second adapter as a pilot. Pull the front bearing from the crankcase, Figure 82.

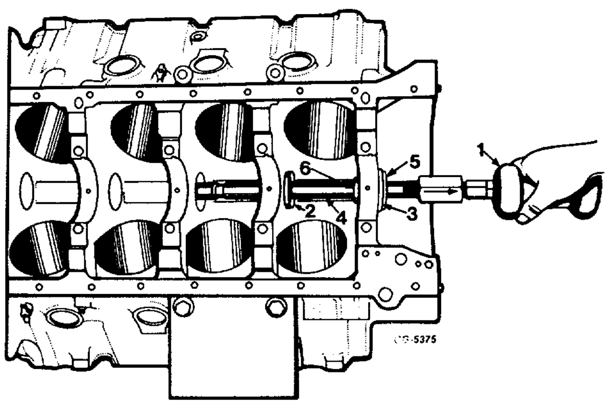


Fig. 82 Removing Front Bearing

1. **Slide hammer**
2. **Second adapter**
3. **Bearing**
4. **Bar**
5. **Front adaptor**
6. **C-washer**

11. Remove the bar and front adapter and position the new bearing on the front adapter. Slide the bar into the block and through the second adapter serving as a pilot, Figure 83.

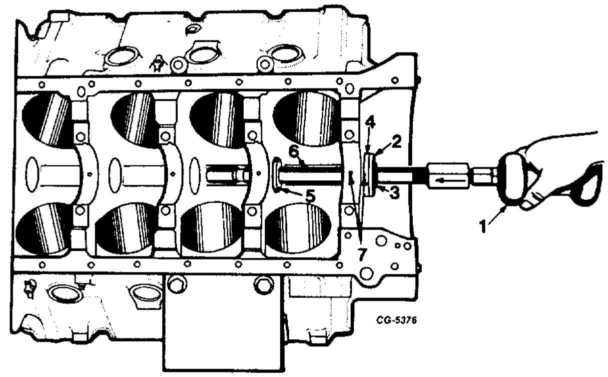


Fig. 83 Installing Front Bearing

1. **Slide hammer**
2. **Front adapter**
3. **C-washer**
4. **Bearing**
5. **Second adapter**
6. **Bar**
7. **Index oil holes**

12. Align the oil holes and drive in the front bearing, Figure 83.

13. The fourth and rear bearings are installed in a manner similar to the front and second bearings using SE1897-7 adapters and working from the rear of the block.

Pistons and Piston Pins

To disassemble the connecting rod from the piston and piston pin assembly, remove the piston pin retainers from each end of the pin using Tru-Arc pliers, Figure 84.

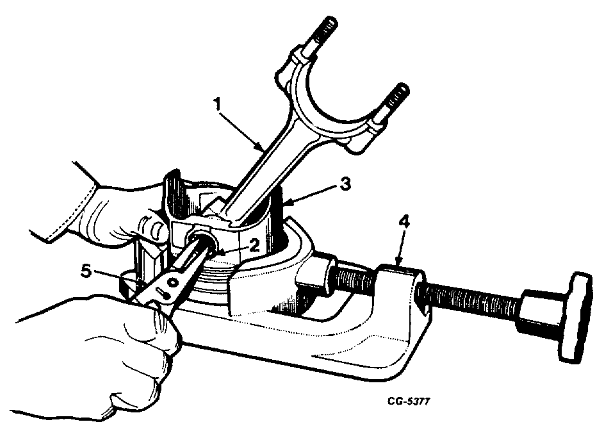


Fig. 84 Removing Piston Pin Retainers

1. **Connecting rod**
2. **Retainer**
3. **Piston**
4. **Piston vise**
5. **Pliers**

Heat piston in boiling water or piston heater and after placing piston in vise drive pin from assembly with a suitable remover or brass drift and soft hammer, Figure 85.

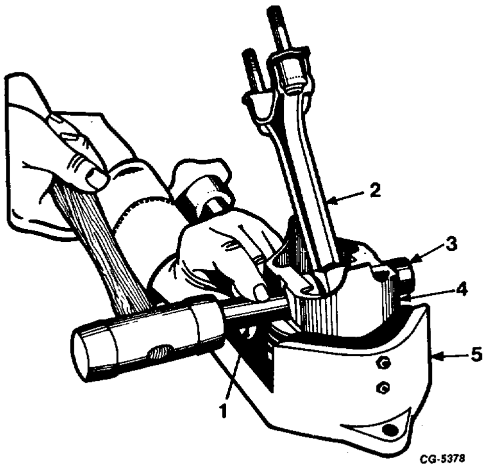


Fig. 85 Removing Piston Pin

1. **Brass drift**
2. **Connecting rod**
3. **Pin**
4. **Piston**
5. **Piston vise**

After the pin is removed, separate the piston from the connecting rod, taking precaution to see that the parts are marked so they may be reinstalled in their respective cylinders unless defective.

NOTE:

Pistons should also be marked at this time to insure they are reinstalled in the same position on the connecting rod as they were removed, Figure 86. Mark the pistons so that the mark will not be removed during cleaning operation. If new pistons are installed, piston may be - installed either way on the connecting rod.

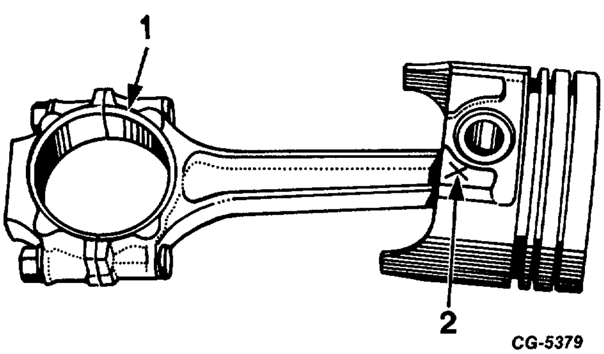


Fig. 86 Mark Piston for Identical Reinstallation on Connecting Rod

1. **Large chamfer**
2. **Place mark here**

Remove all old rings and immerse all parts of the piston in cleaning solvent and clean thoroughly. Use a special ring groove cleaner on broken piston ring to clean all carbon from the piston ring grooves.

NOTE:

Never use a caustic solution for cleaning aluminum pistons.

Inspect the pistons for scuffed or scored skirts or cracked or worn ring lands, discarding any showing such condition.

To select the correct size pistons for an engine overhaul, the size of the cylinder bore diameters must be determined first. This can be accomplished with the use of an inside reading micrometer SE-686 or dial bore gauge SE-2331. (Refer to Figure 71.) Each bore should be measured at the top of ring travel and the lower end of ring travel both parallel and at right angles to the crankshaft.

After the cylinder bores have been measured and recorded, the next step is to select a piston to fit a certain bore. This is accomplished by measuring the piston at the top of the skirt across the thrust faces with an outside micrometer, Figure 87. The size piston selected should be large enough to permit cleaning up the cylinder bore and provide the proper running clearance as shown in the specifications.

Cylinder blocks having deep scuff or score marks may require reboring for use of oversize pistons; therefore, the foregoing information still applies.

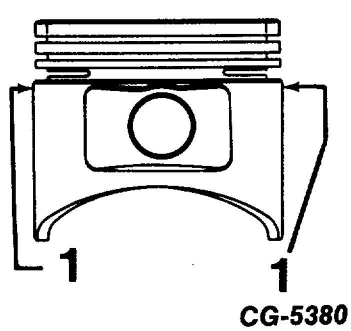


Fig. 87

1. **Measure piston at this area for fitting.**

However, when reboring the cylinder bore, it should be sized to within .003" of the desired size and then honed to provide the proper finish on the cylinder wall as well as the correct running clearance for the piston selected.

Piston pins should be inspected and measured for wear. If piston pins show signs of corrosion or etching or are not within specifications, they should be replaced with new pins. See "Specifications.' Piston assemblies furnished for service replacement are complete with piston pins accurately fitted.

Connecting Rods

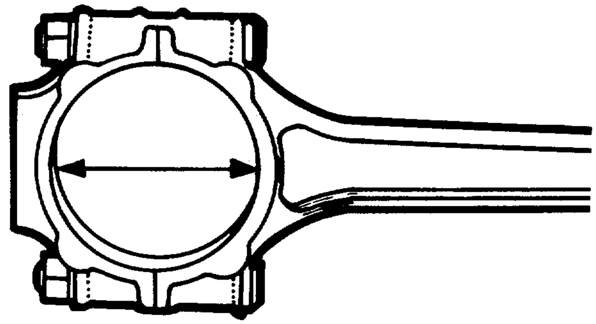
The connecting rod and bearing must withstand extreme forces and high temperatures. In addition, the connecting rod and bearing are subject to changing temperature cycles in a variety of climates and under widely varying operating conditions.

The connecting rod bearing plays a major role in distributing the proper amount of oil to the piston pin bearing surfaces, cylinder walls, piston and piston rings. This is known as oil throw-off and the condition of the connecting rod bearing determines how well the lubrication operation is performed.

The bearing-to-crankshaft clearance affects the volume of oil throw-off. Where the bearing clearance is more than specified, an abnormal amount of oil is thrown onto the cylinder walls causing increased oil consumption and low oil pressure due to oil passing through the bearing surfaces too quickly. Where bearing clearances are less than the specified amount, the oil that passes through the bearing is insufficient to properly cool the bearing, resulting in short bearing life and improper oil throw-off to the cylinder walls, piston pins and piston rings. This condition contributes to scoring of pistons and cylinder walls.

If the connecting rod bore is stretched or out-of-round beyond the specified diameter, the insert will be out-of-round and will not be held securely in the connecting rod since the "crush" may be lost. Bearing failures can result from localized bearing loads or from low oil pressure. The bearing insert locating tangs will keep the inserts from turning in the connecting rod bore under normal conditions but may move and fail due to the foregoing reasons

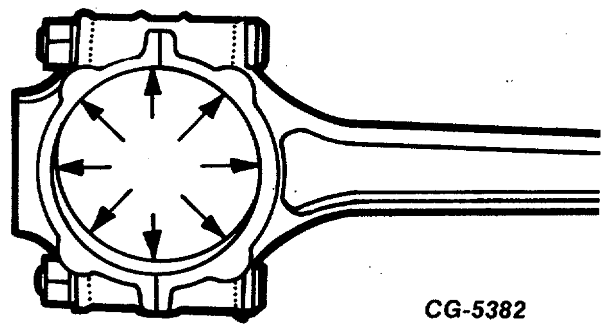
When installing new connecting rod bore inserts, a very thorough inspection of the connecting rod bore is necessary. This inspection consists of the following:



CG-5381

Fig. 88

1. <u>Bore Size</u>: To obtain the proper bearing insert crush, the bore must be I of a specified size, Figure 88. See "Specifications."



CG-5382

Fig. 89

2. <u>Roundness</u>: The bore of the connecting rod when assembled and the rod bolts, nuts and special hardened washers tightened to specified torque is round and should not exceed .005" out-of-round, Figure 89.

3. <u>Surface Finish</u>: The connecting rod bore must be smooth, Figure 90.

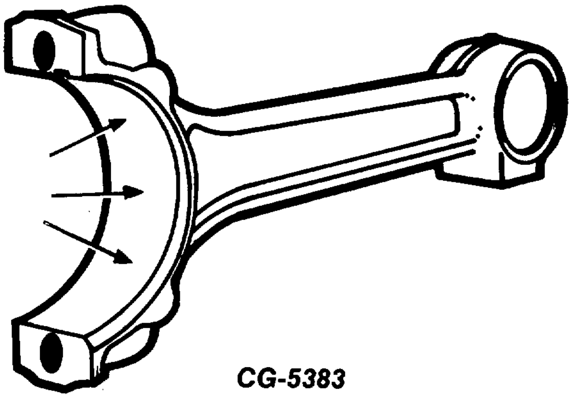


Fig. 90

4. Straightness: The connecting rod bore taper should not exceed .0005",

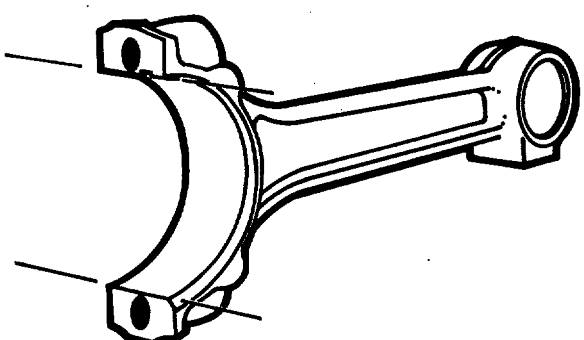


Figure 91

This inspection of the connecting rod can be made using the precision gauge furnished with honing machine, SE2218, Figure 92, or other accurate bore gauge such as SE-2087. For further information refer to the instructions furnished with the gauge.

If the original connecting rod does not meet the foregoing requirements, it must be replaced.

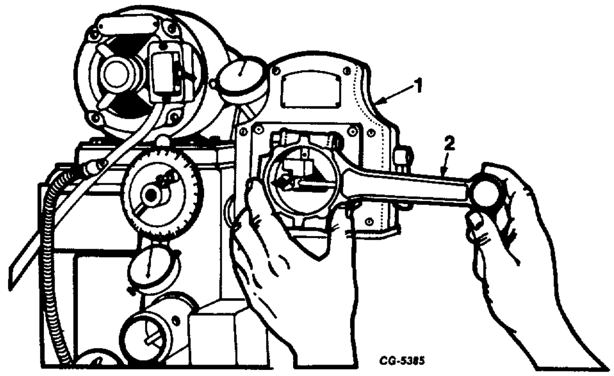


Fig. 92 Checking Connecting Rod Bore Using Precision Gauge Furnished with Honing Machine SE-2218

1. **Bore gauge**
2. **Connecting rod**

The connecting rod must be thoroughly cleaned and visually inspected for defects. The connecting rod bushings should be checked for proper clearance with the piston pin. See "Specifications." The connecting rod bushings should be checked for proper clearance with the piston pin using the precision gauge furnished with honing machine, SE-2218, Figure 93, or other accurate bore gauge such as SE-2087.

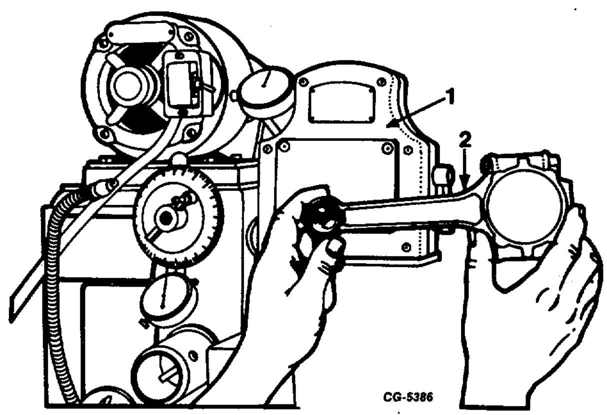


Fig. 93 Checking Connecting Rod Bushing Bore Using Precision Gauge Furnished with Honing Machine

1. **Bore gauge** 2. **Connecting rod**

If inspection shows the piston pin bushings are worn, new bushings must be installed. This can be accomplished by placing the connecting rod under a hydraulic press in line with the properly sized hole in support plate, SE-1033, and using SE-2539 tool, remove the bushing, Figure 94.

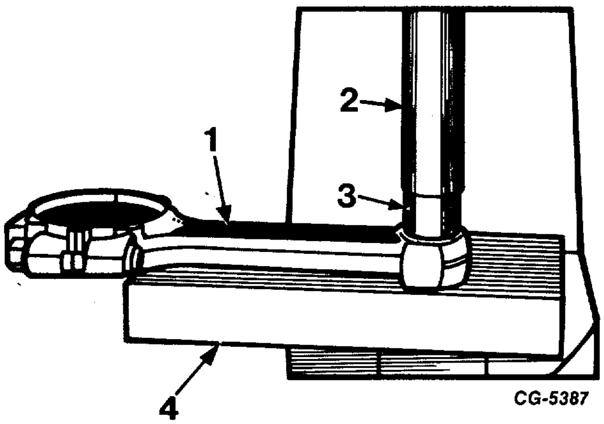


Fig. 94 Using SE-2539 Tool to Remove Worn Connecting Rod Bushing

1. **Connecting Rod**
2. **Press ram**
3. **Remover**
4. **Support plate**

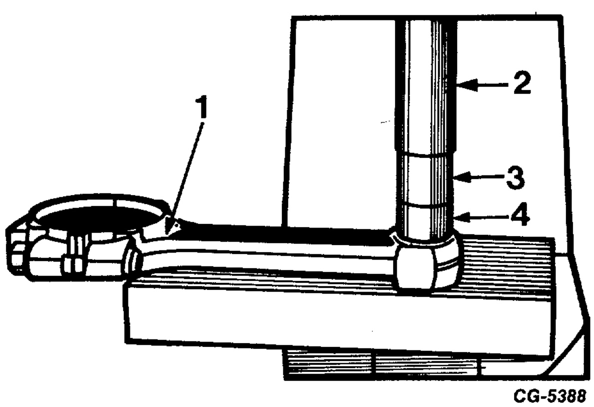


Fig. 95 Using SE-2539 Tool to Install New Connecting Rod Bushing

1. **Large chamfer side**
2. **Press ram**
3. **Installer**
4. **New bushing**

To install the new bushing, place the bushing on SE-2539 Installer and lubricate the bushing outside diameter with light oil. Place the connecting rod on a flat surface plate with the large chamfer side of the main bearing bore up. The split in the bushing must be located in the connecting rod as shown in Figure 97. Press new bushing in until bushing contacts flat surface plate, Figure 95. If the bushing is flush on the surface plate side, the opposite side of the bushing is allowed to be flush to .010" above surface (large chamfered side of connecting rod).

After bushing has been installed in the connecting rod, it must be honed to proper size using SE-2218 Honing Machine and equipment, Figure 96. See "Specifications."

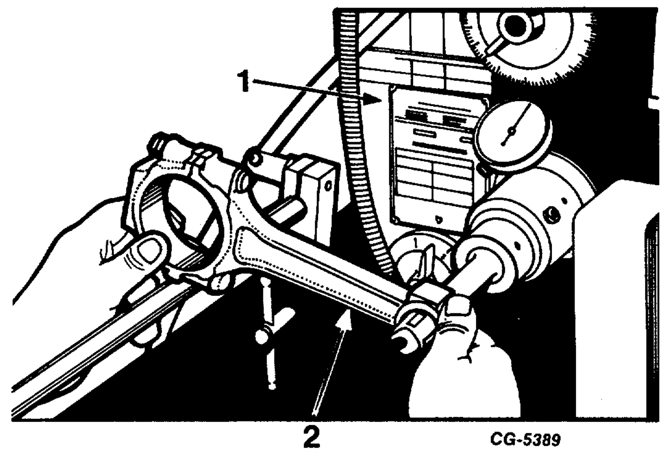


Fig. 96 Honing Connecting Rod Bushing Using SE-2218 Equipment

1. **Honing machine**
2. **Connecting rod**

Insert the piston pin into the piston and connecting rod and place retainers on each end. Make certain the retainers seat fully with tension in the grooves. Test the connecting rod and piston assembly on a connecting rod aligner. If any misalignment is encountered, a new rod or piston may be required to overcome this condition.

The piston is constructed so that it may be assembled either way on the connecting rod. However, when the piston and connecting rod are installed in the engine, the large chamfered side of each rod must be located against the crankshaft face. The chamfer provides clearance at the crankshaft fillet, Figure 97.

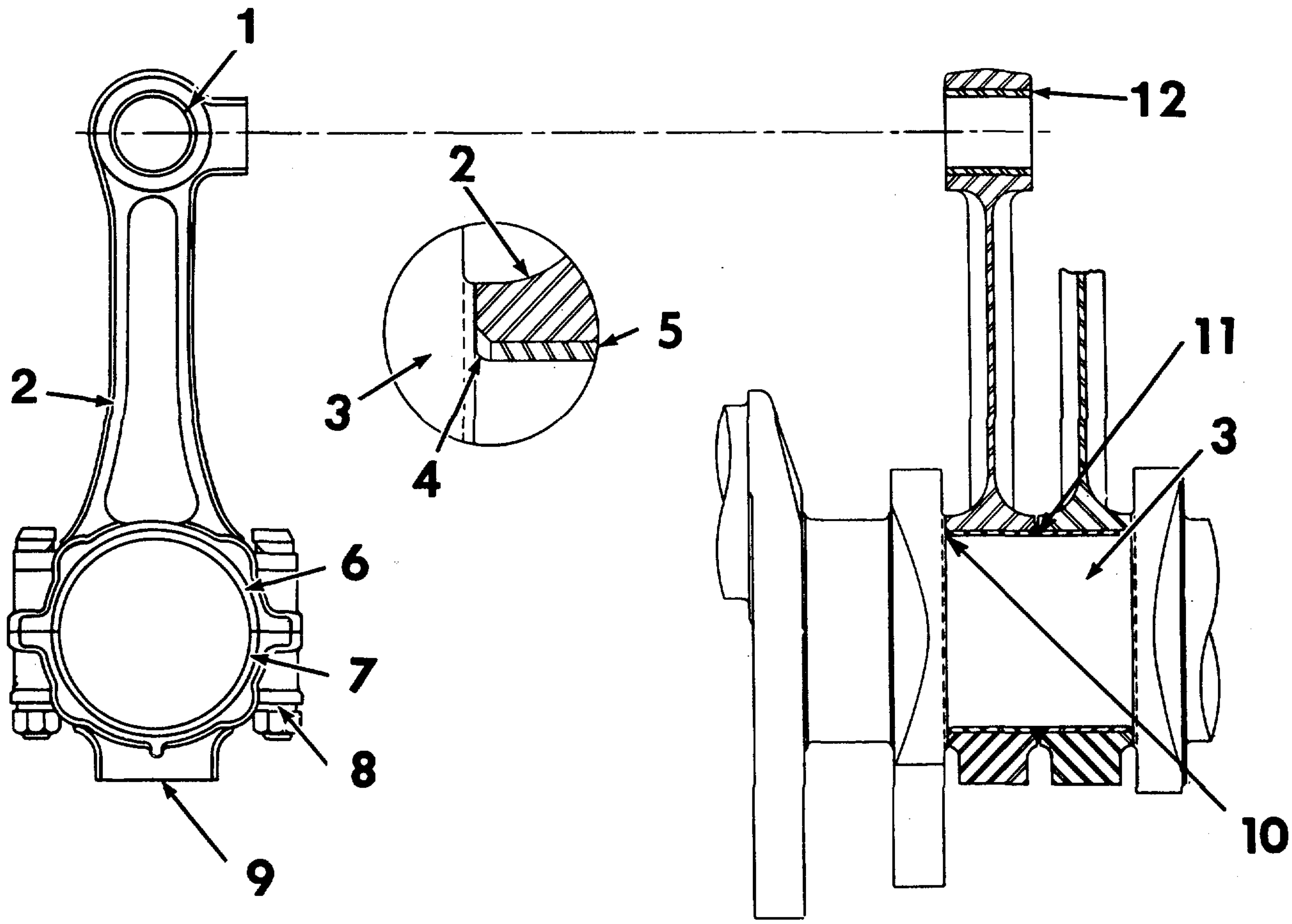


Fig. 97 illustrating Proper Installation of Connecting Rod to Crankshaft

1. **Split in bushing**
2. **Connecting rod**
3. **Crankshaft**
4. **Crankshaft fillet**
5. **Bearing**
6. **Connecting rod bearing-upper**
7. **Connecting rod bearing-lower**
8. **Washer**
9. **Connecting rod bearing cap**
10. **Large chamfer side**
11. **Small chamfer side**
12. **Bushing**

Connecting Rod Caps and Bolts

The fastening of the connecting rods to the engine crankshaft is another important function for mechanics to consider for engine rebuilding. How well this job is performed determines to a large extent what kind of connecting rod bearing will be realized. The correct torque application assures a good job.

NOTE:

Do not use a power wrench for removing or installing connecting rod bolts, nuts and washers. Such practice will cause seizure of the connecting rod bolt or nut threads.

There are a number of conditions which affect torque and the results of torque applications. The major purpose in tightening connecting rods and bolts to a specified torque is to obtain tension in the bolt, Figure 98, which in turn developes a clamping load or preload that exceeds any possible loading imposed on parts due to engine RPM. In other words, the connecting rods must "hang on" to the crankshaft and suffer all the strains of intertia and cylinder combustion impulse without permitting the least movement or flexing of the rod cap, bolts or nuts. At the same time, torque applied must be within the capacity of the parts (bolt, nut, caps and connecting rods) to withstand these loads.

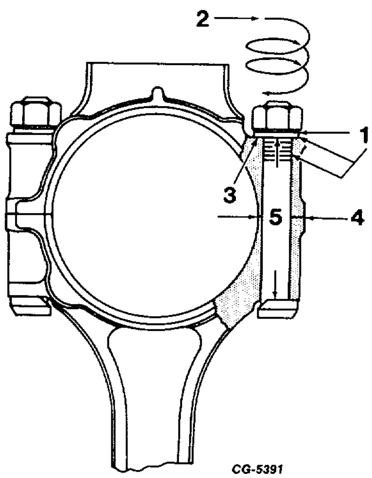


Fig. 98 Connecting Rod Cap and Bolt Details

1. Friction
2. Torque
3. Washer
4. Clamped
5. Tension

In tightening connecting rod bolts and nuts to their specified torque figure, a definite loading is obtained between the connecting rod and cap. Specially designed bolts, nuts and washers manufactured from selected materials permit the application of this loading without undue stretching of bolts. There is a relationship between the torque specifications and clamping effect or load to be applied providing certain conditions exist.

These conditions center largely around the belt itself and its care, pointed out as follows:

1. Bolt and Nut Thread Condition:

Threads that are dry, excessively rough, battered or that are filled with dirt require considerable effort just to rotate the nut. Then when the clamping load is developed or the bolt tension is applied, the torque reading mounts rap o-idly (due to thread friction) to the specified figure without approaching the desired bolt tension and maximum clamping effect. Under these conditions the desired torque reading is obtained, but the clamping effect might be far below requirements, leading to bearing failure or to connecting rod bolt breakage. The proper bolt tension and clamping effect can never be attained if the nut is dry. The nut and bolt must have a film of lubricant in the thread section to be considered lubricated. It is recommended that new connecting rod bolts, nuts and washers be used during reassembly. Due to the close fit of the connecting rod nuts on the bolts, the slightest thread imperfection increases the friction to the extent that incorrect bolt tension is likely.

Connecting rod bolts and nuts must be cleaned of all foreign matter including the anti-rust materials that may be in the threads. Apply light engine oil to the threads to lubricate before installation.

2. Tightening of Connecting Rod Bolts, Nuts and Washers

Tighten the connecting rod bolts, nuts and washers alternately with the torque wrench to the specified torque. Then release the torque load to zero and retorque to specified torque. See "Torque Chart." If nut is overtightened enough to stretch the bolt, the nut and bolt both must be replaced. Use new rod bolts, nuts and flat washers in major engine overhaul.

The application of specified torque to any particular bolt or nut which serves to hold or clamp two parts together should be accomplished with a torque wrench known to be accurate.

Piston Rings

The pistons used in the V-type engines have three piston rings located above the piston pin. The compression rings are located in the top grooves while the lower groove accommodates the oil control ring. Select the proper rings for the size of pistons to be used.

Prior to installing the rings on the pistons, each ring must be checked for proper ring gap. Push the ring down into the cylinder bore making sure the ring is square with the cylinder wall. Check the space or gap between the ends of the ring with a feeler gauge, Figure 99. See specifications for proper ring gap.

NOTE:

Extreme care should be taken during this operation.

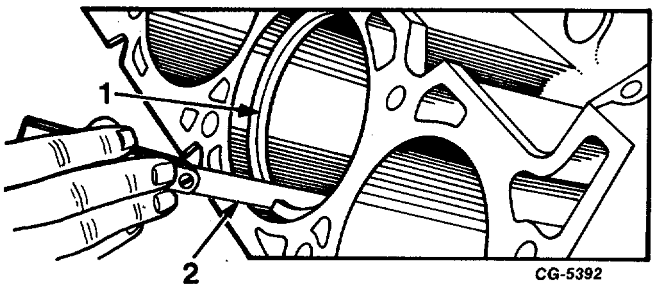


Fig. 99 Checking Ring Gap

1. **Piston ring** 2. **Feeler Gauge**

If the gap on the compression rings is less than the limit, try the next size smaller ring. Each ring should be fitted and checked in the cylinder in which it is to be used and marked accordingly.

Piston rings should be checked for side clearance in the groove of the piston on which they are to be installed. This is done by placing the outer edge of the ring in the piston groove, rolling the ring entirely around the piston to make sure the ring is free in the groove. With a feeler gauge check the side clearance

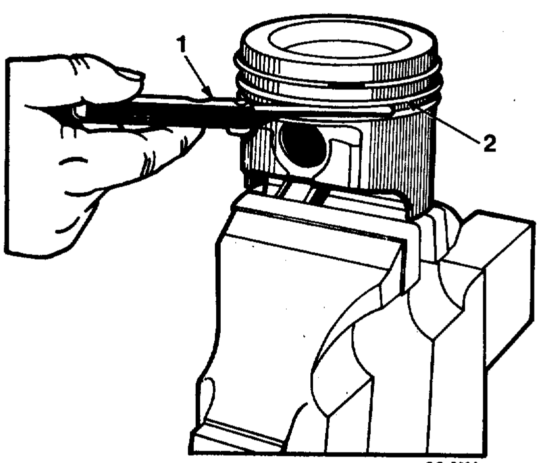


Fig. 100 Checking Ring-to-Groove Side Clearance with Feeler Gauge

1. **Feeler Gauge** 2. **Piston ring**

of each ring in its respective groove, Figure 100. See specifications for proper clearance.

Assemble the rings on the pistons to which they were fitted by using a piston suitable ring expander tool. This type of tool is recommended to avoid over-expanding and also to expand the ring to a true circle to avoid distortion, Figure 101. General practice is to stagger the ring gaps when installing piston rings. For further information refer to the instructions furnished with the service ring sets.

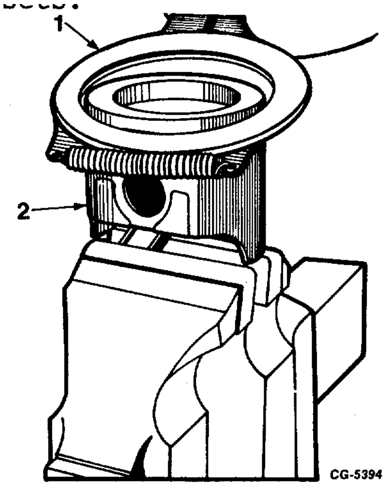


Fig. 101 Installing Piston Ring Using Suitable Piston Ring Expander Tool

1. **Piston ring expander** 2. **Piston**

Cylinder Heads, Valves, Valve Guides, Springs, Etc.

The cylinder heads, as removed from the engine, contain the valve mechanism. The rocker arms were removed prior to removing the heads. Position the cylinder head on the intake manifold surface on a clean work bench or install the cylinder head in holding fixture SE-1939 to protect the machined surfaces during cleaning and disassembly operations.

With the valves installed to protect the seats, clean the carbon deposits from the combustion chambers and valve heads with a wire brush and scraper. Wash the heads in cleaning solvent to remove dirt and grease from all surfaces and dry thoroughly. Check all water passages to make sure they are clear and open.

Examine the cylinder heads for water leaks or cracks in the combustion chambers, exhaust ports and around the valve seats. Inspect the machined or gasket surfaces for scratches or mars which could cause leakage after assembly. The use of holding fixture SE-1939 reduces the chances of gasket surface damage.

Check the gasket surface of the cylinder head for trueness with a straightedge. Test by attempting to insert a .003" feeler gauge ribbon between the straightedge and cylinder head. If this is possible, either resurface or replace the cylinder head.

NOTE:

When resurfacing the cylinder head, do not remove more than .005" material. Cylinder head height measurement should be taken between the machined surface of the head and the machined surface of the bolt bosses on the exhaust manifold side of the head. The original specification for this measurement is 3.282" ± .010".

The cylinder head assemblies and head gaskets are interchangeable from one cylinder bank to another.

To disassemble the valve assembly, turn the head assembly in a vertical position either on a clean work bench or using SE-1939 cylinder head holding fixture as a cradle to hold the assembly.

Apply a valve spring compressor and remove the valve keepers or locks, Figure 102. Remove the spring compressor and disassemble the spring retainer, valve stem seal and Roto-Coil assembly from the exhaust valves. Remove the spring retainer, valve stem damper, spring, valve stem seal and valve spring seat from the intake valves. All valves are removed in

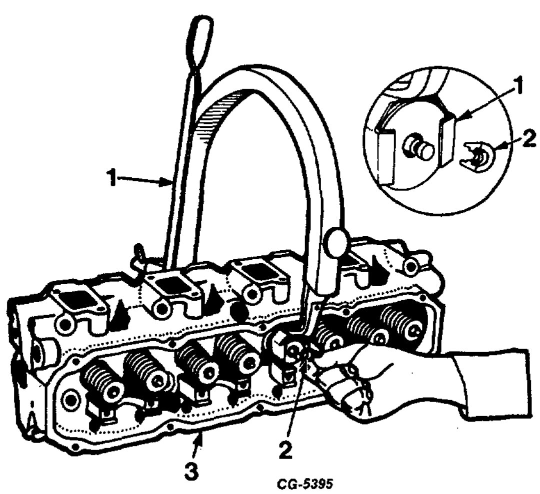


Fig. 102 Removing Valve Keepers

1. **Valve spring compressor**
2. **Keepers**
3. **Cylinder head**

the same manner. Keep valves and their related parts together so they may be reinstalled. in their respective positions.

NOTE:

It may be necessary to strike the valve ends with a light, soft hammer to break the valve keepers loose.

Remove all carbon from valve stems and head using a fine wire brush or buffing wheel. Inspect each valve, discarding any that show evidence of burned, warped or bent condition. SE-2614 valve gauge, Figure 103, or similar tool can be used for checking stem straightness and seat run-out.

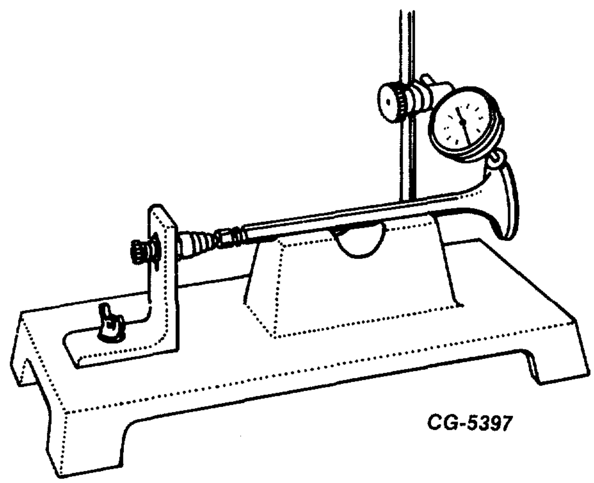


Fig. 103 Checking Valve Stem Straightness and Face Run-Out

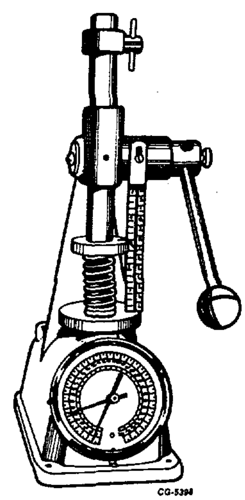


Fig. 104 Checking Spring Tension Using SE-2241 Tester

Inspect the valve springs for proper tension as outlined in specifications. Any evidence of wear, cracks or permanent sets will require replacement. SE-2241 spring tester, Figure 104, or similar tool can be used to check tension.

Inspect valve locks for excessive wear and replace in pairs as required. Rotate the Roto-Coil assemblies and replace if any wear or irregularities are noted. Note particularly if the Roto-Coil is bound up or feels gritty.

Remove SE-1939 Holding Fixture (if installed) and position the cylinder head with combustion chamber facing upward on support blocks, Figure 108. This preparation is done for valve guide removal.

Check the valve guide bore dimensions (see specifications). Prior to inspection it is necessary to clean guides. There are many commercially available wire brushes and scrapers, Figure 105, that clean guides very satisfactorily. Similarly, there are various instruments for measuring the guide bores small-bore gauge SE-2506, plug gauges, etc., Figure 106. Plug gauges of the "go" and "no-go" type are most popular because of the facility with which guides can be checked. However, there are two undesirable guide conditions which are difficult to check with gauges of this type: elliptical or egg-shaped bore wear and bell-mouthing at the port of the guide. Careful guide inspection will detect egg-shaped wear while careful use of the "no-go" gauge will tend to show the degree of bell-mouthing. Replacement is recommended for guides having bore diameters beyond the recommended limit or which are bell-mouthed more than .0005" or which show egg-shaped wear. Excessive guide clearance prevents adequate cooling of the valve through the guide and also allows deposits to tilt or tip the valve which may cause valve breakage at high engine speed. These conditions tend to prevent good seating and promote leakage across the valve face. Excessive guide clearance also affects the proper lubrication of the valve stem.

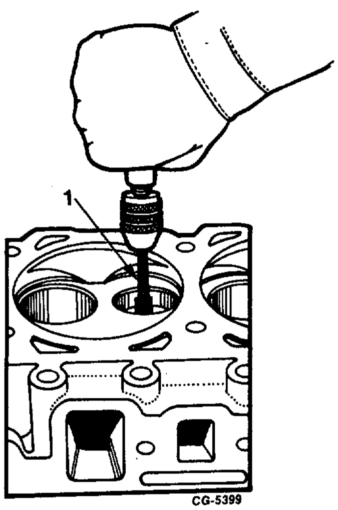


Fig. 105 Valve Guide Cleaning Tool

1. Cleaning tool

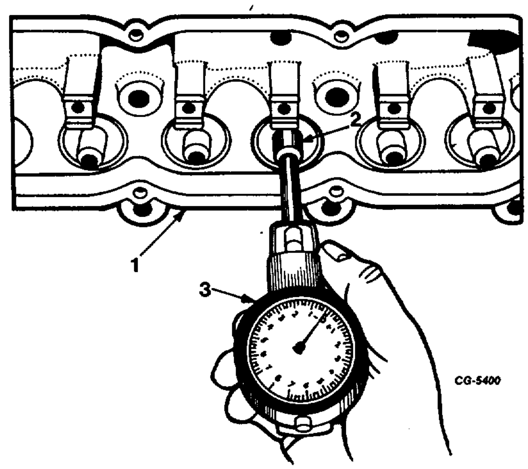


Fig. 106 Checking Guide Bore Using Gauge SE-2506

1. **Cylinder head**
2. **Valve guide**
3. **Bore gauge**

Replacement guides are designed to give proper clearance when installed in the cylinder head. Reaming is not required but care must be taken to see that-the ends of the guides are not burred during installation.

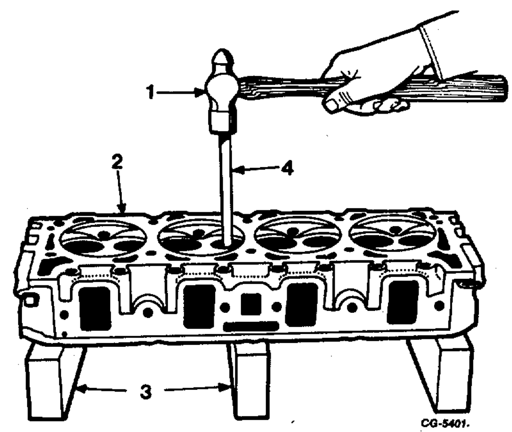


Fig. 107 Removing Valve Guides with SE-1722

1. **Hammer**
2. **Cylinder head**
3. **Support blocks**
4. **Remover**

Remove all guides that exceed wear limitations using SE-1722 valve guide remover. All guides must be driven from the combustion chamber side through the top of the head as shown in Figure 107.

NOTE:

Support blocks used for removing valve guides should be 9" long x 3-5/8" high x 1-5/8" thick rectangular hardwood blocks. These blocks should not be used for installation of valve guides.

Turn the cylinder head over with the top side up on the wood support blocks positioned in the press. Install the valve guides from the top side of the cylinder head using SE-1943 valve guide installer, Figure 109. The tool is designed to install both valve guides. This can be accomplished by adjusting the installer screw in the body to a depth that is equivalent to the specified height that guides are to be installed above the head. Figure 109 illustrates the method to be used when adjusting the installer for specified guide height. Press the guides in until the installer rests firmly on top of the cylinder head, thus maintaining proper spacing.

NOTE:

Guides should be lubricated with a mixture of light engine oil and white lead upon installation. Clean away any excess lubricants.

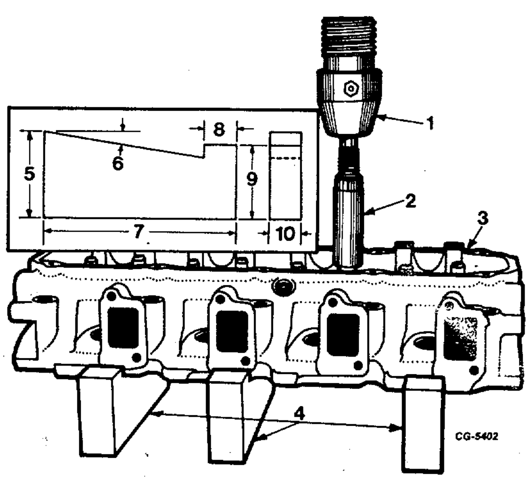


Fig. 108 Installing Valve Guides with SE-1943 Installer and Adaptor

1.	**Press m**	6.	**9°**
2.	**Installer**	7.	**9"**
3.	**Cylinder head**	8.	**11/2**
4.	**Support Blocks**	9.	**31/2"**
5.	**4 1/8**	10.	**11/2"**

NOTE:

Support blocks for installing valve guides can be made locally to the dimensions shown in the insert on Figure 108.

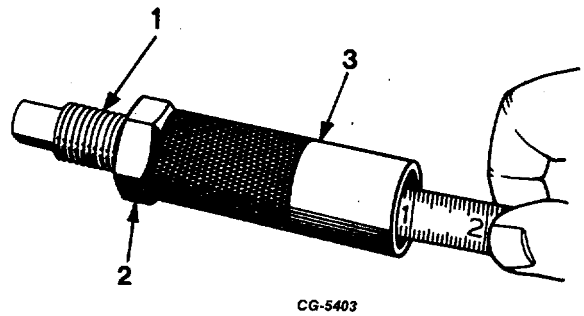


Fig. 109 Adjusting Valve Guide Installer SE-1943 for Proper Height

1. **Adjusting screw**
2. **Locknut**
3. **Body**

After guides are installed, insert SE-2215 reamer in the guides to see that they have not been distorted during installation and to remove any burrs.

Cylinder head core plugs should not be disturbed unless evidence of leakage exists. Remove and install plugs as inspection warrants. The plugs can be removed by drilling a small hole in the center of the plug and with a suitable pry or screwdriver, remove the plug from its bore. To install a new plug, coat the outer edge with a suitable nonhardening sealing compound and with installer SE1945 and driving handle SE-1581-IB, install plug flush with bottom edge of chamfer in cylinder head, Figure 110.

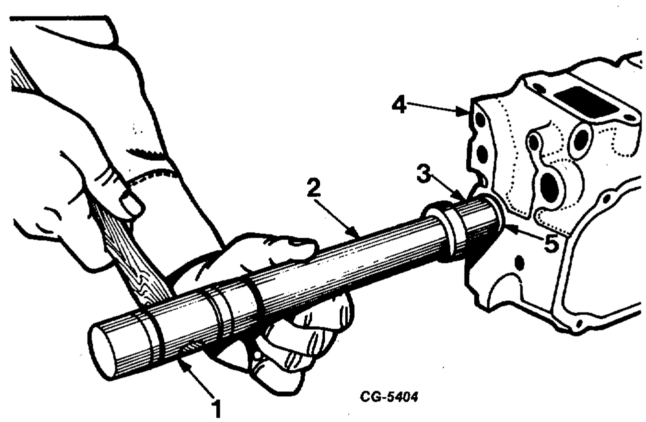


Fig. 110 Installing Cylinder Head Core Plugs Using Installer SE-1945 and Driver Handle SE-1581-1B

1. **Hammer**
2. **Driver handle**
3. **Installer**
4. **Cylinder head**
5. **Core plug**

Inspect the exhaust valve seat inserts for looseness, burned or cracked condition. Use SE-1951 valve insert remover, Figure 111, to remove defective inserts. Position the remover collet into the insert and turn the coned screw out to expand the collet jaws, thus providing a firm grip under the insert ring. Use a slide hammer to remove the insert.

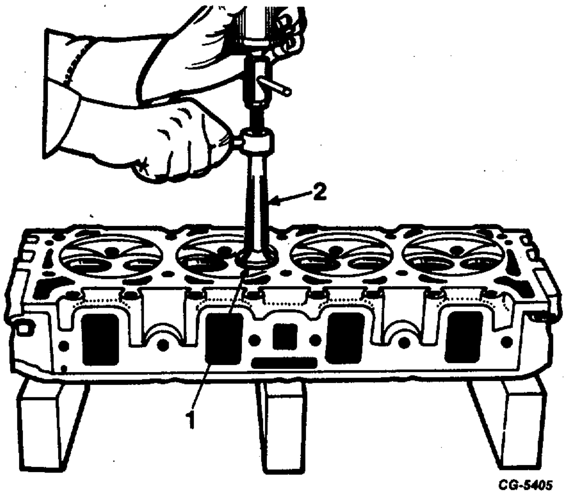


Fig. 111 Pulling Exhaust Valve Insert with SE-1951 Remover

1. Exhaust valve insert **2. Valve insert remover**

Prior to seat reconditioning, it is desirable to clean the seats in order to expose any cracks or other conditions likely to promote valve failure. Such inspection is particularly important in engines equipped with hard seat inserts; cracked or loose inserts are not uncommon and are usually caused by improper installation. Good practice requires that the insert counterbore in the cylinder head be machined prior to insert installation, Figure 112. Cutters are available to dress both the bottom and circumferential surfaces, but regardless of the method, the bottom of the counterbore must be square to assure good seating of the insert.

Before installing inserts they should be thoroughly chilled with dry ice or other means to facilitate their installation in the cylinder head. Use the installer tool, Figure 113, from the counterbore tool set'SE-1797. Valve seat inserts supplied for service are standard size, .015" oversize and .030" oversize.

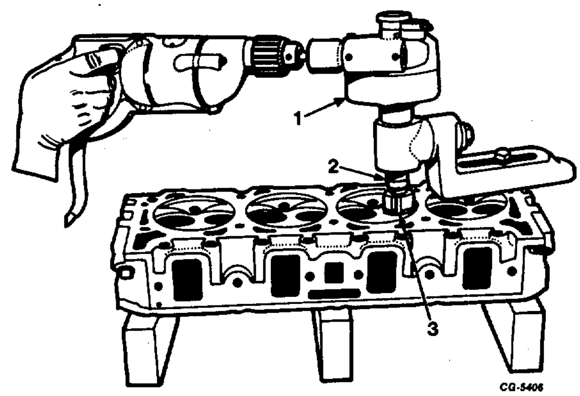


Fig. 112

1. **Cutter drive unit**
2. **Drive shaft**
3. **Cutter**

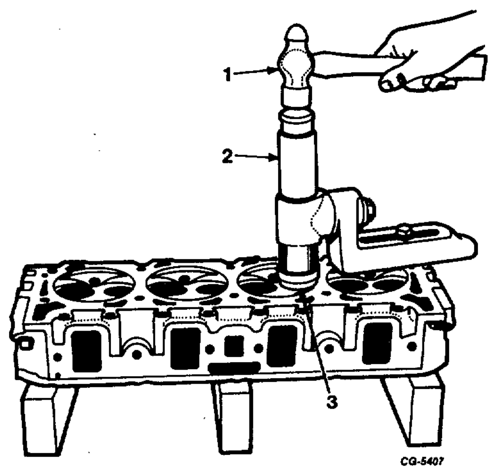


Fig. 113 Using Insert Installer from Counterbore Tool Set SE-1797 for Installing Inserts in Cylinder Head

1. Hammer **3. Seat**
2. Driver

The valve seats "A" and "B" in the cylinder head, Figure 114, must also be ground true to the angles and width shown in the specifications section. If the seat is wider than specified, it will be necessary to grind from the top and/or bottom of the seat until the proper seat width is obtained using grinder SE1631, Figure 115.

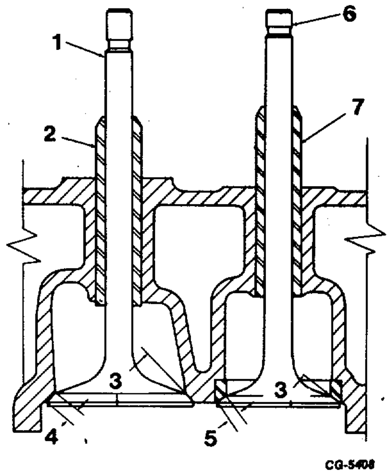


Fig. 114 Sectional View of Valves

1. **Intake valve**
2. **Intake valve guide**
3. **Angle**
4. **A**
5. **B**
6. **Exhaust valve**
7. **Exhaust valve guide**

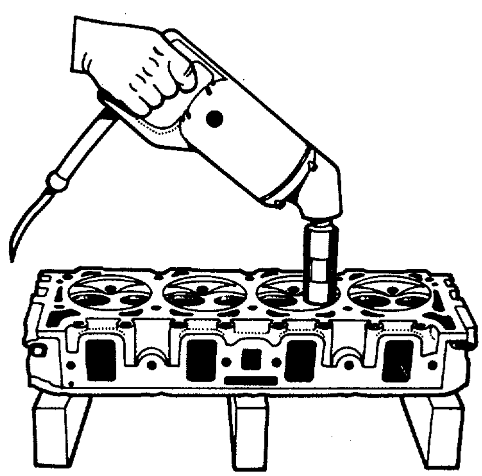


Fig. 115 Grinding Seats Using SE-1631 Grinder

Use a 60° angle grinding stone to remove stock from the bottom of the seat (raise seat). Use a 30° angle stone to remove stock from the top of the seat (lower seat).

After the seat grinding operation has been performed, it is necessary to check the seat for run-out, Figure 116. Seat run-out should not exceed limits as shown in specifications.

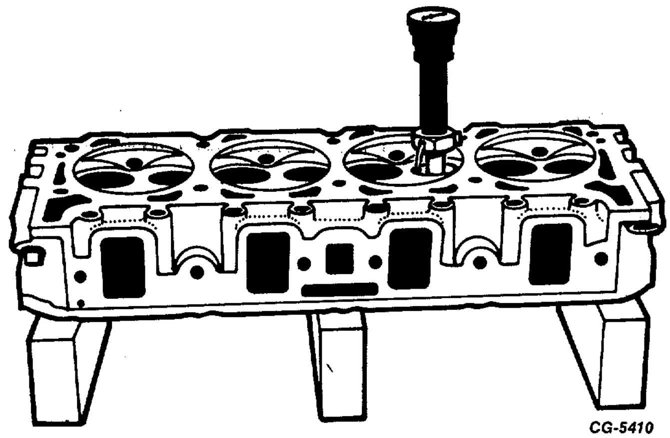


Figure 116 Using Gauge from SE-1631 Tool Grinder Set for Checking Seat Run-Out

It is important to have the finished seat face contact the approximate center of the valve face. Position the valves in the cylinder head. Place a thin coat of Prussian Blue on each valve face and tap the valve lightly to its seat.

NOTE:

This is merely for test and proof of results of refacing and reseating operations. A poor grind job cannot be corrected by lapping. Use of lapping compounds is not recommended. A nearly perfect seat often-times is destroyed by attempting to lap the valves to their seats. Inspect each valve for seat dimensions as outlined in specifications and make any necessary corrections. The corrections should always be made on the seat and not the valve face.

NOTE:

New valves need not be refaced; however, all valves should be carefully inspected for damaged seat faces or for a run-out condition due to a bent valve stem. Use SE-2614 tool to determine the condition of the valve.

If the ends of the valve stems are grooved or scored, they may be ground to true up; however, remove only a minimum amount of material. Rechamfer as necessary.

Wipe valve faces and valve seats with a cleaning solvent to remove all dirt or foreign material. Coat the valve stems and faces with oil and install the valves in the same seats to which they were checked. On the exhaust valves, install the Roto-Cap assembly, valve spring, valve stem damper, valve stem seal and spring retainer. On the intake valves, install the valve spring seat, valve stem seal, valve spring, damper and spring retainer.

NOTE:

Care should be taken to see the valve stem seals are installed correctly. If they are not, their effectiveness in directing oil to the valve guide could be reduced, Figure 117. Notice the valve stem seal is under the spring retainer.

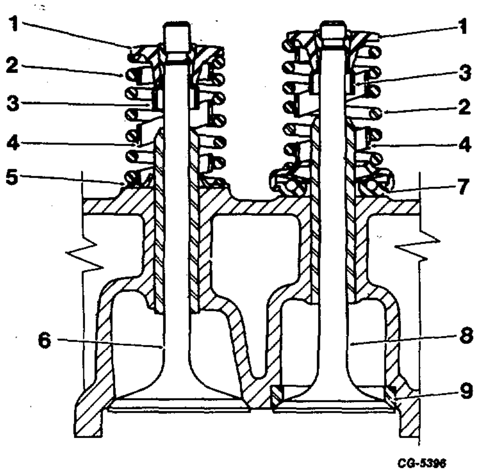


Fig. 117 Cross Section of Intake and Exhaust Valves Installed in Head

1. **Retainer**
2. **Spring**
3. **Seal**
4. **Damper**
5. **Seat**
6. **Intake valve**
7. **Roto coil**
8. **Exhaust valve**
9. **Insert**

Compress the valve springs with a valve spring compressor and install the valve spring retainer locks. Be sure the retainer and locks are correctly seated on all valves.

The cylinder head assembly complete with valves is ready for installation on the cylinder block or crankcase.

Rocker Arm Assembly

Individually mounted rocker arms are retained by flange head retaining bolts and pivot balls, Figure 118. All parts must be retained in the same order as they were on the engine.

Clean all parts with a good cleaning solvent and use compressed air to clean out the oil passages in the rocker arms.

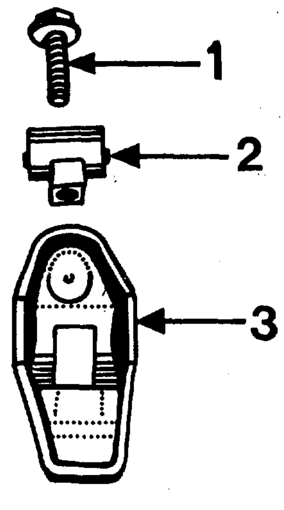


Fig. 118

1. **Retaining bolt**
2. **Pivot ball**
3. **Rocker arm**

Inspect the pivot surface of each rocker arm and pivot ball and replace any parts which are scuffed, pitted or excessively worn. Inspect the valve stem contact surface of each rocker arm and replace any rocker arm which is deeply pitted. Inspect the rocker arm retaining bolts for excessive wear or looseness in the cylinder head: replace if condition exists.

Push Rods

The push rods are hollow and serve as oil galleries to lubricate each individual rocker arm assembly. Prior to installation the push rods should be cleaned thoroughly and inspected for wear and deposits which may restrict the flow of oil to the rocker arm assemblies.

Check all valve lifter push rods for straightness by rolling on a flat surface, Figure 119

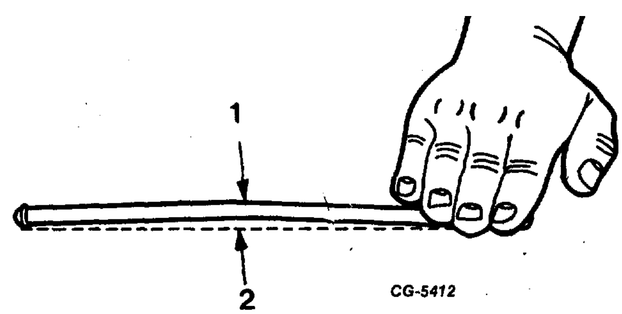


Fig. 119 Checking Push Rod for Straightness

1. **Bent valve lifter rod**
2. **Flat surface**

Hydraulic Valve Lifters (Tappets)

The hydraulic valve lifter or tappet consists of a body (cylinder), plunger, plunger spring and check valve assembly and is removed from the engine as an assembly. The lifters are removed after removing the valve cover, rocker arms and push rods.

NOTE:

If a tappet cannot be removed due to carbon buildup, use a carburetor solvent in the tappet bore. However, if any excessive amount of solvent is used, it will be necessary to change the oil.

Optional sources of hydraulic valve lifters have been established. When disassembling the lifters, do not mix the components of any lifter. Figure 120, illustrates the difference in construction between types "A" and "B." Generally, the service instructions are the same for all types of hydraulic lifters. The push rods are common for all types of lifters.

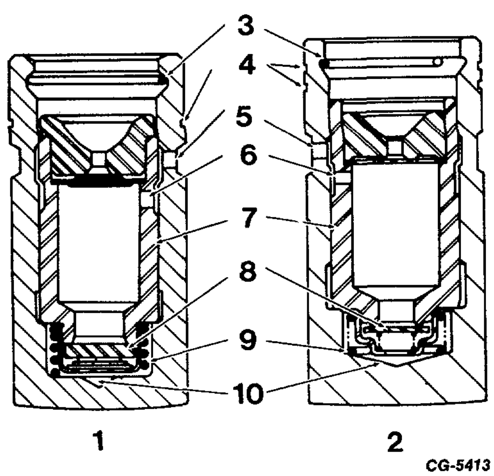


Fig. 120 Sectional View of Hydraulic Tappets Showing Types "A" and "B"

1.Type A
2.Type B
Snap ring
Identification rules
Tappet oil hole

6. Plunger oil hole
7. Plunger 3.
8. Check valve 4.
9. Spring 5.
10. Oil Chamber

Operation of Valve Lifter

Oil from the engine lubricating system is fed to a supply chamber in the hydraulic lifter plunger from which it can flow directly through the plunger, past the check valve and into the compression space between the bottom of the body and the plunger. When the engine is started, oil pressure is built up in the system which fills the supply chamber. With the lifter on the base circle of the cam and the engine valve seated, the light plunger spring moves the plunger outwardly to remove all lash from the valve gear. As the plunger moves outward increasing the volume in the compression chamber, the check valve moves off its seat and the chamber is supplied with oil. As the camshaft rotates and lifts the body upward, a pressure is immediately built up in the compression chamber, forcing the valve onto its seat. Further rotation of the camshaft lifting the valve gear against increasing valve spring pressure increases the oil pressure in the compression chamber, thus acting as a solid member of the valve operating mechanism. As long as the engine valve is off its seat, the load of the mechanism is carried by the column of oil. During initial running of the engine, there might be some air remaining in the compression chamber which, under pressure, tends to leak through the clearance between the plunger and cylinder, thus decreasing compression space volume. However, when the lifter is again on the base circle of the cam, the plunger moves outward, drawing in more oil so that after a number of cycles, the air is completely eliminated and a solid column of oil is maintained in the compression space. During this period when some air is present in the compression space, the valve gear may be somewhat noisy, since it has the same effect as excessive lash with aerated oil. However, once the unit is completely cleared of air, it then becomes a true hydraulic system.

The compensation required to take care of variations in length from the cam to the valve seat is accomplished by the original fit of the plunger in the cylinder bore. These parts are selectively fitted to give a predetermined slight leakage of oil (called leakdown) under load. The purpose of this predetermined leakage is to permit the valve to seat irrespective of the change in length between the cam and valve seat. If the valve gear is expanding, thus reducing the distance between the cam and valve seat, the load imposed by the valve spring on the lifter causes the above mentioned slight leakage between the plunger and cylinder, reducing the clearance volume and, therefore, the overall lifter length. When the valve gear length increases, as caused by lower engine temperatures, the plunger spring keeps all the valve gear parts in contact, increasing the clearance volume under the plunger. At the same time oil is immediately fed past the check valve, thus maintaining correct length under all conditions. This keeps the valve gear operating at no-lash. With this predetermined leakage, is impossible for the no-lash lifter to hold the engine valve open when it should be closed.

When the lifter body is on the base circle of the cam and the engine valve is closed, the only force tending to hold the valve open is from the light plunger spring, which obviously is much lower than the valve spring load. The only additional force tending to push the plunger upward results from pressure of the lubricating oil but its effect is negligible since it is controlled and only acts on the small plunger area.

During shutdown periods of the engine, one or more valves are always in the lifted position thus imposing the full valve spring load on the plunger. This causes oil to leak out of the compression chamber through the clearance space. When the engine is again started, the particular valve that was in the open position returns to its seat and the plunger is immediately forced upward by its spring. Oil from the supply chamber is again fed into the clearance volume under the plunger so that in a very few cycles, the valve gear is operating on a solid hydraulic oil column.

II. When to Service

A. Loud clacking, light clicking or intermittent noise is attributed to a lifter.

Dirt, chips, varnish, etc., generally cause only a few units to become inoperative at any one time. Aeration caused by high or low oil level air leaks into the oil pump suction line, etc., result in all lifters becoming noisy. The cause of aeration must be corrected before the lifters will again operate quietly.

Small metal chips lodging between the plunger and the cylinder tend to prevent free movement. Since loads during the lift portion of the cycle are relatively high, the plunger is forced downward and the very light plunger spring has insufficient force to move the plunger back to normal operating position. After a few lift cycles with metal chips between the plunger and cylinder, the plunger finally reaches a position (usually plunger bottomed) where there is excessive lash in-the valve train with resulting noisy operation.

The type of varnish, resulting from a mixture of permanent antifreeze and oil, is very "tacky" and, particularly when cold, will prevent free movement of the plunger. The resulting action is the same as that caused by a chip in the clearance space. The entire engine must be cleaned and the cause of the leakage corrected.

Varnish of the type resulting from fuels and lubricants, unless excessive amounts are created by poor crankcase ventilation or extremely bad lubricants, seldom causes sticking in the lifter. However, if such deposits do form and cause trouble, it is then necessary to correct crankcase ventilation, lubricant or fuel.

1. Loud clacking noise is the result of excessive lash and indicates that:

   a. The plunger is stuck below its normal operating position, probably plunger bottomed and in this case, the lifter must be disassembled and cleaned of dirt and varnish.
   b. The check valve may not be sealing due to dirt or a damaged seat, which also necessitates cleaning and inspection.
   c. Oil may contain sufficient air, which is compressible, to permit collapse or partial plunger movement beyond its normal operating position. It is necessary to locate and correct the cause of aeration. Just servicing the lifter will not help.

2. Light clicking type noise indicates that the plunger is operating only slightly below its normal position as the result of:

   a. Slight leakage by the check valve or plunger. If the noise is persistent, the lifter must be removed, cleaned and checked.

b. Small amount of air in oil which can only be helped by eliminating the aeration.

3. Intermittent noise is usually the result of:

a. Metal chips or dirt. Occasionally such material becomes lodged between the check valve and seat. Cleaning will correct this condition.

b. Slight plunger sticking caused by dirt or varnish-like substances, which necessitates cleaning and eliminating the source of varnish.

B. When engine is overhauled.

Lifters will need to be removed and normal varnish deposits cleaned off whenever a change has been made that will increase the distance from the cam to the valve tip. This change may cause the plunger to be forced into a varnish deposit accumulated above the original travel of the plunger. Since the plunger previously had not been required to operate in this position, the lifter must be removed and cleaned of all varnish deposits so the plunger can move freely.

The following will cause increased valve train length:

1. Grinding valve tips.
2. Valve train parts not put back in their respective locations.
3. Installing new parts.

Even when doing a valve grind job, it may not be necessary to disturb the lifters. However, it may be found occasionally that worn valve tips will need to be ground to give a smooth surface. In this case the length from cam to valve tip would be increased, which necessitates cleaning the lifter as mentioned above.

<u>As a general rule, hydraulic lifters should be left alone when they are functioning satisfactorily and the valve train or gear remains reasonably quiet</u>. The hydraulic lifter is a fairly simple positive action device which will continue to deliver trouble-free service under all normal engine operating conditions. The major cause of hydraulic lifter problems, where any exist are usually due to grit, dirt or metal chips carried to the lifter with the engine oil.

To minimize lifter contamination, a special box or container should be used to store the lifters when they are first removed from the engine or after they have been cleaned and tested. Keep the lifters in this container until ready for installation in the engine. The container should be numbered to assure return of the lifters to their original location in the engine.

NOTE:
Even when the lifters are working correctly, there are other engine noises which are often "blamed" on lifters but can susally be identified. These may be caused by: valve stem guide clearance, worn timing gears, piston slap, lifter body clearance, worn lifter face or cams, loose main or rod bearings, worn rocker arms, ignition knock, worn valve tips or tight rocker arms.

III. Lifter Disassembly

Before disassembling lifters it may be necessary to remove a portion of the oil from the lifter body. This can be accomplished by turning the tappet upside down and letting it drain for a few minutes. Then with the end of a push rod, compress the plunger and remove the snap ring located on the inside top of the assembly.

Caution should be used in order that the snap ring does not "pop out" and become lost. Removal of this snap ring should allow the separate socket to be readily removed. By shaking the assembly gently, the plunger should also come out unless it is held in place by carbon and varnish deposits. If this is the case, some force will be required to remove the plunger from the body. It may be necessary to hold the assembly upside down and bump the open end gently against some resilient surface (masonite, etc.). Care should be taken so the plunger or body will not be damaged.

After removing the plunger, the check valve assembly may be found to be loose on the plunger. Care should be taken so the small, flat check valve and valve retainer spring are not lost. If the check valve assembly stays attached to the plunger, it would be best to leave it in this position.

IV. Servicing the Lifter

The following is the service procedure to be followed in servicing hydraulic lifters:

A Immerse the unit in carburetor or other suitable solvent to remove excess engine oil and soften varnish deposits.

B. To avoid mixing plungers and cylinders, take one lifter apart at a time and complete all servicing before working on another. However, if tray SE-1892, Figure 121, is available for keeping plungers and cylinders together, all lifters may then be disassembled at the same time.

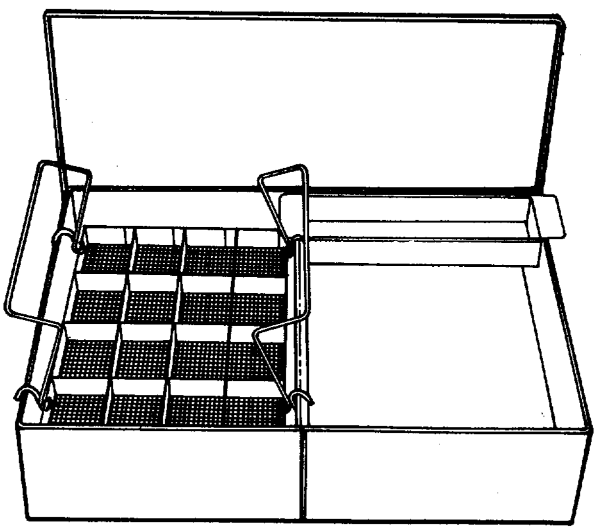


Fig. 121 Hydraulic Lifter Tray SE-1892

C. Wash all parts in solvent and clean all varnish from the plunger and inside diameter of the cylinder.

D. Inspect the plunger and cylinder walls for scratches. Look for nicks on the valve seat and examine the condition of the lifter face. Check for plugged oil holes.

E. Try the plunger for free fit in the cylinder. F. Reassemble all parts in proper sequence Figure 120.

NOTE:

The valve lifter body is to be filled 1/3 full with clean kerosene before assembly of component parts. The parts are to be prelubricated with clean kerosene before assembly. Use of kerosene in place of engine oils provides a faster leakdown and rapid expelling of trapped air in the lifter assembly, thus eliminating the possibility of damage to the valve train when installing the push rods and rocker arm shaft assembly. Engine oil will dilute the kerosene in the lifters as soon as the engine is operated for a short period.

G. After the unit has been washed thoroughly, determine whether the leakage past the plunger and cylinder is correct and if the check valve is functioning correctly. This may be done using one of the two following methods:

1. The SE-1893 leakdown tester, Figure 122, may be used for checking the leakdown rate if available. Instructions which accompany the tester should be followed.

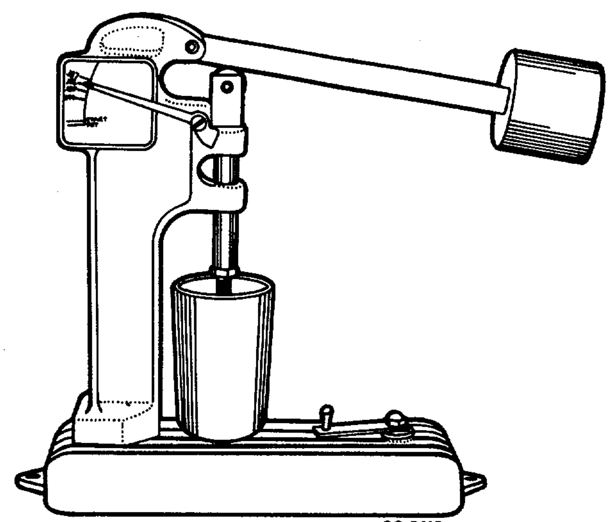


Fig. 122 SE-1893 Tester Used for Checking Leakdown Rate of Tappet

2. If the leakdown tester is not available, a finger check method can be used. In order to check a unit in this manner, make sure there is no lubricating oil on the cylinder or plunger such as immediately after washing in solvent. With the cylinder held in one hand, start the

plunger into the cylinder (do not install the plunger spring) with the other. Depress the plunger with your finger and release quickly. The plunger is now operating against air which is sealed in by the check valve and by the close fit of the cylinder to the plunger. It should yield slightly to the pressure of the finger on the plunger, but the plunger should kick-back upon release of the pressure. If no kick-back of the plunger occurs, the unit may or may not be defective. The lack of kick-back is due to one of three conditions.

First, air is escaping past the check valve because of presence of dirt which prevents proper seating of the valve. Second, air is escaping past the check valve because of a damaged seat. Third, air is escaping because the clearance between the plunger and cylinder wall is too great, which indicates excessive leakdown rate.

Rewash the unit to eliminate any dirt which might still be on the check valve seat and repeat the test. If there is still no kickback, the check valve is damaged and the entire lifter, consisting of cylinder body and plunger, may need to be discarded.

NOTE:
In the event check valve leakage is encountered due to wear on the surface of the check valve, the valve can be turned over to the unworn side. This procedure will extend the useful service life of the lifter assembly, provided all other parts of the lifter are in good condition.

In the above test procedure it is important that the pressure on the plunger be released immediately after it is depressed. If the plunger is held down too long, all the air trapped under the plunger will leak out and the test would be inaccurate.

The unit is suitable for reinstallation in the engine if the test is satisfactory.

Crankshaft

Wash and clean the crankshaft with cleaning solvent or steam.

Inspect the crankshaft for cracks, scored, grooved or worn main bearing and ' connecting rod journals. If journals show wear or out-of-round in excess of .002", the shaft should be reground and undersize bearings installed or the crankshaft replaced. Use a micrometer for checking.

Examine the crankshaft timing gear teeth and replace the gears if the teeth are worn or damaged.

NOTE:

Replace the timing gear on the camshaft when replacing the crankshaft gear. These gears are serviced in matched sets.

Camshaft

Wash the camshaft in cleaning solvent and remove all sludge or carbon deposits with a soft brush.

Inspect the camshaft journals for signs of wear or out-of-round and replace if wear warrants. See ENGINE OVERHAUL Cylinder Block.

Inspect the camshaft lobes. If worn, chipped or scored, replace the camshaft.

Inspect the distributor drive gear and camshaft gear and replace if wear warrants or the gear teeth are nicked or otherwise damaged.

Inspect the fuel pump cam. If worn, chipped or scored, replace the cam.

NOTE:
If the distributor drive gear, fuel pump cam and camshaft gear were removed without complete engine disassembly, they may be reinstalled as follows:

1. Install distributor drive gear against thrust flange on camshaft using SE-1900-14 sleeve with SE1900-16 adapter, Figure 123. A thrust bearing is also used under the forcing screw nut to reduce friction.

IMPORTANT:
Use extreme caution so as not to chip the distributor gear teeth.

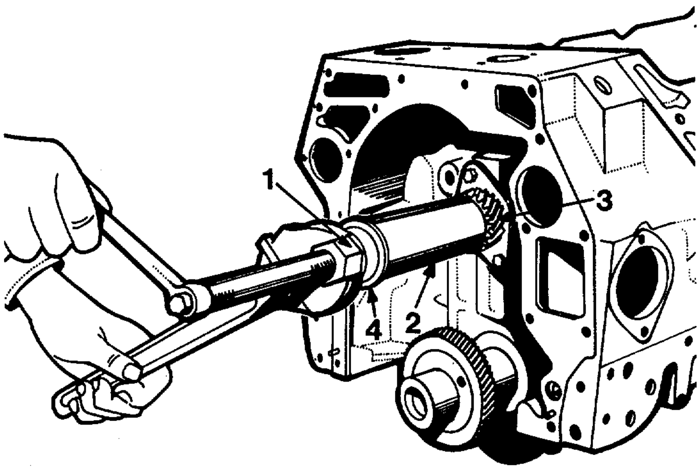


Fig. 123 Installing Distributor Drive Gear Using SE-1900 Tool Set with Thrust Bearing

1. Nut **3. Distributor drive gear**
2. Sleeve **4. Thrust bearing**

2. Install fuel pump cam against distributor drive gear on camshaft using SE-1900-14 sleeve with SE1900-16 adapter and thrust bearing in a manner similar to Step 1.
3. Install camshaft gear against fuel cam on camshaft using SE-1900-14 sleeve with SE-1900-16 adapter and thrust bearing in a manner similar to step 1.
4. Install camshaft gear alien screw and torque to specified torque. See "Torque Chart."

Crankshaft Bearings

The bearing inserts used in this engine are selective fit and require no line reaming upon installation. The bearings are available for service in standard and undersizes for use on journals that have been reground.

If inspection revals badly worn or scored bearings, replace the bearings. The installation of new bearings must be closely checked to maintain the proper clearance between the journal and the bearing surface. A convenient and accurate method for checking the clearance is with the use of Plastigage.

A. General Fitting Procedures

When wear reduces the bearing-tocrankshaft running clearance, undersize precision-type bearing shells should be installed. Premature bearing failure will result from attempts to reduce journal-to-bearing running clearances by reworking bearing caps, bearings or both. Such reworking will alter the engineered fit of the bearing shells in their bores and destroy the specifically desired "crush."

When installing precision-type connecting rod or main bearings, it is important the bearing shells fit tightly in the bore. The bearing manufacturer makes the diameter at right angles to the parting line slightly larger than the actual diameter of the bore into which they are assembled to accomplish this. When the assembly is drawn up tight, the bearing is compressed assuring a positive contact between the bearing back and the bore. This increased diameter is referred to as bearing "crush," Figure 124.

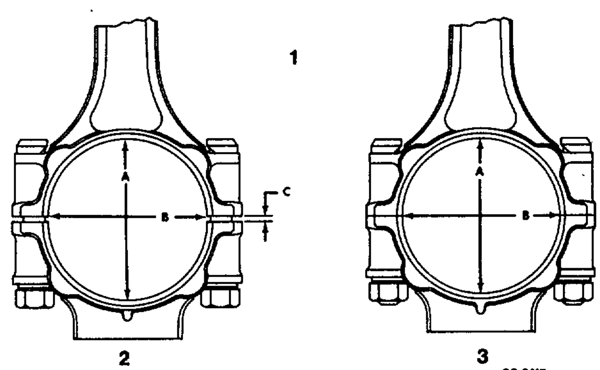


Fig. 124 Illustrating Bearing Crush

1. **Difference between diameters (A) and (B) is bearing crush (C)**
2. **Diameter (A) at right angles to parting lines greater than diameter (B).**
3. **With bearing cap drawn up tight diameters (A) and (B) equal.**

To obtain proper bearing assembly with the correct "crunch," care must be taken when tightening the clamping bolts and nuts to make sure they are drawn down alternately and evenly using a tension wrench and tightened as specified.

Rod caps or blocks must not be filed, lapped or reworked in any other manner in order to reduce clearance. While such practice may make a tighter fit at top and bottom, it will result in an out-of-round bore and bearing shell distortion.

Main and connecting rod bearings are designed with the "spread" (width across the open ends) slightly larger than the diameter of the crankcase bore or connecting rod bore into which they are assembled. For example, the width across the rod bearing not in place is approximately .025" more than when the bearing is in position. This condition is designed into the bearing to cause it to spread outward at the parting line when "crush" load is applied by tightening the nuts and bolts. Some of this "snap" may be lost in normal use, but the bearing need not be replaced because of a nominal loss of this condition.

This condition causes the bearing to fit snugly in the respective bore. The bearing must be "snapped" or lightly forced into its seat, Figure 125.

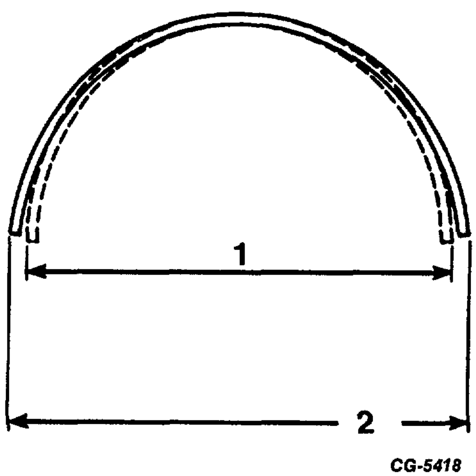


Fig. 125 Illustrating Bearing Spread

1. O.D. of bearing when installed is the same as the diameter of the crankshaft or conn. rod bore.

2. Spread of bearing before installation

BEARING SPREAD DIMENSIONS

Bearing O.D. (Installed)	Specified Spread	Spread of Bearing "A" Fig. 122
Connecting Rod Bearings		
2.6245-2.6250	.030-.0305	2.6545-2.6555
Main Bearings		
No's 1, 2, 4 & 5		
3.3160-3.3152	.0200-.0208	3.336
No. 3 (Thrust)		
3.3160-3.3152	.0020-.0168	3.318-3.332

B. Fitting Main Bearings

To obtain an accurate reading using the Plastigage method of checking, all bearing caps must be in place and torqued to specifications.

1. Remove one bearing cap and insert. Remaining caps are left tight while checking the fit of this bearing.

2. Wipe the oil from all contact surfaces such as crankshaft journal, bearing insert, bearing caps, etc.

3. Place a piece of Plastigage the full width of the bearing surface on the crankshaft journal (or bearing cap insert) approximately ¼" off center. Install bearing cap and tighten cap bolt to recommended torque.

   NOTE: Do not turn crankshaft while making check with Plastigage.

4. Remove bearing cap and insert.

5. Do not disturb Plastigage. Using the Plastigage envelope, measure the widest point of the Plastigage, Figure 126. This reading indicates the bearing clearance in thousandths of an inch.

6. If the bearing clearance is not within specifications, the crankshaft must be reground and underside bearings installed.

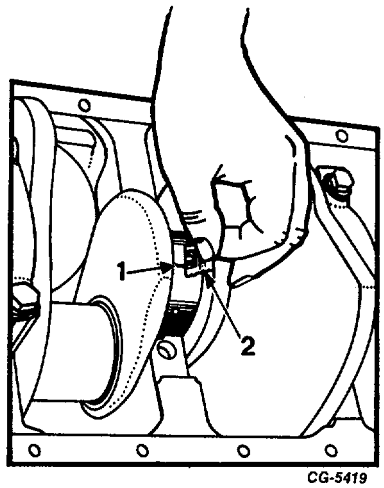


Fig. 126 Checking Main Bearing Clearance

1. Plastigage flattened **2. Gauge**

7. The third crankshaft bearing controls the crankshaft thrust and provides initial location of the crankshaft in relation to the crankcase. Use dial indicator to check end play, Figure 127.

C. Fitting Connecting Rod Bearings

1 Remove bearing cap and wipe oil from face of bearing insert-and exposed portion of crankshaft journal.

2. Place a piece of Plastigage on the bearing surface the full width of the bearing about ¼" off center.

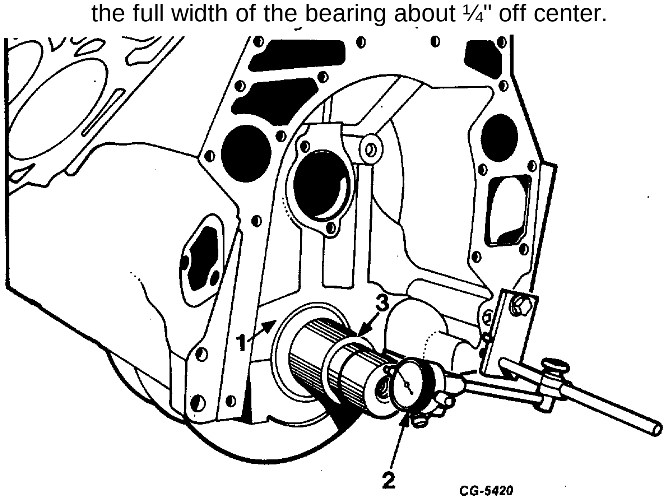


Fig. 127 Checking Crankshaft End Play

1. **Crankcase** 3. **Crankshaft**
2. **Dial indicator**

3. Install cap and tighten to recommended torque.

   NOTE: Do not turn crankshaft while Plastigage is in place.

4. Remove bearing cap and use Plastigage scale to measure widest point of Plastigage, Figure 128. This reading indicates the bearing clearance in thousandths of an inch.

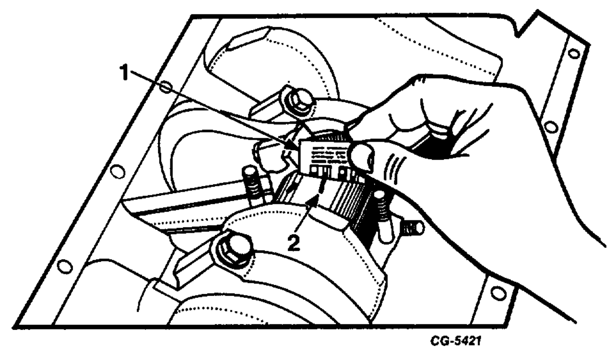


Fig. 128 Checking Connecting Rod Bearing Clearance

1. Gauge **2. Plastigage flattened**

5. If the bearing clearance is not within specifications, the crankshaft must be reground and undersize bearings installed.

6. Check the connecting rod end clearance using a feeler gauge as shown in Figure 129. Excessive clearance may require replacement of rods or shaft. The check should be made to make certain the specified running clearance exists. Lack of clearance could indicate a damaged rod or a rod bearing out of position.

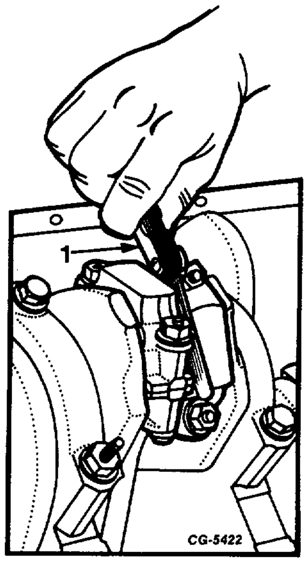


Fig. 129 Checking Connecting Rod End Clearance

1. Feeler gauge

Oil Pump Assembly

The oil pump, Figure 130 consists of two gears and a pressure relief valve enclosed in the body. The pump is driven from the distributor drive gear which, in turn, is driven by a helical gear on the camshaft.

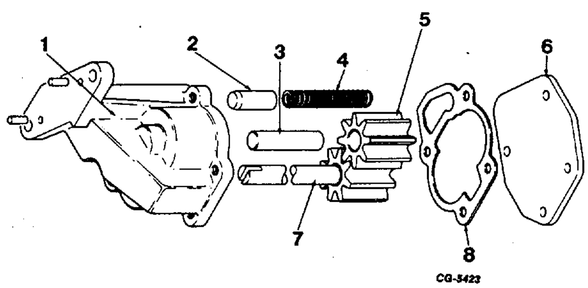


Fig. 130 Exploded View of Oil Pump

1. Body	**5. Idler gear**
2. Valve	**6. Cover**
3. Idler shaft	**7. Drive shaft and gear**
4. Spring	**8. Gasket**

The body is equipped with a regulator valve that limits oil pressure to approximately 50 psi.

The pump intake is through a screen assembly attached to the pump body. A mesh screen filters out particles of dirt which may be present.

A thorough cleaning and inspection of the oil pump should be made whenever the oil pan is removed from the engine. The recommended inspection and repair procedures are as follows:

1. Wash all pump parts and screen assembly in cleaning solvent.
2. With pump cover removed and gears and shaft in place, exert pressure against the gears with the thumb so as to push the gears away from the outlet side of the pump.
3. While holding the gears in this manner, measure the clearance between the outside diameter of the gear and the bore of the housing, Figure 131. Clearance should be within the limits given in the specifications.

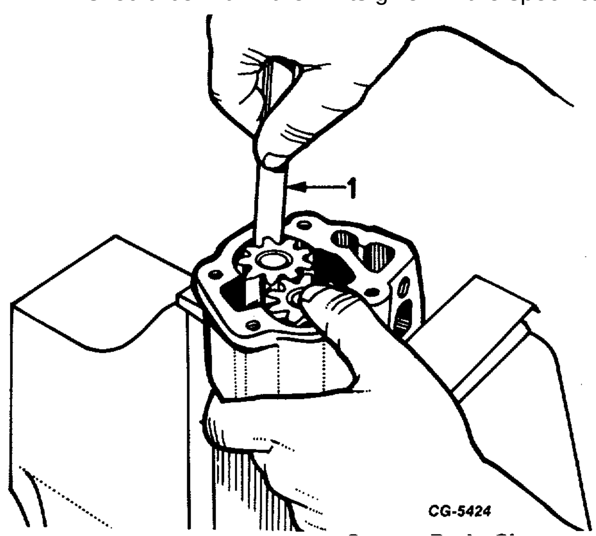


Fig. 131 Measure Pump Gear-to-Body Clearance

1. Gauge

4. If clearance is less than specifications, obtain new parts.

5. Check the pump shaft clearance in the bore. To correct for wear beyond limits given in specifications, replace pump assembly.

6. Check backlash between pump body gears If this exceeds the figure shown in the specifications, replace gears.

7. Establish body gear end clearance.

   NOTE: The oil pump cover gasket controls the clearance (end play) between the pump body gears and the pump cover. Add or remove gaskets to obtain desired clearance. See "'Specifications."

8. When installing pump gears and shaft, these parts should be oiled liberally with engine oil for initial lubrication.

9. Before installing the relief valve in the pump body, insure valve is free of burrs and the valve bore is free of varnish so the valve operates smoothly in its bore.

   NOTE: If it becomes necessary to remove burrs from the valve, insure valve edges are not rounded.

10. Check relief valve spring for proper tension. See SPECIFICATIONS.

11. When assembling the screen assembly to the pump body make sure the gasket is in place. Then tighten bolts securely, Figure 132.

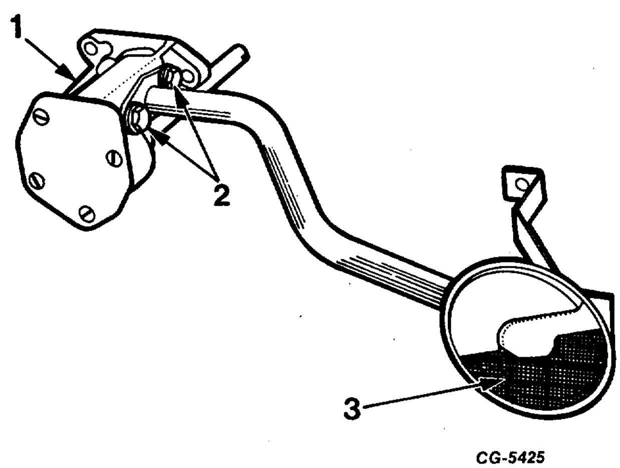


Fig. 132 Oil Pump and Screen Assembly

1. Oil pump 2. Bolts 3. Screen assembly

Oil Cooler and Filter Base

Figure 133 illustrates an exploded view of the oil cooler and filter base. Upon engine overhaul, the oil cooler and filter base, if so equipped, should be disassembled and the cooler element cleaned in a commercial radiator type solvent. Then flush the element with clean water until rinse water runs clear.

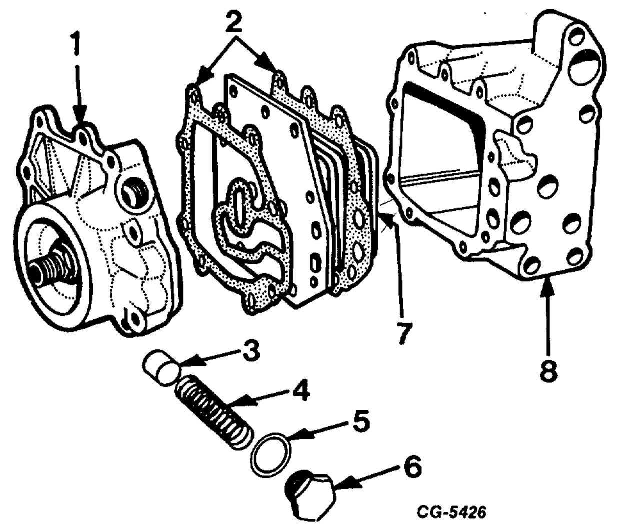


Fig. 133 Exploded View of Oil Cooler and Filter Base

1. Filter base
2. Gaskets
3. Valve
4. Spring
5. O-ring
6. Plug
7. Cooler element
8. Cooler body

Check the relief valve spring for proper tension, see SPECIFICATIONS. Also, check the valve for burrs or scratches. Small burrs or scratches may be removed with crocus cloth.

When reassembling the oil cooler, use new gaskets and tighten the bolts securely.

NOTE: On engines not equipped with the oil cooler, the filter base should be cleaned and passages checked clear of restrictions.

Oil Cooler Pressure Test

Where conditions indicate the need for testing the engine oil cooler core assembly for leaks, the core inlet and outlet openings must be closed off and the assembly pressurized. Instructions for pressure testing the oil cooler core assembly are as follows:

1. Attach test plate and gasket to core assembly mounting face flange (Figure 134). The test plate must be made locally according to the dimensions in the insert in Figure 134. Obtain engine oil cooler housing gasket from service parts stock.

   NOTE: The oil inlet opening in the cooler core assembly is located in one of two locations. Therefore, the test plate must include a tapped hole for either location to permit applying air pressure to the core. Install test plate pipe plug at oil inlet hole not in use.

2. Install pressure gauge, air control valve and quick connect air coupler to test plate (Figure 134). Apply 80 to 100 lbs. of air pressurelt6 the core assembly.

3. Immerse oil cooler core assembly in a container of water. If a leak is observed, replace core assembly.

   CAUTION: Use adequate safety precautions when preforming pressure test.

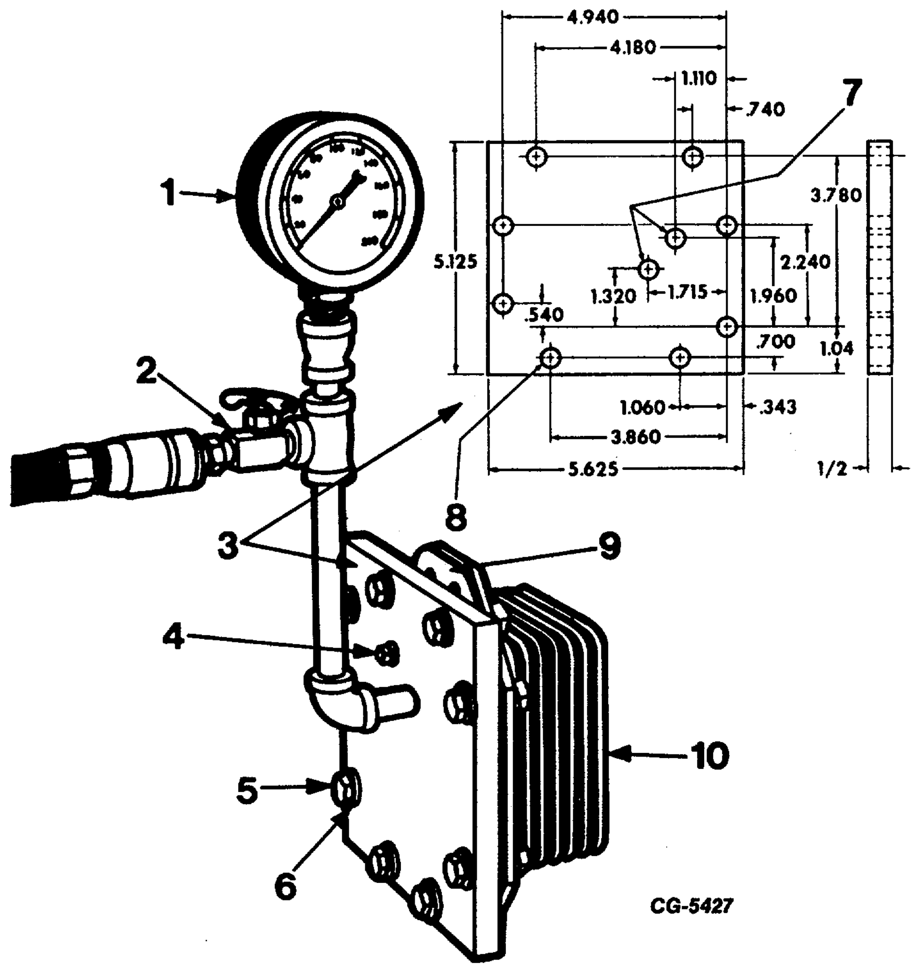


Fig. 134 Pressure Testing Engine Oil Cooler Core Assembly

1. **Pressure gauge**
2. **Air control valve**
3. **Test plate (make locally)**
4. **Pipe plug 1/8 NPT**
5. **Hex head bolts 5/16 NC x 1% - (8 required)**
6. **Flat washers - (16 required)**
7. **Drill & tap 1/8 PT THD. this side two holes**
8. **.375 Dia. - (8 holes)**
9. **Gasket, oil cooler housing IH No. 446647-C1**
10. **Core assembly, oil cooler**

Oil Pan

The pan should be thoroughly cleaned in cleaning solvent to remove any foreign material from around the baffle plate which is spot welded in place. Inspect oil pan for cracks or deformation and straighten or weld.

Remove all gasket material from the oil pan flange.

Check the oil pan drain plug boss for fit and thread wear. If the plug is loose or the threads are damaged, repair the threads or replace the oil pan.

Manifolds

The intake manifold is cast in one piece and supplies both cylinder banks. It should be cleaned and examined for cracks or leaks. Warpage of the intake manifold will require replacement as any attempt to resurface the intake manifold will create misalignment of the ports to the cylinder heads. The intake manifold also contains the direction of distributor rotation, firing order and the cylinder numbers Figure 135.

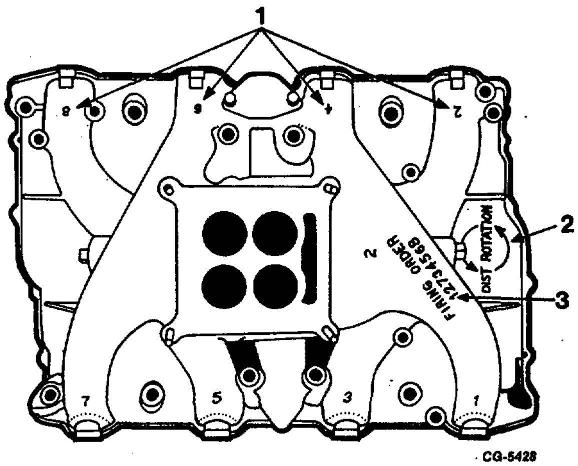


Fig. 135 Illustration of Information Contained on Intake Manifold

1. **Cylinder number**
2. **Direction of distributor rotation**
3. **Firing order**

Each bank has a separate exhaust manifold which should both be cleaned and examined for cracks or leaks.

Flywheel and Ring Gear

Clean the flywheel and ring gear with a cleaning solvent, removing all traces of oil and grease. Inspect the flywheel ring gear. If any teeth are damaged or if the ring gear is loose on the flywheel, the ring gear must be replaced. Check the flywheel mounting bolt holes for wear; also check mounting face of flywheel for indication of looseness.

To replace the flywheel ring gear, heat the gear with a torch and remove it from the flywheel with a' hammer and drift Heat the new ring gear evenly all the way around with a torch. While the ring gear is hot, install the gear on the flywheel and allow it to cool.

Water Pump and Coolant Flow

Coolant enters the engine at the lower left hand corner of the crankcase. The coolant then flows into the water pump where it is mixed with a quantity of bypassed hot coolant. The water pump discharges into both the right and left of the crankcase. The circulation of the coolant is from front to rear of the crankcase, then flows up into the cylinder head via three holes. The flow continues forward through the cylinder head. In flowing through the cylinder head the coolant is forced through a zig-zag path to insure maximum scrubbing of critical areas of the cylinder head such as exhaust valve seats and spark plugs.

The coolant exits the cylinder heads into a common cavity at the front of the crankcase. Temperature sending unit is located in this cavity. From this cavity the coolant flows into the chassis radiator or back into the water pump via a variable orifice bypass. The amount of

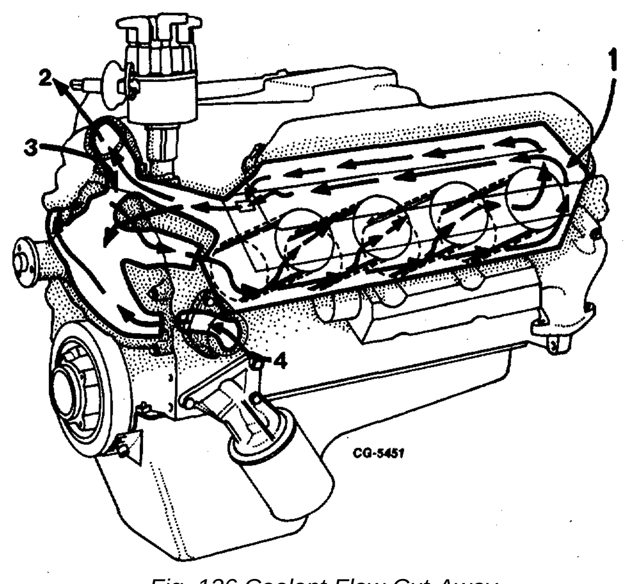


Fig. 136 Coolant Flow Cut-Away

1. **Full pressure flow to rear of crankcase-up-and to front of lead.**

2. Outlet **3. Bypass** **4. Inlet**

coolant directed to the radiator is modulated by the thermostat that opens the outlet to the radiator and reduces the orifice size of the coolant bypass. Figure 136.

Secondary cooling systems include the engine oil cooler, chassis heater and air compressor.

The oil cooler is mounted at the lower left corner of the crankcase. The coolant flows from the left bank crankcase water jacket through the cooler and into crankcase inlet area. The amount of coolant flowing through the cooler is metered by the diameter of the outlet hole on the oil cooler housing.

Coolant for the air compressor is tapped off the front of the cylinder head, left bank, flows through the air compressor and back into the crankcase coolant inlet casting.

Coolant for the chassis heater is picked up off the rear of the right cylinder head and returned to the suction side of the coolant pump.

The centrifugal water pump is serviced only as a complete assembly, Figure 137.

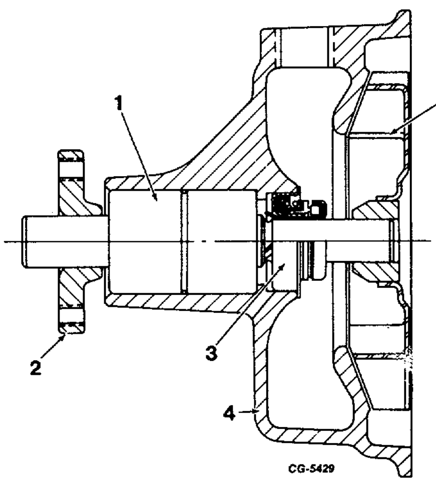


Fig. 137 Section View of Water Pump Assembly

1. Bearing assembly **4. Housing**
2. Pulley hub **5. Impeller**
3. Seal

Engine Assembly

1. With the cylinder block attached to the engine repair stand, turn the block on the stand so the bottom faces upward. Make sure the drain plugs are installed in the cylinder block if they have been removed.

2. Coat the camshaft lobes, bearing surfaces, gears and bores with engine oil.

3. Install camshaft into bore with fuel pump cam, distributor drive gear, camshaft gear and thrust flange installed on shaft.

   NOTE: If gears and fuel pump cam have been removed, use SE-1880 installer and SE-1880-2 adapter to install camshaft, Figure 138. This will help prevent nicking or other damage to the camshaft bearings. Install distributor drive gear, fuel pump cam and camshaft gear as outlined under Camshaft Engine Overhaul.

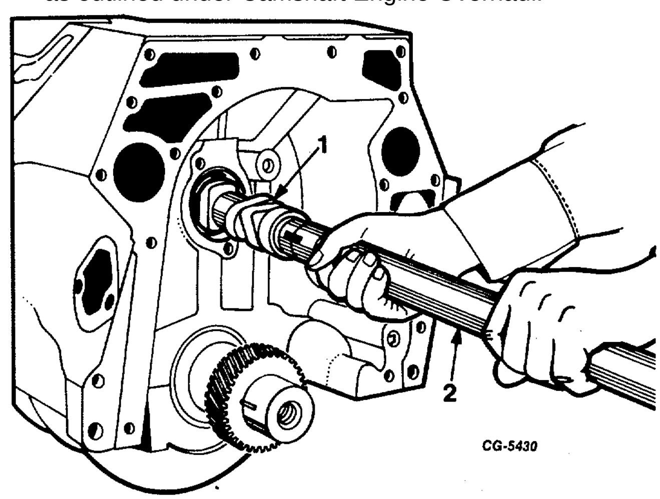


Fig. 138 Use of SE-1880 Camshaft Installer and SE-188G-2 Adapter

1. Camshaft **2. Installer**

4. Install two bolts and lockwashers in camshaft thrust flange, working through the holes in the camshaft gear. See "Torque Chart" for proper torque.
5. With the use of a dial indicator, check the camshaft end play, Figure 139. See "Specifications." If-the end play exceeds the limits, replace the camshaft thrust flange.

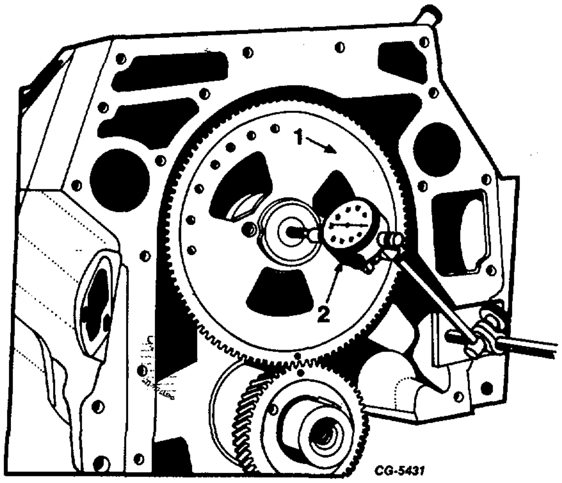


Fig. 139 Checking Camshaft End Play

1. Camshaft gear **2. Dial indicator**

6. Wipe the backs of the cylinder block half of the bearings, making sure the dirt is removed. Lubricate the block half of the bearings on both sides with a light film of engine oil. Place the bearing shell halves in position in the bore of the cylinder block, making sure the bearing shells are fully seated, the oil holes in the bearing shells line up with the oil holes in the cylinder block and the locking tangs on the bearings fit into the recesses. Follow the same procedure and place the bearing shell halves in the bearing caps. Place a film of engine oil on both sides of the shell surfaces and

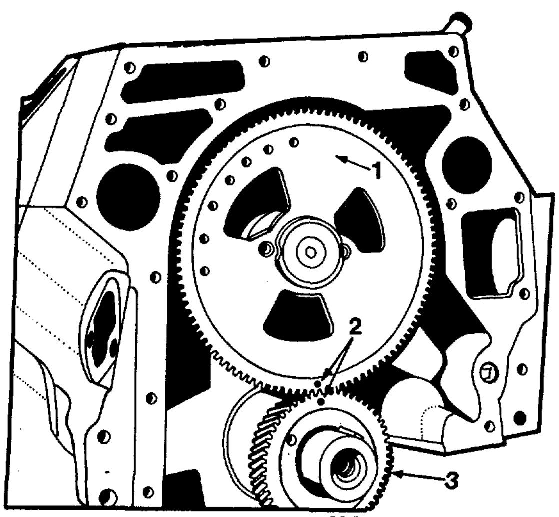


Fig. 140 Aligning Timing Marks on Camshaft and Crank- shaft Gears

1. **Camshaft gear**
2. **Timing marks**
3. **Crankshaft gear**

install the crankshaft, aligning itself in the bearing while, at the same time, aligning the timing marks of both the camshaft and crankshaft gears, Figure 140

NOTE: If crankshaft gear has been removed, it may be installed with the crankshaft in the engine using SE-1900 Installer, with SE-1900-18 Adapter and thrust bearing to reduce friction, Figure 141.

7. Place the bearing caps and bearing lower halves over the crankshaft journals. Be sure the bearing caps are properly installed with the number toward the left side of the crankcase and the arrow, pointing toward the front of the engine. Use new selflocking bolts for installing the bearing caps. Finger tighten the bearing caps. Using a soft hammer, tap the number 1, 2 and 4 bearing caps until the rear machined faces of the caps are flush with the machined faces of the crankcase.

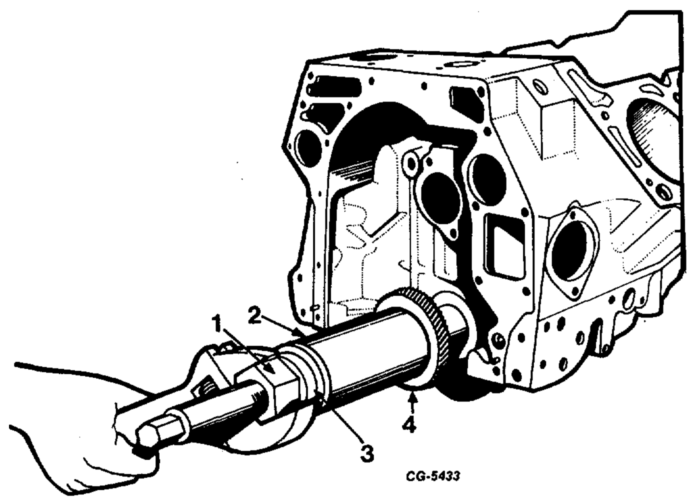


Fig. 141 Installing Crankshaft Gear with SE-1900 Installer and SE-1900-18 Adapter

1. Nut **3. Thrust bearing**
2. Sleeve **4. Gear**

Repeat the same operation for bearing cap number 5 only aligning the front face of the cap with the crankcase. The number 3 bearing rear thrust flanges must be flush with each other. Aligning caps in this manner will assure proper cap location. Check this alignment at both sides (left and right) of the bearing cap. Torque the bolts to specified torque using a tension wrench. See "Torque Chart."

Apply the same procedure to the remaining bearing caps. Recheck the crankshaft end play as outlined under "Fitting Main Bearings."

8. Install flywheel housing on crankcase. Torque bolts to specified torque. See "Torque Chart." Install oil pressure sending unit.

9. Press crankshaft rear oil seal into retainer plate using SE-1905 installer and 5-1/4" O.D. adapter, Figure 142. The seal must be installed from the crankcase side of the retainer flush with the seal bore inner surface.

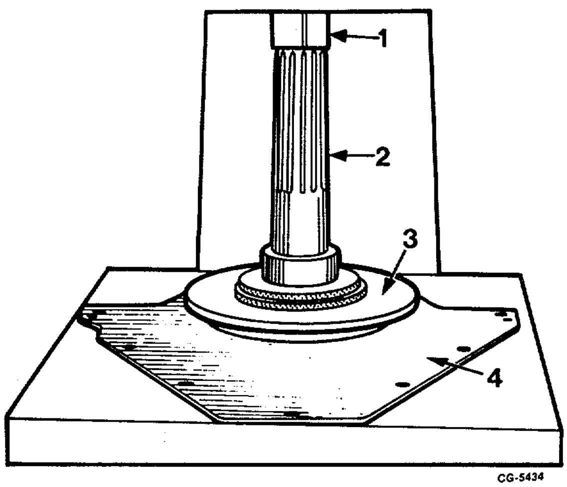


Fig. 142 Pressing Rear Oil Seal into Retaining Plate Using SE-1905 Installer with 5-1/4" O.D. Adapter

1. Press ram **3. Adapter**
2. Installer **4. Retainer**

NOTE: Wipe inside of retainer plate clean to insure a proper fit.

10. Use SE-1942-2 Pilot to install rear oil seal and retainer with gasket on crankcase, Figure 143. Dowel pins are provided for proper alignment. Torque bolts to specified torque. See "Torque Chart."

NOTE: Drill two 25/64" diameter holes in SE-1942-2 Pilot according to the dimensions on Figure 144 to accept two 3/8" diameter x 4" pilot studs. The pilot studs serve as a safety measure to retain the pilot on the crankshaft where seal replacement is performed with engine in the vehicle.

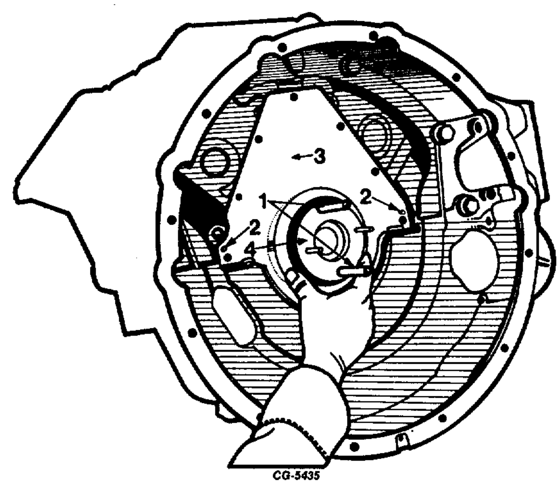


Fig. 143 Installing Retainer with Rear Oil Seal Using SE-1942-2 Pilot

1. Pilot studs **3. Retainer**
2. Dowel pins **4. Pilot**

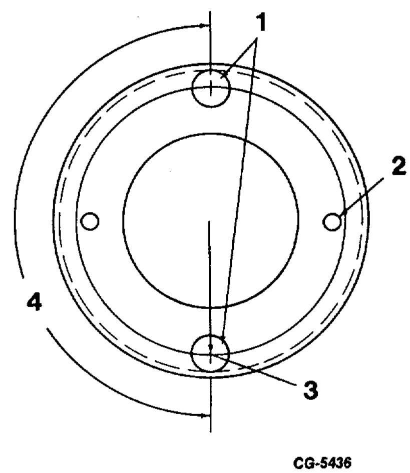


Fig. 144 Dimensions for Rework of SE-1942-2 Pilot

1. **25/64" dia. holes**
2. **Existing guide pin holes**
3. **1.59375R**
4. **180°**

11. Rotate the crankshaft and camshaft to determine that the gears do not bind or interfere. With the use of a dial indicator, Figure 145, check the backlash. See "Specifications" for backlash.

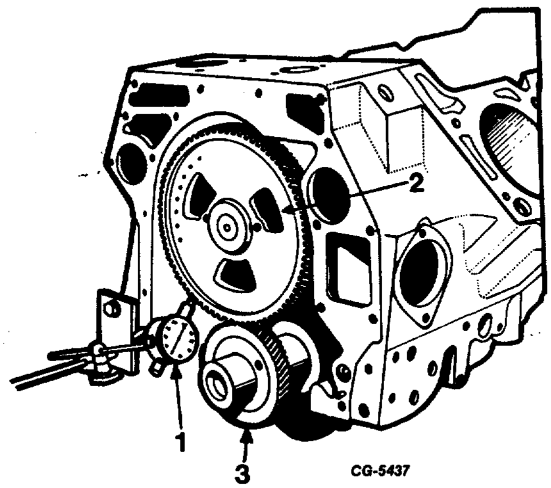


Fig. 145 Checking Camshaft and Crankshaft Gear Backlash

1. Dial indicator **3. Crankshaft gear**
2. Camshaft gear

12. Turn the crankshaft so No. 1 crankpin is at the top of its stroke. Coat the cylinder bores, crankshaft journals, pistons, piston pins and piston rings with engine oil. Insert the piston into the ring compressor and install the piston assembly into its respective cylinder bore, Figure 146. Make certain the odd numbers stamped on the connecting rods (1-3-5-7) are facing toward the right side of the cylinder block, while even numbers (2-4-6-8) are facing the left side of the cylinder block. Install the connecting rod bearings and caps, coating each bearing shell surface on both sides with engine oil. The numbered side of the cap must match and be on the numbered side of the rod.

    NOTE: If the connecting rods and bearing caps are properly installed, the large chamfer side of the rod and cap will be to the fillet side of the crankpin. Install new bearing cap bolts, washers and nuts and tighten to the specified tortue as shown in "Torque Chart."

13. Follow the procedure outlined in Step 12 for the remaining connecting rods and pistons.

14. Recheck connecting rod end play using a feeler gauge as outlined under "Fitting Connecting Rod Bearings" in CLEANING, INSPECTION AND RECONDITIONING.

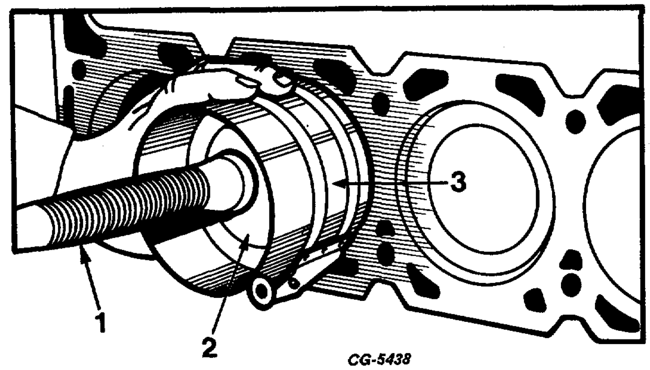


Fig. 146 Installation of Piston in Cylinder Block

1. Hammer handle **3. Ring Compressor**
2. Piston

15. Press new oil seal in engine front cover using SE-1949 installer and support blocks, Figure 147. Install oil seal flush to .010" below front face of front cover.

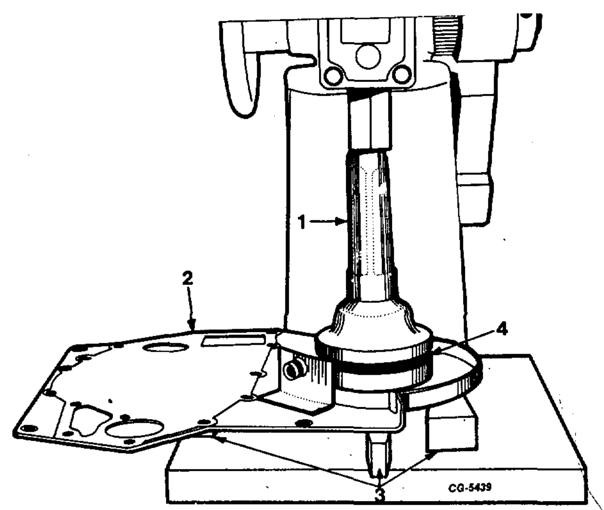


Fig. 147 Pressing New Seal in Engine Front Cover Using SE-1949 Installer and Support Blocks

1. Installer **3. Support blocks**
2. Front cover **4. Oil seal**

NOTE: With the engine front cover assembled to the cylinder block, a new oil seal can also be installed using SE-1949 installer as shown in Figure 148. Install oil seal flush to .010" below front face of front cover.

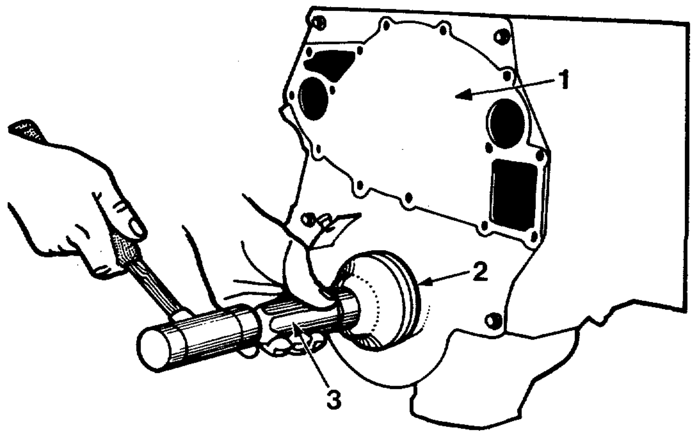


Fig. 148 Installing Engine Front Cover Oil Seal with Cover Assembled to Cylinder Block Using SE-1949 Installer

1. Front cover **2. Oil seal**

16. Position a new front cover gasket to the cylinder block and install the engine front cover assembly. Dowel pins are provided for proper alignment.

17. Install woodruff key in the crankshaft and install the crankshaft vibration damper using SE-1900 installer and SE-1900-18 adapter, Figure 149, with thrust bearing to reduce friction. Install damper bolt and washer and tighten to specified torque. See "Torque Chart."

18. Install crankshaft pulley on vibration damper with bolts and lockwashers. Tighten to specified torque. See "Torque Chart."

19. Install oil pump, pick-up tube and screen assembly. Check alignment of pump to cylinder block for free movement of oil pump shaft. There should be no bind if the pump is correctly aligned.
20. Place the flywheel in position on the crankshaft. Apply sealing compound not affected by oil to the threads of the flywheel mounting bolts. Avoid getting sealing compound on mating surfaces of flywheel and crankshaft. Install mounting bolts to specified torque.

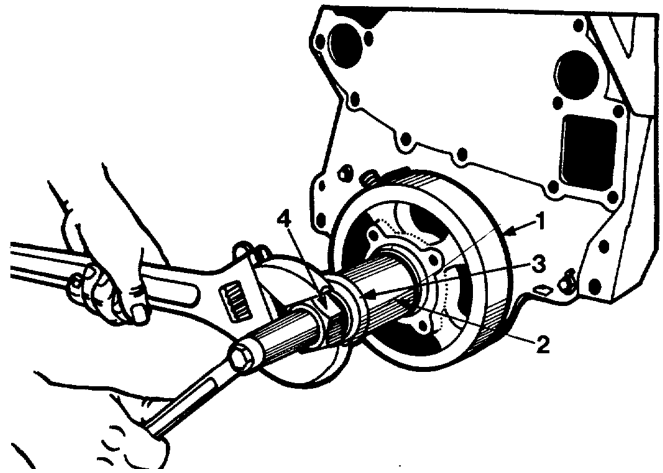


Fig. 149 Installing Crankshaft Vibration Damper Using SE-1900 Installer and SE-1900-18 Adapter

1. Damper **3. Thrust bearing**
2. Sleeve **4. Nut**

21. Install the clutch pilot bearing into the flywheel. To assure the clutch pilot bearing does not rotate in the flywheel bore, it is recommended that Loctite grade B be applied evenly around the O.D. of the bearing and the I.D. of the flywheel bore at the time of installation. Do not allow Loctite to contact inside of bearing or between flywheel and crankshaft.

    After the Loctite grade B has been applied, allow to cure for 1 to 2 hours. The interval required to reassemble the vehicle from the point of clutch bearing is considered adequate for the curing of Loctite.

22. Place the clutch driven disc against the flywheel so the long portion of the hub is toward the rear. Place the clutch in position on the flywheel over the clutch driven disc, install two or three mounting bolts and lockwashers loosely. Install a clutch aligning arbor, if available, or a transmission main drive gear shaft, Figure 150, through the clutch driven disc hub spline and into the clutch pilot bearing. Hold the clutch driven disc in position while completing installation of the remaining mounting bolts and lockwashers in the flange of the clutch backing plate or cover. Tighten all bolts

alternately, evenly and securely. Remove the three retaining bolts and flatwashers which were installed to hold the clutch compressed, Figure 49.

NOTE: The clutch will not operate properly unless these retaining bolts and flatwashers are removed.

23. Position a new water pump mounting gasket on the cylinder block and install water pump.

NOTE: Use a nonhardening sealing compound on the water pump capscrews and torque to specified torque.

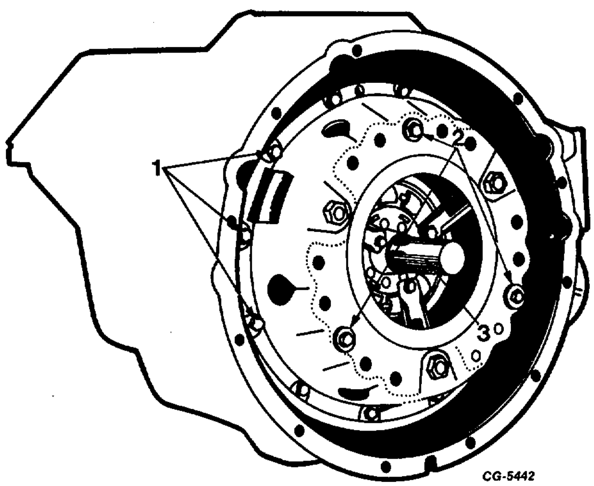


Fig. 150 Clutch Installation to Flywheel

1. **Cover retaining bolts**
2. **Retaining bolts for compressing clutch**
3. **Aligning bar**

24. Position new cylinder head gaskets (insure the stamped "Front" is to the front of the engine) on each bank over the aligning dowel sleeves insuring that all bolt holes in the gaskets are in line with those on the cylinder block. Place cylinder head on the proper bank aligning the head with the dowel sleeves in the crankcase. Loosely install all cylinder head bolts and flatwashers.

25. Repeat Step 24 for the opposite cylinder head.

26. Tighten the cylinder head bolts alternately and evenly in sequence as illustrated in Figure 151 to the torque shown in the "Torque Chart."

Repeat this operation on the opposite cylinder head. It is not necessary to retorque the cylinder head bolts after a run-in period.

27. Install the hydraulic tappets in their respective bores in the cylinder block.

28. Insert the valve lifter (push) rods in their respective positions.

29. Place the rocker arms and pivots on their respective cylinder heads making sure the rocker arms are in line with the push rods and valves. Install mounting bolts and tighten to specified torque. See "Torque Chart."

30. Position the intake manifold seals in position in front and rear of crankcase. See Figure 38.

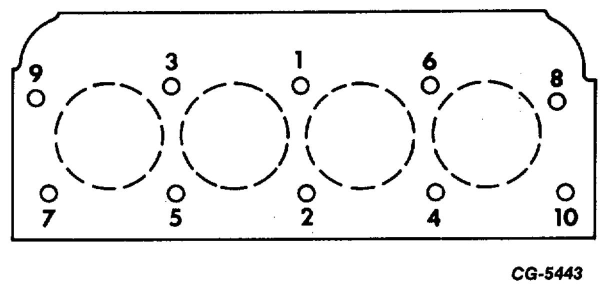


Fig. 151 Cylinder Head Mounting Bolt Tightening Sequence

31. Position the tappet cover and intake manifold gasket assembly on the crankcase. Note the roll pins provided for proper alignment.

32. Place intake manifold in position making sure the direction of distributor rotation is located at the front of the engine. Secure the manifold to the cylinder heads with bolts and washers. Tighten to specified torque.

NOTE: Use nonhardening sealing compound on bolts prior to installation. Also, insure that lifting eyes are installed under the right front and left rear bolts.

33. Place the cylinder head cover gaskets in each cover and install the cylinder head cover with the oil filler cap on the right cylinder head securing with screws and washers. Repeat this operation for opposite cover.

NOTE: Do not install screw and washer that secures the fuel line bracket to the right cylinder head cover at this time. However, insure that cable support brackets are installed.

34. Install engine oil level gauge assembly.
35. Install the spark plugs in the cylinder head and tighten to specified torque. See "Torque Chart."
36. Position left exhaust manifold and gasket to cylinder head and install bolts and lock tab washers. Tighten to specified torque. See "Torque Chart." Bend lock tabs against bolt head.
37. Repeat Step 36 for installation of the opposite exhaust manifold with gasket and manifold heat shroud.
38. Install air manifold check valves in their respective cylinder heads.
39. Install thermostat in crankcase and place engine water outlet gasket on crankcase, Figure 152. Then secure engine water outlet to crankcase with two bolts and lockwashers according to specified torque. See "Torque Chart."

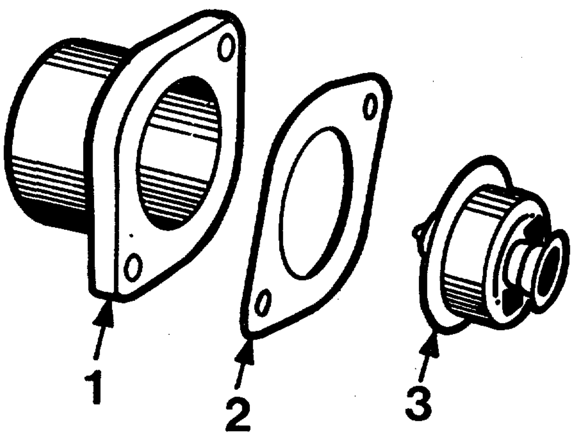


Fig. 152 Exploded View of Thermostat, Gasket and Engine Water Outlet

1. **Engine water outlet**
2. **Gasket**
3. **Thermostat**

40. Install water temperature sender in top front of crankcase. Refer to Figure 34 in "Engine Disassembly."
41. Install low temperature vacuum control valve, exhaust gas recirculating valve and gasket, if so equipped.

    NOTE: If not equipped with these valves, install cover plate and gasket on intake manifold and plug from crankcase if removed.

42. Install the ignition coil and bracket on the mounting boss provided on the intake manifold securing the bracket with bolts and lockwashers.
43. Install carburetor return spring bracket on intake manifold with bolt and flatwasher. Refer to Figure 29 in "Engine Disassembly."
44. Install carburetor with two gaskets and spacer plate over studs in intake manifold. Secure with nuts and washers. Attach return spring between carburetor and bracket installed in Step 43.
45. Install the distributor assembly with clamp, hold-down bolt, lockwasher and "O"-ring in crankcase.
46. Install vacuum line and governor line from the distributor to the carburetor connections.

    NOTE: Insure governor line is sealed at both connections.

47. Install all cable brackets for high tension lines.
48. Install distributor cap and thread the cables through the cable support brackets to their respective spark plugs. Connect the high tension cable from the distributor to the coil.
49. Install fuel pump with gasket to the crankcase with two bolts and hardened washers.

    NOTE: When installing the fuel pump mounting bolts, it is necessary to tighten the bolts evenly. If they are not installed evenly the operating arm on the fuel pump will not be in correct position with the fuel pump cam on camshaft.

50. Install fuel line with filter between the fuel pump and carburetor. Secure fuel line bracket to right cylinder head cover with screws and washer.

51. Install flame arrestor and hose to left cylinder head cover, Figure 153. Install opposite end of hose to air cleaner after its installation.

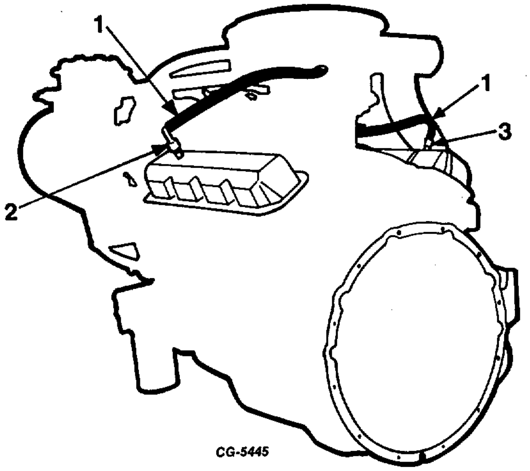


Fig. 153 Flame Arrestor and Crankcase Ventilator Valve Installation

1. **Hose**
2. **Flamearrestor**
3. **Crankcase ventilator valve**

52. Install crankcase ventilator valve in right cylinder head cover and connect hose to valve and tube fitting in carburetor, Figure 153.

53. Install engine water inlet and gasket with two bolts and lockwashers.

54. Install oil pan on crankcase using the liquid gasket material, Figure 154.

NOTE: Caution should be taken not to apply excessive amounts which could contaminate the engine oil.

55. Install oil filter and cooler with gasket, if so equipped, to the crankcase. Also install air compressor oil feed line to crankcase. Refer to Figure 27 for location.

NOTE: If the vehicle is not equipped with an oil cooler, install filter base and filter with gasket.

56. Place the starting motor into the flywheel housing and secure with two bolts and lockwashers.

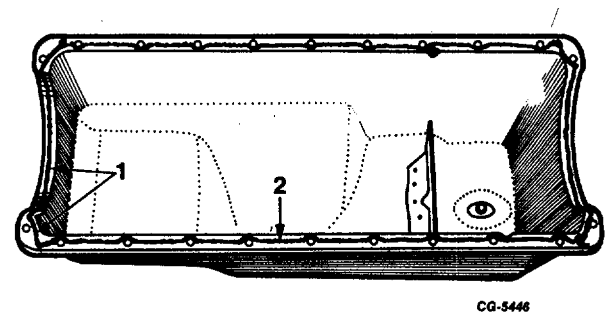


Fig. 154 Application of Liquid Gasket Material on Oil Pan

1. **1/8" bead at corners and both ends**
2. **1/16" bead on both sides**

57. Install power steering pump bracket and adjusting bracket. Refer to Figure 25.

58. Loosely install power steering pump with side bracket to pump mounting bracket.

59. Place power steering pump pulley on shaft aligning the pulley with the keyway and tap gently with a soft hammer. Use a 5/16" x 18" x 1-1/4" long bolt and washers to pull the pulley against the shoulder of the pump, Figure 155. Then replace the long bolt with the shorter bolt and tighten to specified torque.

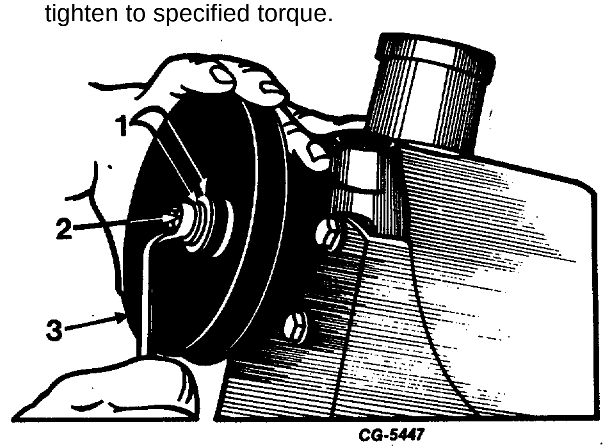


Fig. 155 Pulling Power Steering Pulley Against Shoulder of Pump

1. **Washers**
2. **Bolt**
3. **Pulley**

60. Place the water pump pulley on the shaft and install V-belt over crankshaft, water pump and power steering pulleys.
61. Install freon compressor bracket to right cylinder head. Refer to Figure 20.
62. Place freon compressor on bracket and secure it with four bolts and lockwashers.
63. Install idler pulley bracket on freon compressor with bolts and washers.

    NOTE: The bottom two bolts utilize two hardened washers each. Refer to Figure 18.

64. Install air pump mounting bracket and adjusting strap with spacer on right side of freon compressor.
65. Install air pump loosely on bracket. Place V-belt on air pump and freon compressor pulleys. Connect air hoses between air pump and air manifold check valves. Refer to Figure 16 for location.
66. Install V-belt on freon compressor, idler, water pump and crankshaft pulleys.
67. Place alternator bracket and adjusting strap in position and secure with bolts and flat washers.
68. Install alternator loosely in position on bracket and adjusting strap. Install two V-belts alternator, water pump and crankshaft pulleys.
69. Place air compressor bracket with "O"-ring in position and secure with bolts and washers.
70. Place air compressor with gasket in position on bracket and secure with bolts, nuts and washers. Install water return, water inlet, air inlet and oil feed lines. Refer to Figure 8 for proper locations.
71. Install V-belt on air compressor and water pump pullys.
72. Place fan blade and spacer in position and secure with bolts and lockwashers.
73. Adjust all belts to proper tension according to "Accessory Drive Belts" in CLEANING, INSPECTION AND RECONDITIONING.
74. Install low temperature vacuum control valve and exhaust gas recirculating valve hoses if so equipped.
75. Install engine front mounting bracket.
76. Attach suitable hoisting equipment to the lifting eyes and apply sufficient pull to support the engine assembly. Remove the engine overhaul stand bracket from the engine.

Accessory Drive Belts

Conventional "V" belts are utilized to drive the various accessories. Four belts, driven from the crankshaft pulley, drive the freon compressor, alternator, water pump, fan and power steering pump. Another belt, driven from the water pump pulley, drives the air compressor and another belt, driven from the freon compressor pulley, drives the air pump. Engines having dual belts driving the water pump and alternator should have the belts replaced in matched pairs.

Alternator belt tension can be accomplished with the use of SE-2312 gauge, Figure 156. Check tension at midpoint between the pulleys. Apply gauge to the longest belt span. Instructions for checking are as follows:

1. Grasp gauge and depress ball handle all the way down. Make certain hook extends beyond legs to pick up the belt.
2. Apply gauge to belt, Figure 156. Be sure belt is positioned between nose piece and hook and that the nose piece is centered on the belt.
3. Release ball handle quickly. A slow release may prevent full return of the hook, thus giving a false reading.
4. Observe the area of the gauge face indicated at the index mark. If the index mark does not indicate a NEW reading on a new belt, or a USED reading on a used belt, it will be necessary to increase or decrease belt tension as required.
5. Before changing belt tension, repeat Step 3 several times to become familiar with gauge operation. Observe gauge reading each time the operation is repeated.

NOTE: Check tension of both belts when so equipped.

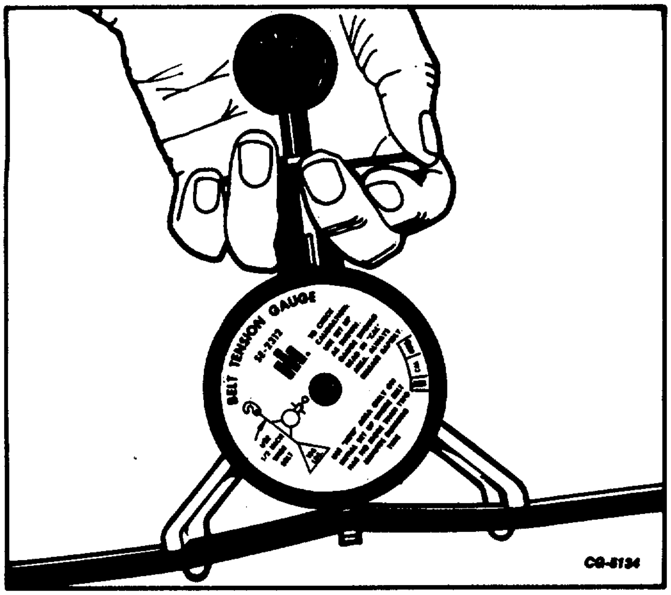


Fig. 156 Testing Alternator Belts Using SE-2312 Gauge

To establish tension of a loose belt, apply SE-2312 gauge to the belt and make the adjustment. Tighten belt until proper area for the belt is indicated at the index mark on the gauge. Lock the adjustment and recheck belt tension. Readjust as necessary.

When using the SE-2312 belt tension guage, remember to set new belts (belt with less than two minutes running time) to the NEW area on the gauge face and used belts (more than two minutes running time) to the USED area on the gauge.

NOTE: Where the SE-2312 belt tension gauge is not available or cannot be used because of interference with fan shroud, accessories or close clearances, a deflection check can be made. Depress the belt at a point midway between the water pump and alternator pulleys. One-half inch (2") deflection is considered acceptable as a final setting after the belt has been operated for a short period of time.

The air or freon compressor and power steering or air pump belts are adjusted in a similar manner.

TORQUE SPECIFICATIONS

Size and Thread	Location	Recommended Wrench Torque (Ft. Lbs.)
5/16 - 18 and 24	All Locations except as Listed	10 - 15
5/16 - 18	Rocker Arm Post	18 - 22
5/16 - 18	Rocker Arm Cover	4 - 7
3/8 - 16 and 24	All Locations except as Listed	27 - 37
3/8 - 24	Connecting Rod	38 - 44
7/16 - 14 and 20	All Locations except as listed	45 - 60
7/16 - 20	Camshaft Screw	12 - 18
1/2 - 13 and 20	All Locations except as Listed	65 - 85
1/2 - 13	Main bearing Caps	90 - 100
1/2 - 13	Cylinder Head Bolts	100 - 110
5/8 - 11	Crankshaft Vibration Damper	80 - 100
14mm	Spark Plug	12 - 18
	Generator Pulley Nut (10 SI Alternator)	40 - 60
	Generator Pulley Nut (27 SI & L/N 105 Alternator)	70 - 80

SPECIFICATIONS

ENGINE MODELS	MV-404	MV-446
Number of Cylinders	8	8
Bore (Inches)	4.125	4.125
Stroke (Inches)	3.740	4.180
Displacement (Cu. In.)	399.9	446.9
Compression Ratio	8:1	8:1
Rated H.P. (A.M.A.)	54.5	54.5
Weight (Bare) (Lbs.)	740	737
Weight (w/Std. Acces.) (Lbs.)	942	1030
Engine Serial No. Location	Stamped on top of cylinder block in front of distributor.	
Firing Order	1-2-7-3-4-5-6-8	1-2-7-3-4-5-6-8

SPECIFICATIONS

ENGINE MODELS	MV-404	MV-446
CYLINDER BLOCK:		
Bearing Bore	3.3152-3.3162	3.3152-3.3162
Bore Diameter (Standard)	4.125	4.125
CRANKSHAFT:		
Number of Main Bearings	5	5
Main Journal Diameter	3.1228 - 3.1236	3.1228 - 3.1236
Main Bearing Clearance	0010 - .0036	0010 - .0036
Crankshaft End Play	0025 - .0085	0025 - .0085
Thrust Taken by	3rd. Main	3rd. Main
Rod Journal Dia. (Crankpin)	2.4980 - 2.4990	2.4980 - 2.4990
CAMSHAFT		
Camshaft Bore	2.1515-2.1525	2.1515-2.1525
Number of Camshaft Bearings	5	5
Camshaft Journal Diameter	2.0990 - 2.1000	2.0990 - 2.1000
Bearing Clearance	001 - .0035	001 - .0035
Camshaft End Play	001 - .009	001 - .009
Thrust Taken by	Thrust Plate	Thrust Plate
Timing Gear Backlash	009 - .0067	0009 - .0067
CONNECTING RODS:		
Bearing Bore Diameter	2.6245 - 2.6250	2.6245 - 2.6250
Bearing Clearance	0011 - .0036	0011 - .0036
Side Clearance	008 - .020	008 - .020
PISTONS:		
Recommended Piston Clearance	0012 - .0022	0012 - .0022
Ring Groove Size:		
Compression Rings (2)	0955 - .0965	0955 - .0965
Oil Ring	1885 - .1895	1885 - .1895
Pin Bore Diameter	1.0203 - 1.0205	1.0203 - 1.0205
PISTON PINS:		
Length (Inches)	2.815 - 2.825	2.815 - 2.825
Diameter	1.0199 - 1.0201	1.0199 - 1.0201
Clearance in Piston	0002 - .0006	0002 - .0006
Clearance in Rod	0004 - .0008	0004 - .0008
PISTON RINGS:		
Compression Rings (2):		
Size (Face Width)	0925 - .0935	0925 - .0935
Gap	013 - .023	013 - .023
Side Clearance (Fit in Groove)	002 - .004	002 - .004
Oil Control Ring:		
Number Used on Each Piston	1	1
Size	1855 - .1865	1855 - .1865
Ring Diameter	4.125	4.125
Gap	013 - .023	013 - .023
Side Clearance (Fit in Groove)	002 - .004	002 - .004
VALVES:		
Intake Valves:		
Face Angle	450	450
Seat Width (Inch)	060 - .090	060 - .090
Seat Run-Out (T.I.R.) (Max.)	002	002
Valve to Rocker Arm Clearance	None*	None*
Stem Diameter	37215 - .37285	37215 - .37285
Stem Clearance in Guide	00115 - .00285	00115 - .00285

*Hydraulic Lifters.

SPECIFICATIONS

ENGINE MODELS	MV-404	MV-446
VALVES: (Continued)		
Exhaust Valves:		
Face Angle	450	450
Seat Width (Inch)	085 - .115	085 - .115
Seat Run-Out (T.I.R.) (Max.)	002	002
Valve to Rocker Arm Clearance	None*	None*
Stem Diameter	37165 - .37235	37165 - .37235
Stem Clearance in Guide	00165 - .00235	00165 - .00235
Valve Guides:		
Length (Inches)	2.600	2.600
Bore Diameter	374 - .375	374 - .375
Distance Above Head (Inch):		
Intake (Inch)	838	838
Exhaust (Inch)	1.122	1.122
Valve Springs:		
Free Length (Inches)	2.065	2.065
Test Length (Inches)	1.429	1.429
Pressure (Lbs.) @ Test Length	188.1 + 8	188.1 + 8
Valve Lifters (Tappets):		
Diameter	9040 - .9045	9040 - .9045
Bore Diameter in Block	9058 - .9068	9058 - .9068
Clearance in Bore	0013 - .0028	0013 - .0028
Bleed-Down Rate (1/8" Travel @ 50 Lb. Loading)	20 - 110 Sec.	20 - 110 Sec.
Valve Lift (Inch):		
Intake	435	435
Exhaust	435	435
Push Rods:		
Length	10.294	10.294
Valve Timing:		
Intake Opens (before TDC)	14	14
Intake Closes (after BDC)	70	70
Exhaust Opens (before BDC)	59	59
Exhaust Closes (after TDC)	25	25
OIL PUMP:		
Body Gear End Clearance	0015 - .0065	0015 - .0065
Body to Gear Clearance	0014 - .0054	0014 - .0054
Pump Shaft Diameter	4885 - .4890	4885 - .4890
Shaft Clearance in Body	001 - .0025	001 - .0025
Body Gear Backlash (Max.)	0107	0107
Idler Shaft Diameter	4845 - .4855	4845 - .4855
Idler Gear Clearance on Shaft	0015 - .004	0015 - .004
Pressure Regulator Spring:		
Free Length (Inches)	2.600	2.600
Test Length (Inches)	1.58	1.58
Pressure @ Test Length	8	8
Oil Pressures:		
(With SAE-30 Oil @ 2000 F)		
Minimum (@ Idle Speed)	8-20 psi	8-20 psi
Maximum (@ 1800 RPM)	44 - 50 psi	44 - 50 psi
THERMOSTAT:		
180		
Start to Open at (Deg. F.)	175 - 182	175 - 182
Fully Open at (Deg. F.)	202	202

*Hydraulic Lifters.

ENGINE MODELS	MV-404	MV-446
THERMOSTAT: (Continued)		
192°		
Start to Open at (Deg. F)	188-195	188-195
Fully Open at (Deg. F)	212	212
OIL COOLER PRESSURE REGULATOR SPRING:		
Free Length (Inches)	2.567	2.567
Test Length (Inches)	1.400	1.400
Pressure Test Length	3.680	3.680

FRAMES

INDEX

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.

TYPES

Because International chassis are manufactured with frame rails of either cold rolled steel, heat treated steel, or aluminum alloy, each must be handled in a specific manner to assure maximum service life.

IDENTIFICATION

No unusual difficulty should be encountered in identifying aluminum alloy frames. These side rails and cross members are made of thicker material than are the components of a comparative size steel frame. If there is any doubt, use a file to expose the material hardness or color. There are several methods of identifying heat treated frame rails, the most common of which is a stencil marking on the inside middle section of the rail or a stencil mark on one of the cross members. The stencil notes that the rail is heat treated and rail flanges must not be drilled or welded. This is to caution against the welding of additional brackets or crossmembers or the welding of full length reinforcement rails. Minor repairs as indicated in later paragraphs are acceptable.

A number of the heat treated frame rails have small patches covering "Brinell" test mark along the inside (web) of the rail. These patches are at about three or four foot intervals. The patch can be removed to expose the "Brinell" marking.

Some rails are stamped "H" for heat treated, on the upper face of the rail flange about three inches from the rail end.

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 plumbbob 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 intersection 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. Measuring 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 alignment. 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 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 the frame side rails, the use of angle reinforcements is acceptable. When ever 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.

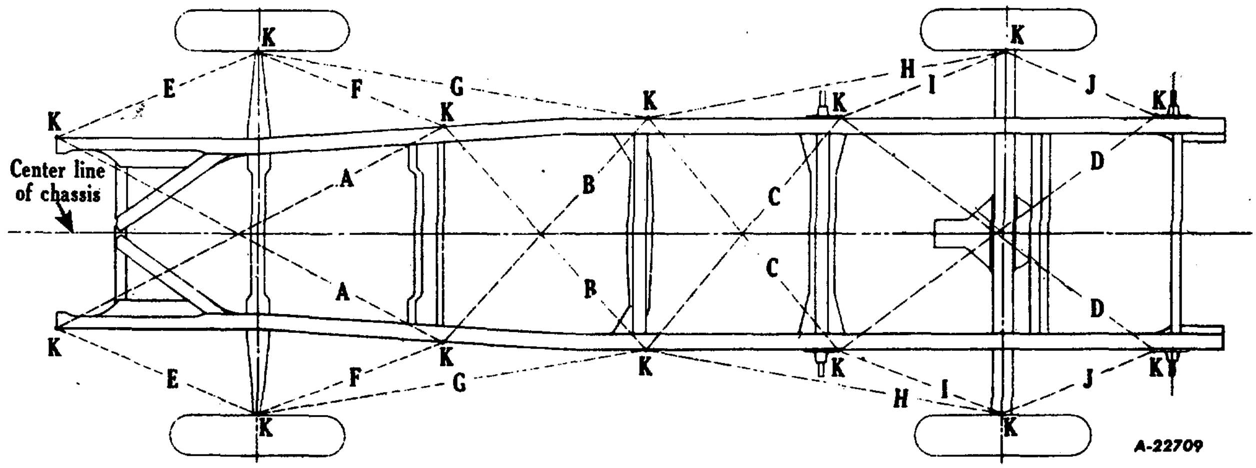


Fig. 1.

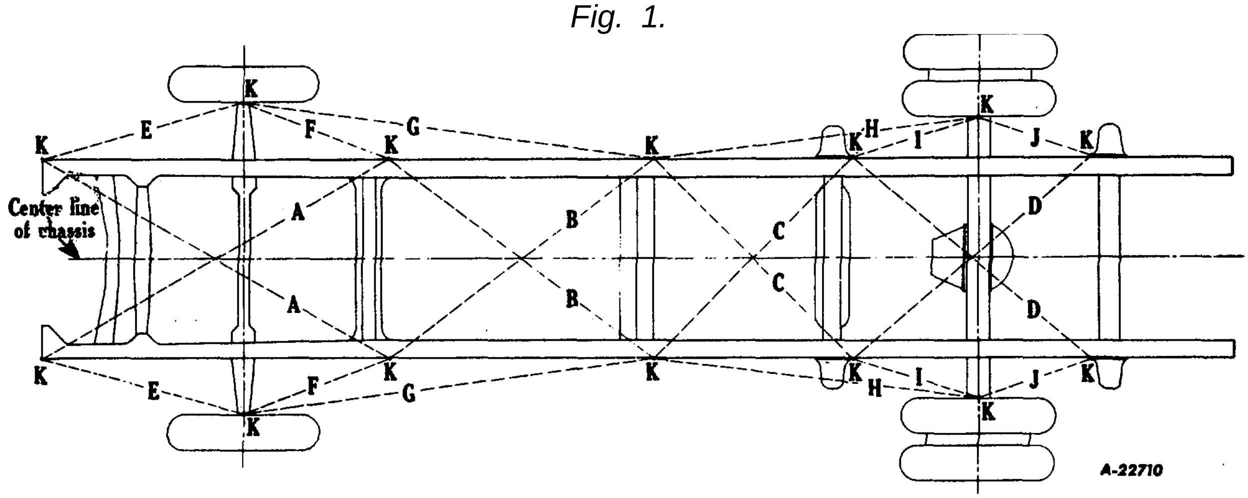


Fig. 2.

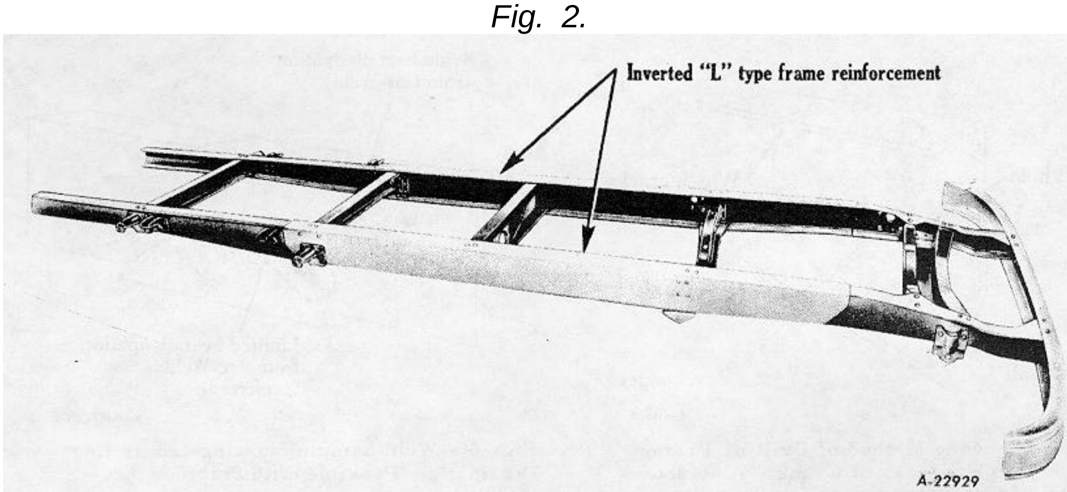


Fig. 3.

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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.

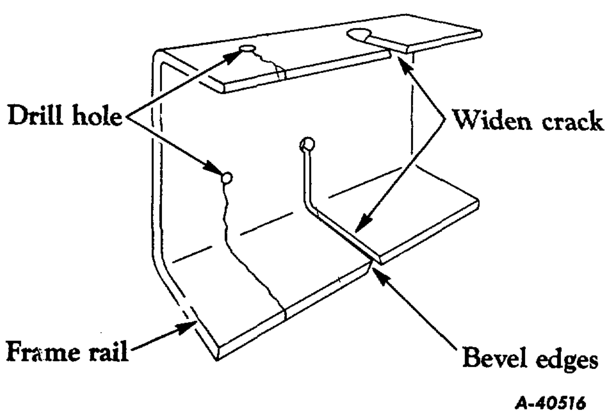


Fig. 4-Showing Method of Drilling Frame Rail to Stop Progress of Crack. Also shows Method of Preparing Crack for Welding.

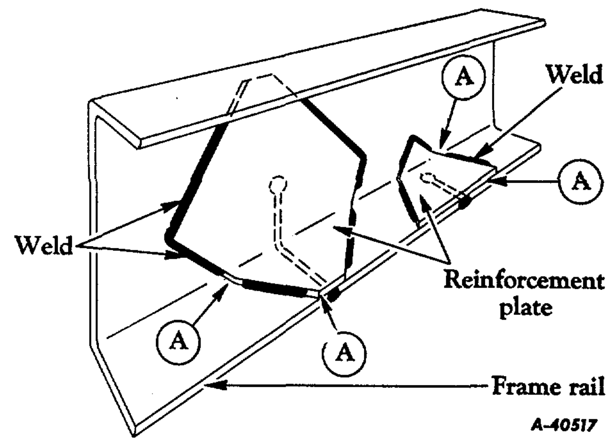


Fig. 5-Suggested Types of Reinforcing Plates and Method of Attaching to Frame Rail.

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.

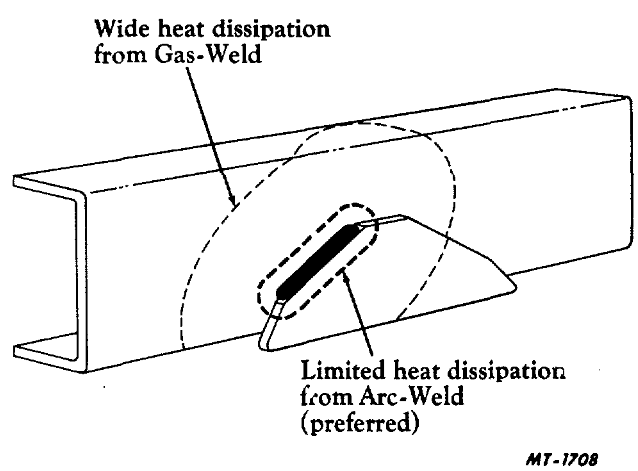


Fig. 6-Weld Sample Showing Lower Heat Dissipation Possible with Shielded Arc Welding.

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 of oil or grease.
2. Always avoid craters, notching, and undercutting.
3. Peen new welds to relieve stresses caused by shrinkage.

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 weakness after straightening, should be replaced or reinforced.

Repair and Reinforcements
(Aluminum Alloy Frames)

The cutting and welding of aluminum alloy frames for repair or reinforcement can be accomplished providing correct procedures are followed and proper welding equipment is utilized. The use of heat for straightening aluminum frame rails is not recommended.

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 the field with a time saving advantage when replacing crossmembers or frame attaching parts.

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

NOTE: 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 <u>220-250 ft. lbs</u>. 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.

REPAIR AND REINFORCEMENTS
(Heat Treated Frames)

With the use of heat treated frame rails in International vehicles, it becomes advisable to outline some of the procedures to be followed whenever these frames require repair.

Heat treated frame rails must not, of course, be intermixed with non-heat treated rails. If one side rail is to be replaced, the new rail material must match the old frame rail.

Preparation Of Frame For Repair

A good method to follow when repairing a cracked frame where the crack is accessible from both sides is as follows:

a. Grind a V notch or groove extending along the full length of the crack and slightly beyond each end of the crack. A heavy copper strip or "chill" should be clamped to the rail side away from the groove to help control the temperature and cooling rate. See Fig. 7. NOTE: Discarded short lengths of heavy copper electrical bus bars make suitable chills.

b. Preheat the frame rail along the crack area to 500-600 degrees to burn off excess oil or paint then permit heated area to cool to 200 degrees or below before welding is started. Under no circumstances should the rail be heated to a temperature exceeding 900-950 degrees F. since this is the tempering temperature of the rail.

c. Either alternating current or direct current reversed polarity, combined with a short arc and a beading or narrow weave technique may be used. Direct current reversed polarity is recommended or preferred.

d. Slag should be removed after each pass and an interpass or constant temperature of 200 degrees should be maintained.

e. When sufficient metal has been deposited, the weld bead should be ground flush, Fig. 7, with the surface being repaired.

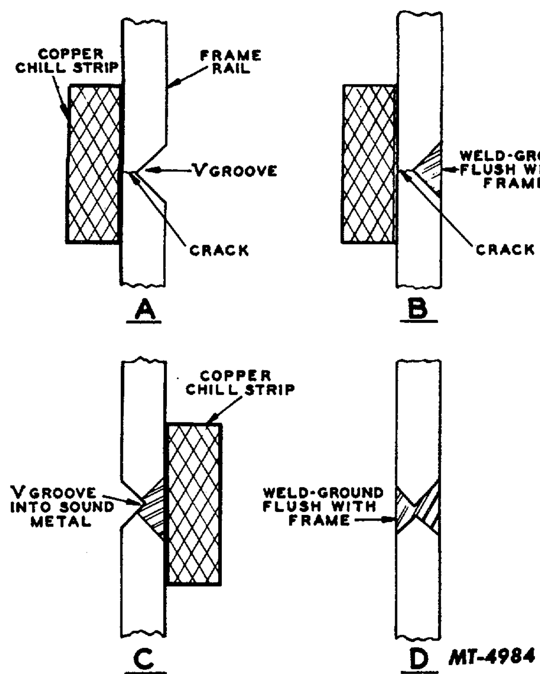


Fig. 7.

f. Where both sides of the frame rail are accessible, a V-groove is ground from the side opposite the repair and the procedure outlined above repeated. Dependent upon accessibility, "chill" strips should be used wherever possible. The V-groove ground on the opposite side of the repair should be deep enough to enter the sound metal of the first weld repair "C" of Fig. 7.

Frame

Welds on heat treated material tend to reduce physical properties in the weld heat-affected zone. Because of this, it is recommended that all reinforcements be designed so that all welds are parallel, rather than perpendicular to the frame rail edges. Welds perpendicular to the flange edges will reduce the carrying capacity of the rail, Fig. 8 and 9.

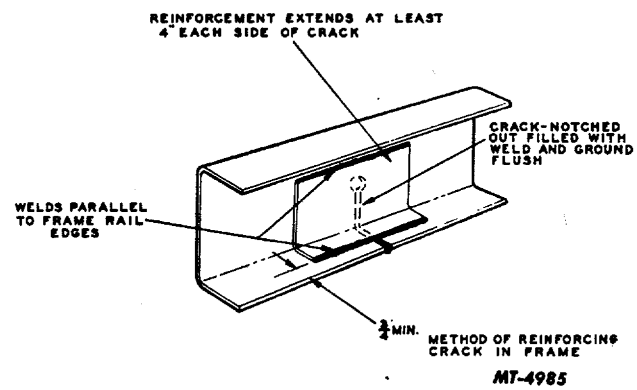


Fig. 8

The edge of the reinforcement flange to the edge of side rail flange dimension should be held to a minimum of three quarters of an inch to keep the heat-affected zone from extending to the sidemember flange edge. Wherever possible, it is recommended that plug welds of the type shown in Fig. 9, be substituted for edge welds when assembling the reinforcement to the side rail. Plug welds offer the advantages of a reduced heat-affected zone plus increased flexibility and reduced stress concentrations. When using this method, one half inch (minimum) diameter holes should be drilled and chamfered in the reinforcement on 2" center to center distances. At no time should these holes be drilled in the frame rail being repaired. The reinforcement should then be installed in its proper position on the sidemember and the holes filled with weld material.

Again a minimum dimension of 3/4" should be maintained between the weld and the edge of the sidemember flange. The voltage, amperage and pre-heat specifications listed below should be followed.

Welding Position	Amperes	Voltage
Downhand	130/140	21/23
Overhead	130/140	21/23
Vertical Up	110/120	22/24

Use low hydrogen electrodes which have superior crack resistance and notch toughness similar to AWS-E11018. This type electrode should be stored in a moisture-free container to avoid porosity during welding.

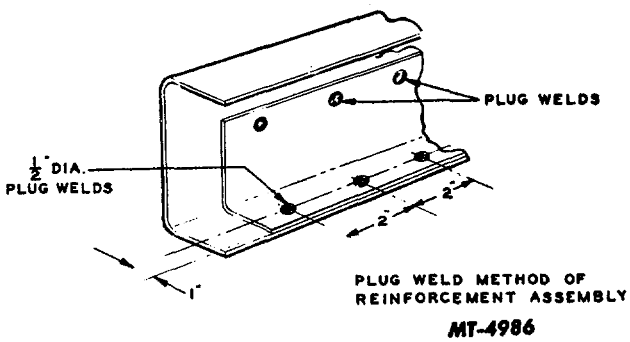


Fig. 9

Full Length Reinforcement

When heat treated frames are to be reinforced over a greater portion of their length, frame channel reinforcements should be installed using bolts. Bolts of high strength material conforming to SAE grade 5 or better should be used. The bolts and nuts should be inspected periodically and kept tight, since the strength of the reinforcement depends somewhat on the maximum clamping force between the members.

Drilling

The drilling of heat treated frame rails presents no unusual difficulty. Standard high speed drills of good quality will serve provided they are sharpened properly and not overheated during sharpening or use. There are, however, special high speed twist drills available having special materials which will hold a cutting edge longer. These drills are expensive and require especially rigid support, otherwise drill breakage will result. When drilling heat treated rails, like in any other drilling operation, sufficient pressure must be applied to the drill bit to maintain continuous cutting. The drill point should frequently be drenched with cutting oil (soluble oil) to help cool the drill. Avoid letting a drill bit turn in the work without cutting. To do so will usually overheat and ruin the drill.

The drill must be held steady during the drilling operation. Avoid wobble or change of drill angle during the drilling operation.

Frame Straightening

When heat treated frame rails have been bent or twisted, they should not be heated for straightening. This work should be done with the frame rails cold. Heating for straightening purposes is likely to destroy the rail temper in localized areas, which will bring about rail failures.

FIFTH WHEEL MOUNTING

The following information has been prepared to avoid any unnecessary drilling of standard non-heat treated and heat treated frame rails, especially at the frame rail flange when the fifth wheel is being installed.

In no instance should welding be used to attach the fifth wheel or mounting parts to the frame rails. The application of the weld is likely to reduce the strength of the rail in the area of the weld. Bolts must be used throughout the fifth wheel installation. The only exception to welding in the fifth wheel installation is the locating block installation at each corner as shown in Figs. 10 and 11.

Figs. 10 and 11 show two methods of mounting the fifth wheel. Fig. 10 shows mounting where the deck plate is attached at frame rail level. This mounting can be modified to raise the fifth wheel; however, the mounting should be changed to that shown in Fig. 11. The mountings illustrated in Figs. 10 and 11 should not be utilized without the use of a deck plate.

Low Mounting

With reference to this type mounting Fig. 10 shows the various details to follow. Note that the drawing shows a 4 x 3-1/2" mounting angle at the frame rail which is cut out at the spring hanger to provide 1/8" clearance.

Where rivets are present the mounting angles must be drilled to provide clearance for rivet heads (C on drawing). This applies to rivets in the frame flange as well as frame side.

Bolts must be used throughout the installation of the fifth wheel mounting. However, locating blocks can be welded to the mounting angles as shown in Fig. 10. These blocks must be welded in place before the angles are installed on the frame rail.

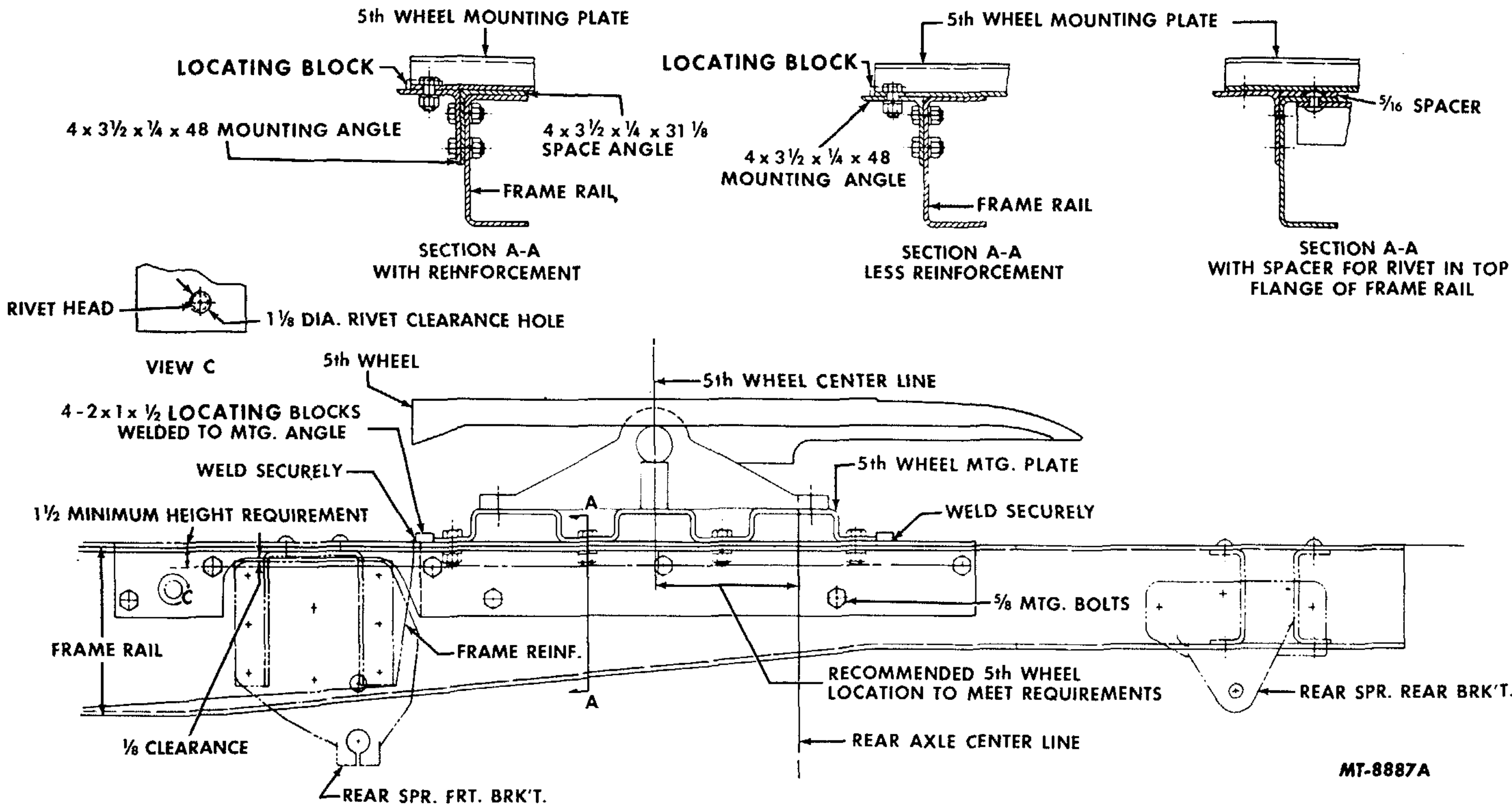


Fig. 10 Low Mounted Fifth Wheel

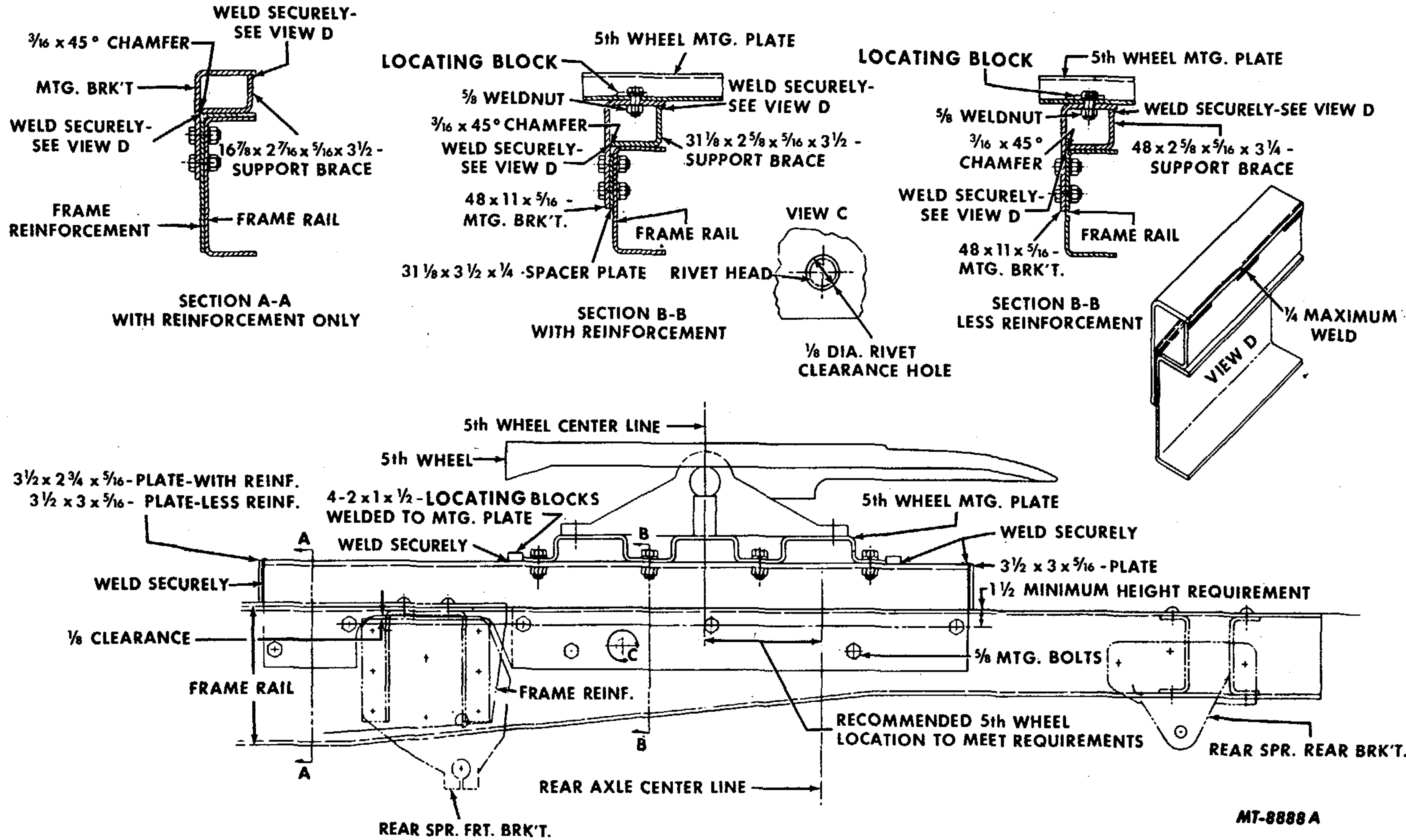


Fig. 11 High Mounted Fifth Wheel

Fig. 10 shows the mounting with reinforced and non-reinforced frame rail. (Section A-A.) Where the mounting is made on a reinforced rail, an additional 4 x 3-1/2" angle is utilized as a spacer. (A-A reinforced.)

The illustration, Fig. 10, represents a typical installation. Wheel base or fifth wheel location requirements may dictate some modification or deviation from that shown.

High Mounting

Where the fifth wheel is to be in a raised position, the mounting details shown in Fig. 11 are to be followed.

With reference to Fig. 11, it will be noted that the support plates or spacers are fabricated to minimize weight and assure sufficient fifth wheel support. Note also that these fabricated sections are extended well forward of the rear spring front brackets. Here again, welding applied to these parts should be performed off the vehicle to avoid heating the frame rail. When welding the spacer or support plate, apply short runs of weld alternately on each side of the plate as shown in View D. This procedure will minimize warpage of the plate during welding.

Fig. 11 shows details of the mounting with reinforced and non-reinforced frame rail. (Sections A-A and B-B.)

Fig. 11 is also a typical installation and can be varied to suit requirements. NOTE: Holes drilled should be 1/32" oversize. Additional bolts can be added where need is indicated.

AIR CLEANERS

CONTENTS

GENERAL

Air must be clean if engine is to deliver proper performance throughout its life span. Dirty air introduced into the engine may ruin the carefully engineered close tolerance of the engine.

Air cleaners are designed to supply clean air to the engine; and if not kept clean, the supply of air will become restricted. This will cause loss of power, sluggish performance and poor gas mileage.

Four types of air cleaners are used on International vehicles. They are the modulated dry type, dry type, oil bath type and combination oil bath and dry type.

A description of the operation of each type is given in the following paragraphs.

OPERATION

Due to the many variations in size and shape of air cleaners used on International vehicles, no attempt has been made to accurately illustrate all variations. Thus, all illustrations herein are only typical of the type of air cleaner being represented.

Modulated Dry Type Air Cleaner

The modulated dry type air cleaner (Fig. 1) provides a thermostatically controlled damper connected to an exhaust manifold stove to provide faster engine warm-up in any weather.

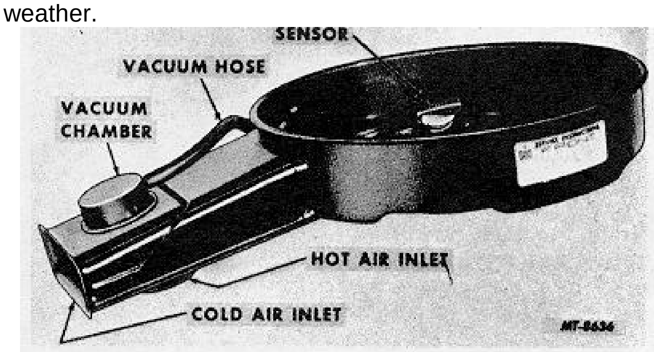


Fig. 1 Typical Modulated Dry Type Air Cleaner (Air cleaner lid and element removed for illustration purposes.)

The air temperature sensor mounted inside air cleaner body and the vacuum chamber mounted on top of inlet tube are factory calibrated units. Operation of the system is completely automatic. The damper, operated by the sensor-controlled vacuum chamber, regulates air entering carburetor to 36-37° C (98-100° F) at all outside temperatures. Hot and cold air conditions are thereby eliminated and better carburetor calibration can be accomplished.

Dry Type Air Cleaner

Dry type air cleaners employ dry type elements sealed within the air cleaner such that all air drawn into the engine must pass through the air cleaner element.

The direction of air flow through the element of dry type air cleaners illustrated in Figs. 2 and 3 is from the outside to inside of filter element. This permits excess foreign particles to fall free from outside surface of element prolonging element service life.

The air cleaner in Fig. 3 is equipped with a vacuator valve. Vacuator valves provide a means of escape for foreign particles from the air cleaner without the necessity of air cleaner disassembly.

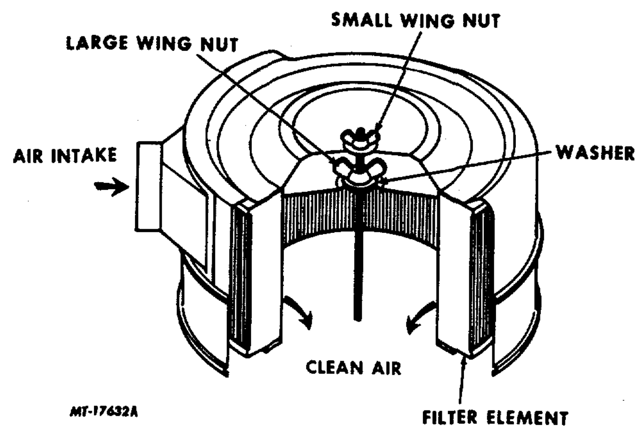


Fig. 2 Typical Dry Type Air Cleaner

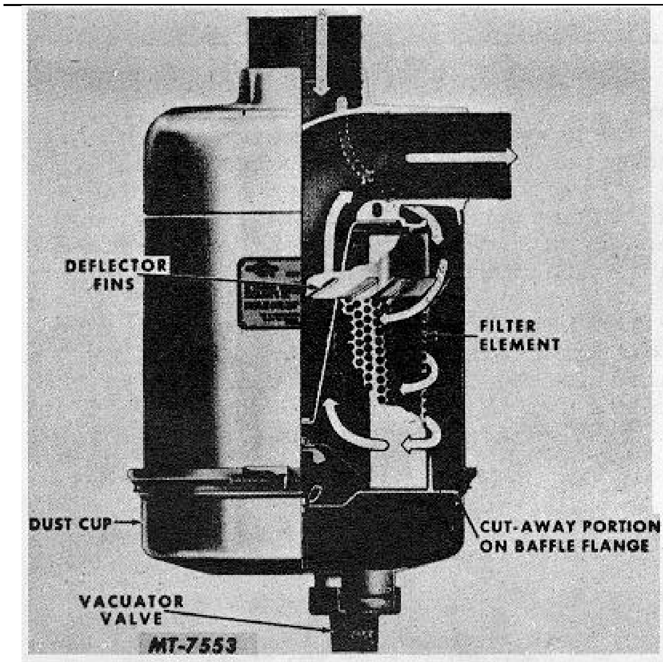


Fig. 3 Typical Dry Type Air Cleaner

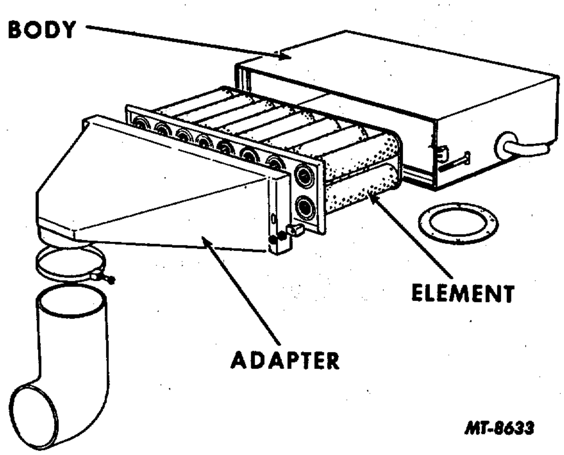


Fig. 4 Typical Dry Type Air Cleaner (Box Type)

The box dry type air cleaner shown in Fig. 4 differs from the other dry type air cleaners illustrated, in that air passes through the air cleaner element from inside to outside (Fig. 5).

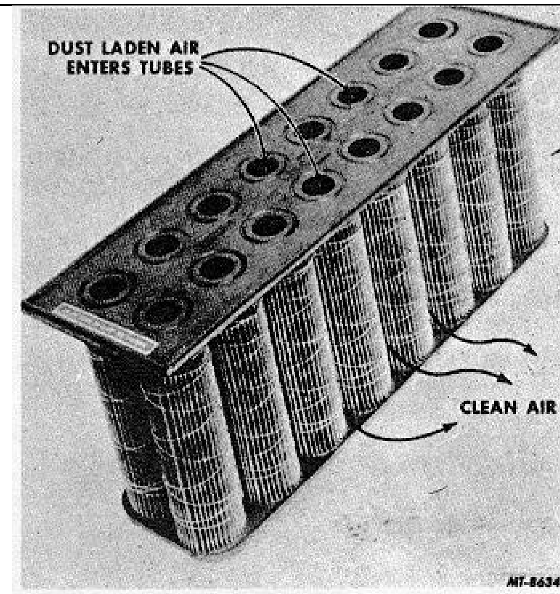


Fig. 5 Box Type Dry Air Cleaner Element

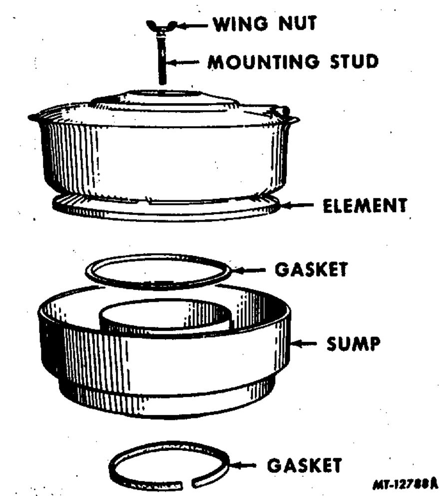


Fig. 6 Typical Oil Bath Air Cleaner

Oil Bath Air Cleaner

All oil bath air cleaners, regardless of size or shape (see Figs. 6 and 7), clean air in the following manner. Uncleaned air is drawn through the upper portion of the unit and then downward at high velocity. Just above the oil reservoir, in the bottom of the cleaner, the direction of air travel is suddenly reversed. This reversal of air flow causes the larger particles of dirt to fall into the oil. The partially cleaned air then travels upward through an oil moistened filtering element where any remaining dirt and dust particles are removed. The cleaned air then enters the carburetor.

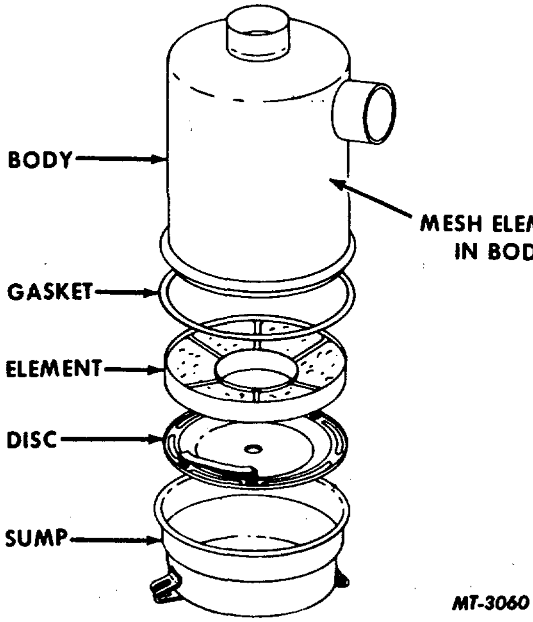


Fig. 7 Typical Oil Bath Air Cleaner

Combination Oil Bath and Dry Type Air Cleaner

The combination oil bath and dry type air cleaner is a two-stage air cleaner. Air entering the air cleaner first flows through an oil bath type air cleaner and then through a dry type element before entering the engine. Fig. 8 illustrates a typical combination oil bath and dry type air cleaner with an adapter arrangement.

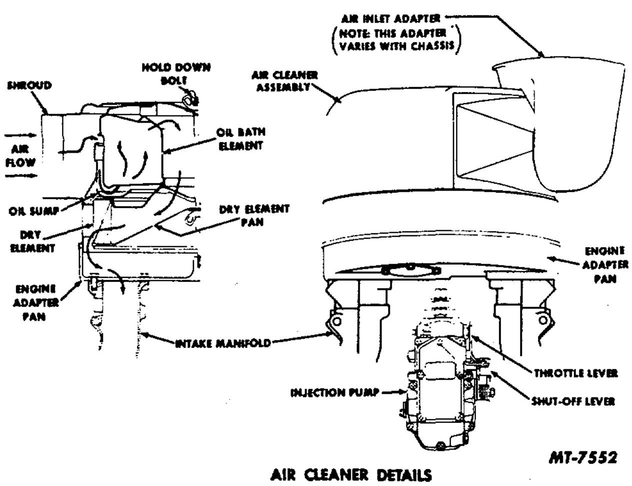


Fig. 8 Typical Combination Oil Bath And Dry Type Air Cleaner

Air Cleaner Restriction Indicators

Air cleaner restriction indicators used in conjunction with dry type air cleaners perform the function which their name implies. Actuated directly by a pressure drop between air cleaner and engine, restriction indicators show when an air cleaner element has reached maximum allowable restriction.

The restriction indicator shown in Fig. 9 contains a red signal band located in the indicator housing above the window and is not visible when engine is stopped if air cleaner does not require servicing.

Fig. 9 Air Cleaner Restriction Indicator

After starting the engine, the band may drop sufficiently to be seen in upper part of window. This must not be mistaken as a signal for element service.

During operation, the red signal band will gradually drop in window as dirt accumulates in filter element. When filter element reaches the maximum allowable restriction, the red band reaches the bottom of window and automatically locks in this position. The band will remain fully exposed even after stopping the engine. When this happens, filter element service is required.

After servicing filter element, reset signal (red band) by pressing reset button and then releasing. This allows red signal band to again rise above window.

Where a direct reading air cleaner restriction gauge (Fig. 10) is used, the maximum allowable restriction is 25 inches of water measured at the air cleaner outlet during any phase of engine operation. When this happens, filter element service is required.

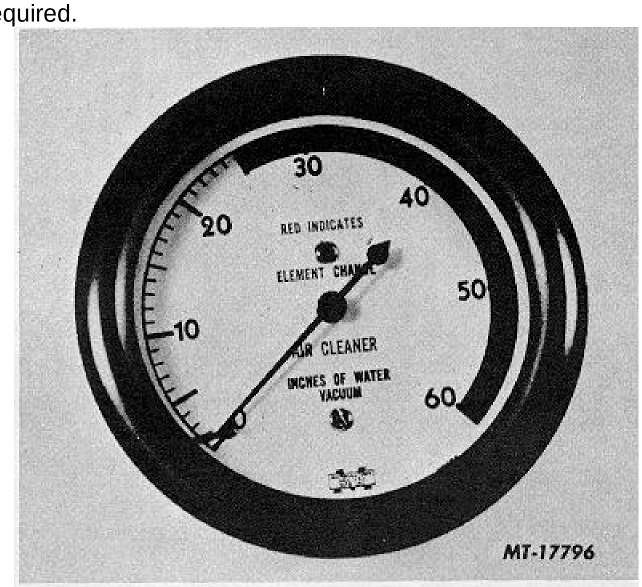


Fig. 10 Air Cleaner Restriction Gauge

SERVICING

NOTE: Refer to the applicable owner's manual to obtain recommended mileage intervals for air cleaner element replacement and service.

Modulated Dry Type Air Cleaner

Service of modulated dry type air cleaner paper element is limited, consisting mainly of checking the element for punctures or splits by looking through element toward light. Tap element-lightly on a flat surface or use low air pressure to remove dirt particles. Do not wash or oil element.

Operation of the vacuum chamber and temperature sensor may be checked by conducting the following tests.

NOTE: Tests should be conducted with engine started from cold and ambient temperature of vehicle being not less than 40° F. Air cleaner must have all hoses, piping and cover in place. No leaks permitted.

1. With engine off inlet tube damper should be in full down position to close heat tube inlet pipe from exhaust manifold stove. Damper position can be determined by looking in end of inlet tube and should be parallel to tube bottom. If damper assembly is not in the correct position, vacuum chamber should be removed and damper movement loosened. Replace vacuum chamber and recheck damper position.

2. Start engine and note that damper has rotated up to close off cold air inlet. Observe damper position by looking in the inlet tube. If damper did not immediately close cold air inlet, shut off engine and disconnect the two hoses from sensor. Connect the two hose ends together using suitable tubing.

   Restart engine and again check damper location. If damper fully closes cold air inlet, temperature sensor is defective and must be replaced. If damper did not close cold air inlet, sensor is okay but damper has bind or vacuum chamber is defective. Remove vacuum chamber and check damper for free movement. If damper moves freely, replace vacuum chamber.

3. After a cold start operate engine for 10 minutes at medium RPM. When engine is at normal operating temperature, slow engine to idle and observe position of inlet tube damper. If damper has not rotated all or part way down to allow some cold air to enter inlet tube, replace temperature sensor.

Vacuum Chamber Replacement (Fig. 11)

Vacuum chamber is replaced by bending tab nearest inlet tube entrance down from inside of tube. Disconnect vacuum hose and lift vacuum chamber, sliding rear tab out of its slot and disengaging damper hook from damper.

The new chamber is attached by engaging hook in damper, sliding rear tab into its slot and fitting front tab into place. A spring preload should be felt when vacuum chamber is pressed firmly against top of inlet tube. If no preload is felt, check the installation or be sure parts are not faulty. Press front vacuum chamber tab firmly against tube inside surface. Connect vacuum hose.

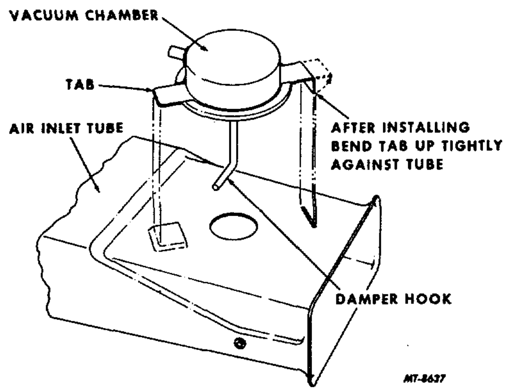


Fig. 11 Vacuum Chamber Replacement

Temperature Sensor Replacement (Fig. 12)

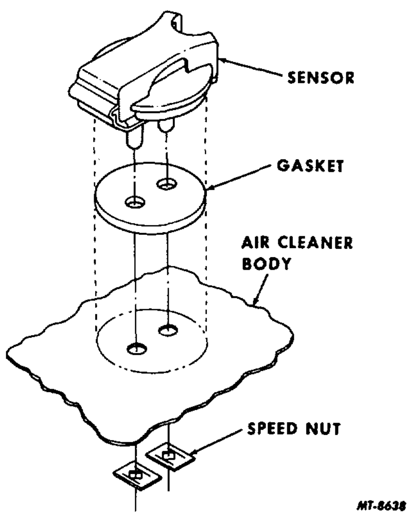


Fig. 12 Temperature Sensor Replacement

Disconnect two vacuum hoses attached to sensor inlet and outlet tubes on underside of air cleaner body. Remove clamps or speed nuts from tubes and lift sensor from body. Position new sensor and gasket inside air cleaner body. Firmly press two new speed nuts or clamps on tubes to hold sensor in place. Attach vacuum hoses to sensor tubes.

<u>Dry Type Air Cleaners</u>

Nonwashable Element

Dry type air cleaners equipped with nonwashable element may be serviced by removing element and wiping inside surfaces of air cleaner free of foreign particles.

Elements may be cleaned with compressed air [not to exceed 276 kilopascals (40 psi)) directing air stream up and down pleats on clean air side of element. Hold air nozzle approximately 15 centimeters (6 in.) from element surface.

Do not strike rim of element against any hard surface. Damage could result to the rim and affect sealing at reassembly.

Before reassembly place a light on inside of element and inspect outside surface of element for punctures or splits.

If so equipped, inspect air cleaner and element gaskets and replace if necessary on reassembly.

Washable Element

Dry type air cleaners equipped with washable element may be serviced by removing element and wiping inside surfaces of air cleaner free of foreign particles.

If air cleaner is equipped with a vacuator valve, remove valve and clean.

Elements may be cleaned with compressed air [not to exceed 276 kilopascals (40 psi)] directing air stream up and down pleats on clean air side of element or by washing. When using compressed air hold air nozzle approximately 15 centimeters (6 in.) from element surface.

When washing element remove all loose dust with a flow of water. Use a hose without a nozzle and do not permit water pressure to exceed 276 kilopascals (40 psi).

Next, immerse element in a solution of nonsudsing household detergent and warm water [not to exceed 60° C (140° F)] for approximately 15 minutes. Agitate element occasionally to aid cleaning action.

Remove element and rinse thoroughly by running clean water through element from clean air side to dirty side until water passing through element is clear. Use a hose without a nozzle and do not permit water pressure to exceed 276 kilopascals (40 psi).

Allow element to dry completely.

CAUTION: Never use compressed air or light bulbs to hasten drying. High pressure air can tear holes in paper pleats and light bulbs can cause burning.

Inspect element after cleaning by inserting a light bulb inside element and inspecting outside surface of element for punctures or splits.

If so equipped, inspect air cleaner and element gaskets and replace if necessary on reassembly.

It is not recommended to attempt cleaning box dry type elements. When box dry type elements have reached maximum allowable restriction as outlined in the applicable operator's manual, they should be replaced.

Oil Bath Air Cleaners

Remove cover or sump. Wash mesh element and sump in cleaning solvent or kerosene. Some oil bath air cleaners have two mesh elements: one removable and one integral in the body assembly.

Cleaning solvent must be flushed through element with sufficient force and volume to dislodge foreign material. Use a long bristle, brush to assist in dislodging any dirt or dust. Air cleaners having integral elements can be submerged and agitated briskly in cleaning solvent to force the cleaning fluid through the element.

NOTE: Steam cleaners may be used to perform the cleaning operation if the air cleaner is unusually dirty; however, be careful not to damage the air cleaner.

Refill sump to oil level mark and oil mesh element freely with engine oil of same viscosity used in crankcase. Allow excess oil to drip from element before installation.

Combination Oil Bath and Dry Type Air Cleaners

Refer to the oil bath air cleaner and dry type air cleaner service instruction contained in this manual section to service the corresponding sections of combination oil bath and dry type air cleaners.

ENGINE
CARBURETOR MODELS 4150, 4150C, 4150G AND 4150EG
CONTENTS

GENERAL INFORMATION

The outward appearance of 4150 series carburetors described in this service manual differ with engine model, vehicle model or year. Manually and automatic operated chokes are used on the model 4150 and 4150C respectively. The centrifugal-vacuum type governor is used on the model 4150G and the electronic vacuum modulating governor is used on the model 4150EG carburetor.

The model 4150 series carburetor is of the four-barrel, two stage, downdraft type. The first stage (primary stage) supplies a fuel/air mixture throughout the entire range of engine operation and contains the choke valve. The secondary stage constantly supplements the fuel delivery as needed. The secondary throttle plates are vacuum controlled and operated by the primary stage and governor.

There are three major subassemblies of the carburetor and they are: 1) the main body assembly, 2) the fuel bowls and metering assemblies, and 3) the throttle body assembly.

The die-cast fuel bowls and metering bodies contain the fuel chambers, fuel inlet needle valves, accelerating pump, primary and secondary main jets and fuel metering passages. The die-cast throttle body assembly contains the primary and secondary throttle plates, throttle linkage and various fuel and vacuum passages.

A diaphragm-type operated accelerator pump is located in the bottom of the fuel bowl. The pump functions when pump lever is activated by cam on throttle lever assembly. An override spring on pump lever adjusting screw allows a prolonged discharge of fuel for smooth acceleration

CARBURETOR SYSTEMS

The primary side of the carburetor utilizes four basic fuel metering systems. The Idle System provides, supplemented by the secondary side, a mixture for idle and low speed performance. The Accelerator System provides additional fuel during acceleration; the Main Metering System provides an economical mixture for normal cruising conditions; and the Power Enrichment System provides a richer mixture when high power output is required.

In addition to these four basic systems, there is a fuel inlet system that constantly supplies fuel to the basic metering systems and a choke system which temporarily enriches the mixture to aid in starting and running a cold engine.

The secondary side of the carburetor utilizes, depending on engine model, two or three basic fuel metering systems. The Idle System supplements the primary side to provide a rich mixture for smooth idle and low speed performance; the Main Metering System provides, with the primary system, an economical cruising mixture; and the Power Enrichment System (not used on all carburetors) provides a richer mixture when required.

In addition to the basic secondary systems, there is also a fuel inlet system to supply fuel to the metering systems.

Fuel Inlet System

Fuel enters the fuel bowls through a filter screen in the fuel inlet and into the fuel inlet valves which are frequently referred to as the fuel inlet needle and seat assembly (Fig. 6). The amount of fuel entering the fuel bowls is determined by the space between the top of the movable needle and its seat and also by the pressure from the fuel pump. Movement of the needle in relation to the seat is controlled by the float and lever assembly which raises and falls with the fuel level. As the fuel level drops, the float drops, opening the needle valve to allow fuel to enter the float chamber.

When the fuel reaches a specified level, the float moves the needle valve to a position into the seat where it restricts the flow of fuel, admitting only enough to replace that being used. Any slight change in the fuel level causes a corresponding movement of the float, opening or closing the fuel inlet needle valve to immediately restore or hold the correct fuel level.

The fuel inlet system must constantly maintain 'the specified level of fuel as all the other metering systems are calibrated to deliver the proper mixture only when the fuel is at this level.

Prior to the introduction of the emission control systems, most all fuel bowls were vented to the atmosphere. On later model carburetors, fuel bowls are vented internally and vapors are burned in the engine.

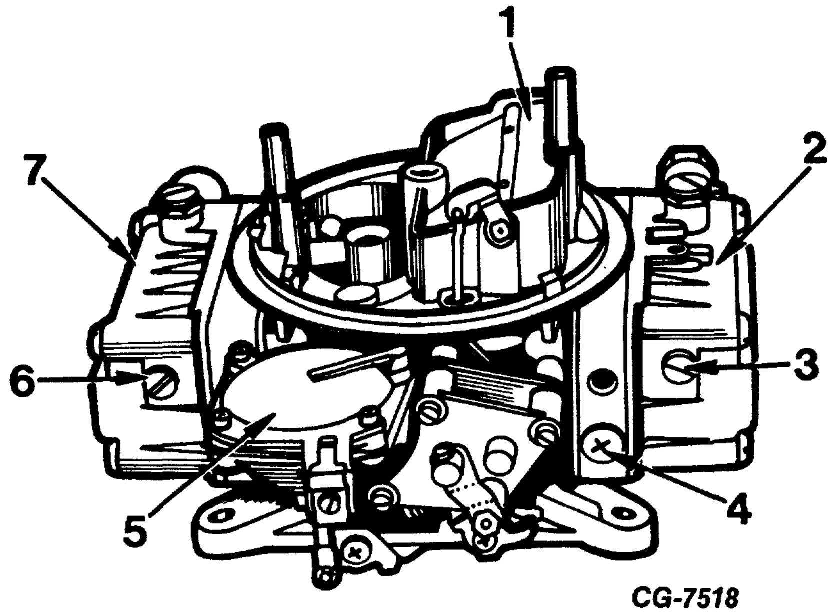


Figure 1 Model 4150 Carburetor

1. Choke Plate
2. Primary Fuel Bowl Assembly
3. Fuel Level Sight Hole
4. Idle Limiter Cap
5. Secondary Diaphragm Assembly
6. Fuel Level Sight Hole
7. Secondary Fuel Bowl Assembly

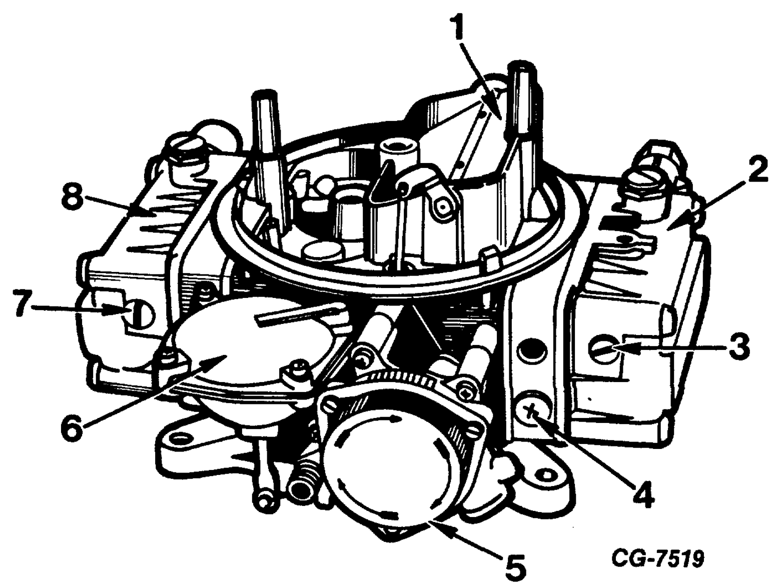


Figure 2 Model 4150C Carburetor

1. Choke Plate
2. Primary Fuel Bowl Assembly
3. Fuel Level Sight Hole
4. Idle Limiter Cap
5. Automatic Choke Assembly
6. Secondary Diaphragm Assembly
7. Fuel Level Sight Hole
8. Secondary Fuel Bowl Assembly

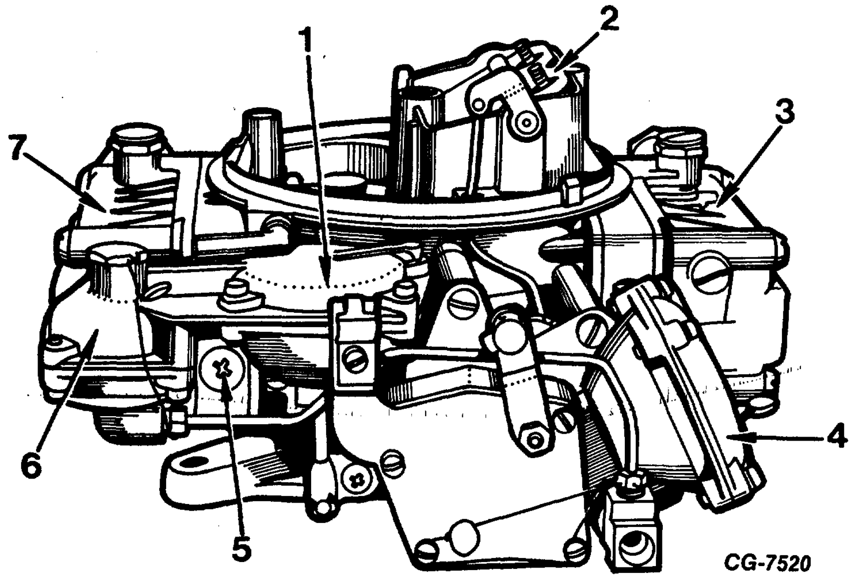


Figure 3 Model 4150G Carburetor with Centrifugal-Vacuum Type Governor

1. Secondary Control Valve Assembly
2. Choke Plate
3. Primary Fuel Bowl Assembly
4. Governor Assembly
5. Idler Limiter Cap
6. Secondary Control Valve Assembly
7. Secondary Fuel Bowl Assembly

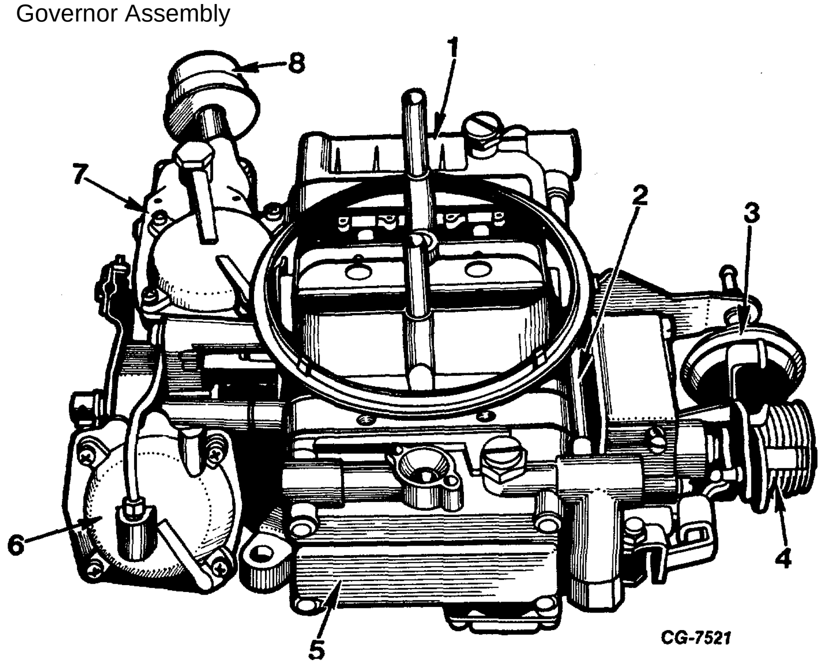


Figure 4 Model 4150G Carburetor with Redundant Safety Spring and Deceleration Throttle Modulator

1. Secondary Fuel Bowl Assembly
2. Fuel Transfer Tube
3. Throttle Modulator
4. Throttle Redundant Safety Spring System
5. Primary Fuel Bowl Assembly
6. Governor Assembly
7. Secondary Control Valve Assembly
8. Secondary Control Valve Air Filter

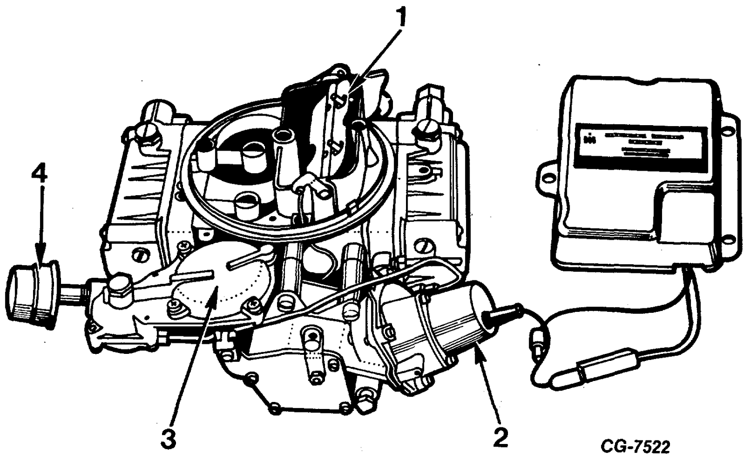


Figure 5 Model 4150EG Carburetor with Electronic Vacuum Modulating Type Governor

1. Choke Valve
2. Governor Solenoid Assembly
3. Secondary Control Valve Assembly
4. Control Valve Air Cleaner

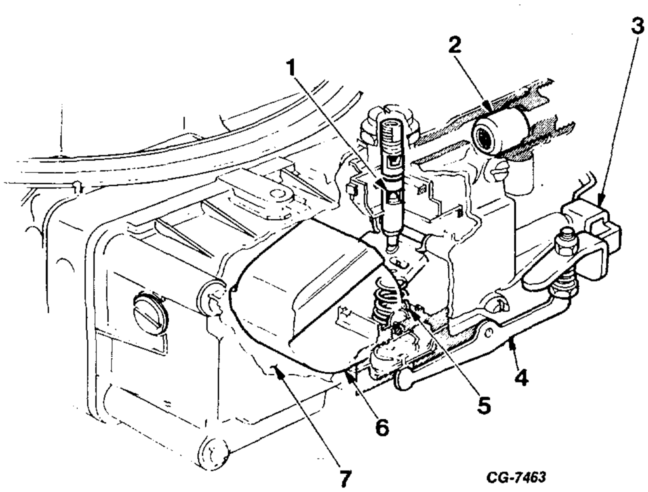


Figure 6 Typical Fuel Inlet System

1. Needle and Seat Assembly
2. Filter Screen Assembly
3. Accelerating Pump Operating Lever
4. Accelerating Pump Cover Lever
5. Float Spring
6. Float and Lever
7. Fuel Bowl

Idle System

Primary Side. The 4150 series carburetors utilize two identical idle systems, one for each primary bore. At idle, normal air pressure in the primary float chamber causes

the fuel to flow through the idle system to the greatly reduced pressure area below the throttle plate. Fuel flows from the float chamber through the main jet into the small horizontal passage that leads to a vertical passage.

Fuel flows up the idle well passage past the idle feed restriction. The fuel then is mixed with incoming air from the idle air bleed. This fuel and air mixture flows down a vertical passage to the idle transfer passage and is discharged into the throttle bore below the throttle plate. (Fig. 7)

Secondary Side. Because of driving habits, some drivers would use the secondary side very little. If the secondary system remains inoperative over long periods the system may become blocked with gum and carbon formations. To prevent this condition, an idle system is incorporated on the secondary side.

Fuel flows from the secondary fuel bowl through the main jet, up the idle well and through the idle feed restriction. Then it crosses a horizontal passage and blends with idle air from the idle air bleed. This fuel-air mixture flows down a vertical passage to the idle adjusting needle.

Part of this mixture flows into the idle discharge passage and part into the idle transfer passage. The fuel-air is

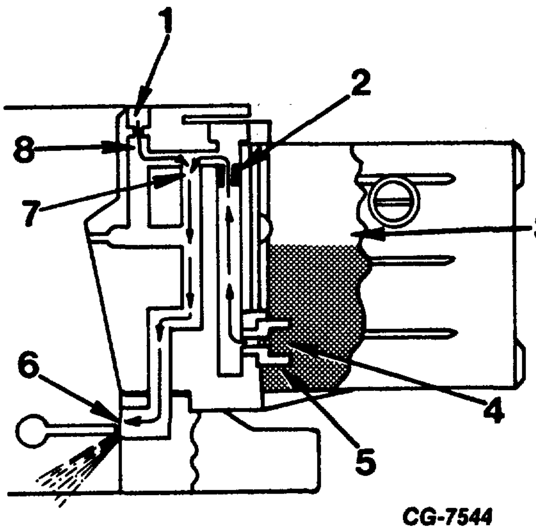


Figure 7 Idle System Fuel Air Flow Primary Side

1. Idle Air Bleed
2. Idle Feed Restriction
3. Fuel Bowl
4. Fuel Flow
5. Main Jet
6. Idle Discharge Slot
7. Fuel/Air Flow
8. Air Flow

discharged through the idle discharge hole into the throttle bores below the secondary throttle plates. As the throttle plates are opened fuel-air is discharged into the throttle bores from the idle transfer slots. (Fig. 8)

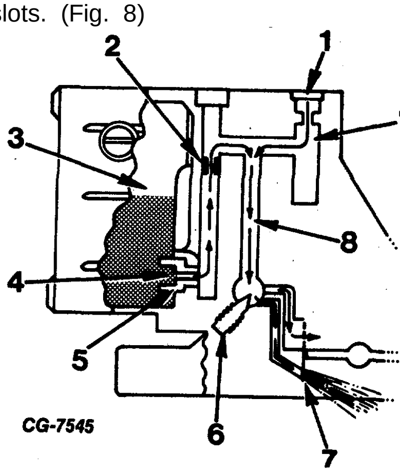


Figure 8 Idle System Fuel Air Flow Secondary Side

1. Idle Air Bleed
2. Idle Feed Restriction
3. Fuel Bowl
4. Fuel Flow
5. Main Jet
6. Idle Adjusting Needle
7. Idle Discharge Hole
8. Fuel/Air Flow
9. Air Flow

Main Metering System

As the throttle plates open in response to speed and/or load demand, the air flow through the carburetor main venturi increases in velocity, inducing an increased depression on the main metering system, causing air/fuel mixture to flow from the main discharge nozzle. The flow from the idle system gradually decreases and reverses as the carburetor approaches a wide open throttle condition (Fig. 9).

In the main metering system, the fuel flows from the fuel bowl through the main metering jet which meters the fuel into the main well. The fuel mixes with air inducted through the main well air bleed in the side of the well. The emulsion created then passes through the discharge channel and is discharged into the carburetor venturi by the discharge nozzle.

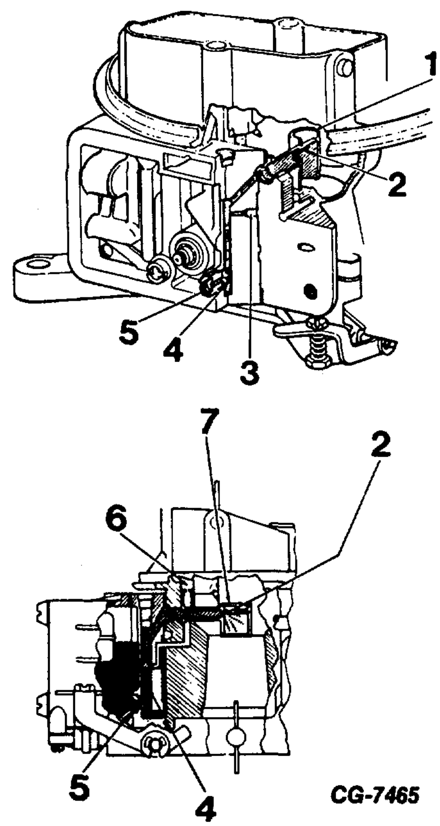


Figure 9 Main Metering Fuel Air Flow

1. Booster Venturi
2. Discharge Nozzle
3. Main Well Air Bleed
4. Main Well
5. Main Jet
6. High Speed Air Bleed
7. Booster Venturi

Power Enrichment System

The enriched air/fuel mixture required under heavy load conditions is provided by a supplementary fuel metering system and the power valve which is controlled by manifold vacuum. Since manifold vacuum is proportional to engine load, the enrichment can be triggered at any required point in the load range. Some versions of this carburetor contain a two-stage power valve which can be calibrated to enrich the air/fuel ratio in two increments in the load range in order to provide more precise calibration where required for emission control (Fig. 10).

The power valve in this carburetor is a diaphragm actuated, spring loaded conical valve normally closed under high manifold vacuum conditions (cruise or idle) by the force of the vacuum acting on the diaphragm. When the manifold vacuum is reduced to a given level (acceleration or load), the spring force will open the valve, providing a path for fuel to flow from the fuel bowl to the main metering well, bypassing the main metering jet. As engine load decreases, manifold vacuum increases and the valve returns to the closed position, eliminating the supplementary fuel.

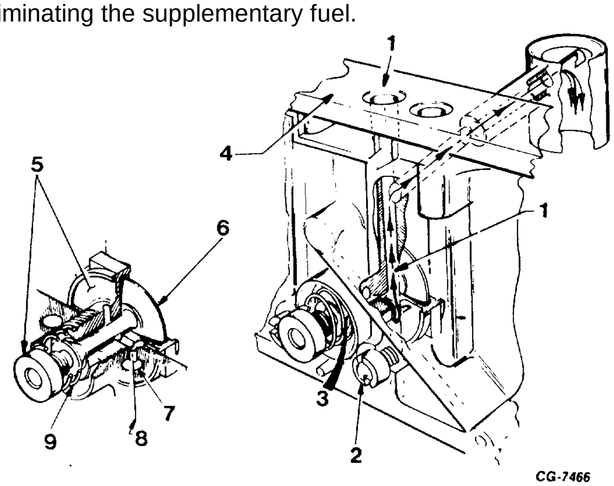


Figure 10 Power Enrichment Fuel Air Flow

1. Main Well
2. Main Jet
3. Fuel Flow
4. Metering Body
5. Power Valve Assembly
6. Power Valve Diaphragm
7. Main Well
8. Channel Restriction
9. Spring

Two-Stage Power Valve

The added supply of fuel necessary for high speed or full power operation is delivered by a fully automatic power enrichment system. Manifold vacuum on the power valve diaphragm actuates the power enrichment system.

To provide a leaner light load and light part-throttle operation, a twostage diaphragm-actuated power valve is used in some model series carburetors (Fig. 11).

During light load and light part throttle operation where manifold vacuum drops to a pre-determined level, the first stage of the power valve opens and enriches the mixture slightly. As manifold vacuum decreases on acceleration or steeper grades, the second stage opens, providing full power enrichment. The two stage power valve is serviced as an assembly and is not adjustable in the field.

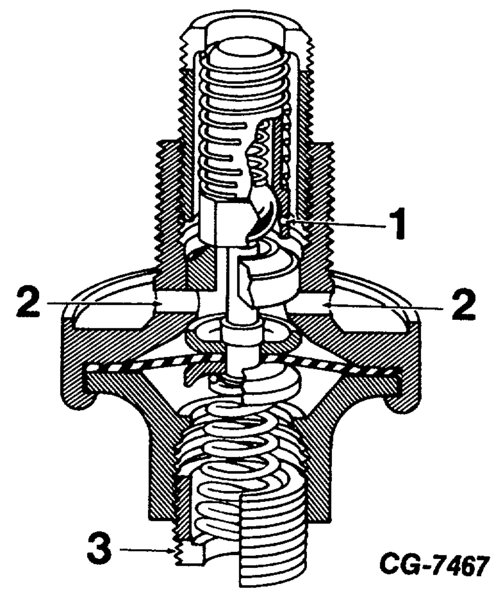


Figure 11 Two-Stage Power Valve

1. First Stage Orifice
2. Main Passage
3. Main Stage

Power Valve Modulator

The power valve modulator is incorporated in the power valve vacuum system to ensure fuel enrichment during high speed, wide open throttle operation. As wide open throttle engine speed approaches the maximum engine RPM, intake manifold vacuum may rise to a level sufficient to close the second stage of the power valve, thereby reducing fuel flow and engine power. The power valve modulator system is designed to bleed off power valve cavity vacuum when the throttle plates are opened to 50 degrees or greater. At this angle a hole in the throttle shaft and the hole in the throttle body are aligned, permitting flow of clean air from the air cleaner to the power valve cavity, thus reducing cavity vacuum and insuring full fuel enrichment (Figures 12 and 13).

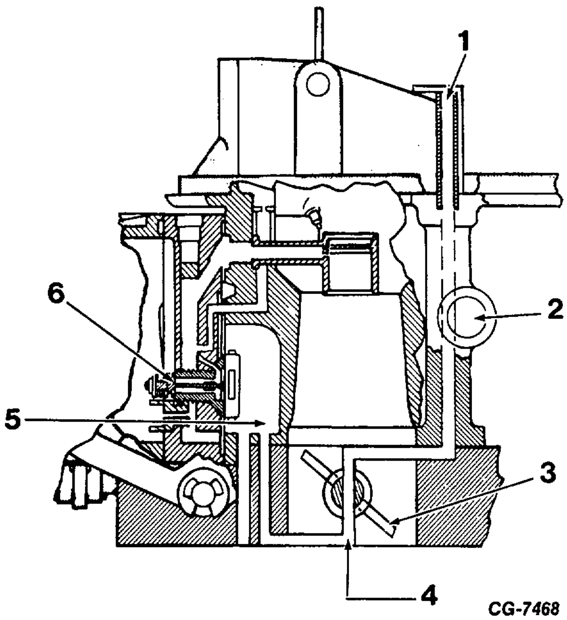


Figure 12 Modulator Valve in Open Position Power Valve Open

1. Clean Air Tube
2. Air to Governor
3. Throttle Plate
4. Hole in Throttle Shaft Aligned with Hole in Throttle Body
5. Vacuum Cavity
6. Two-Stage Power Valve

Acceleration Pump System

The accelerating pump is located in the bottom of the fuel bowl. The function of the pump is to discharge fuel into the carburetor upon acceleration demand in order to compensate for the inertia of the fuel metering system with a temporary, instantaneous enrichment of the air/fuel mixture. The pump consists of a spring loaded diaphragm, a normally closed needle check valve (discharge) and a normally open ball or plastic check valve (inlet). The pump is actuated by a rotating mechanical link mounted between the diaphragm and the throttle lever assembly (Figures 14 and 15).

As the throttle is opened, a cam mounted to the throttle lever rotates the pump lever, depressing the pump

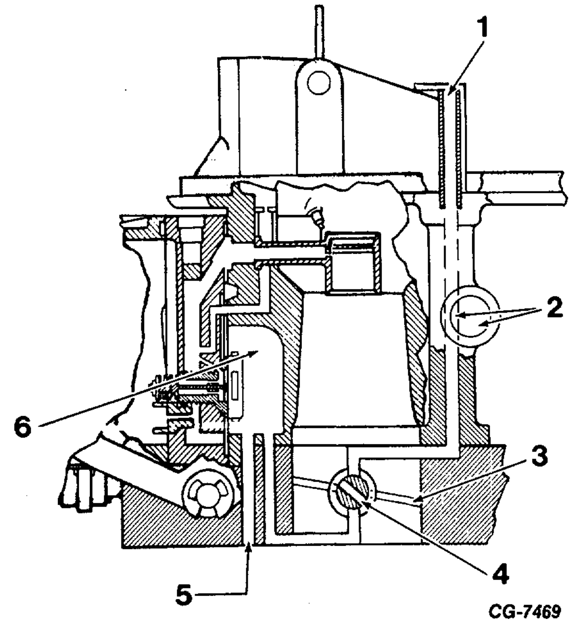


Figure 13 Modulator Valve in Closed Position Power Valve Closed

1. Clean Air Tube
2. Air to Governor
3. Throttle Plate
4. Hole in Throttle Shaft
5. Vacuum to Power Valve Diaphragm
6. Vacuum Cavity

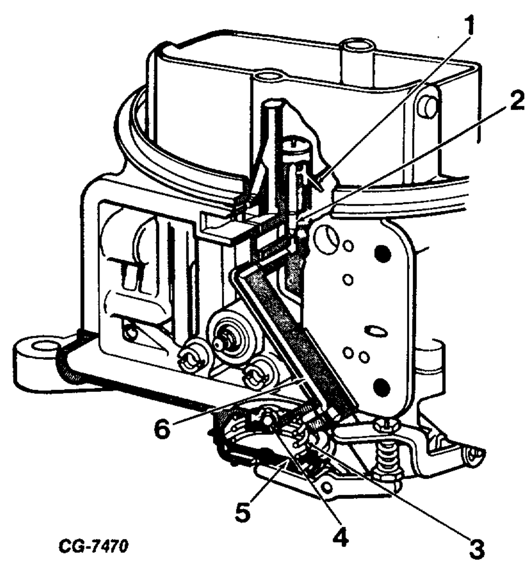


Figure 14 Acceleration Pump Fuel Flow (shown with inlet check ball not used on early models).

1. Discharge Nozzle
2. Pump Discharge Weight
3. Diaphragm Return Spring
4. Pump Inlet Check Ball
5. Diaphragm
6. Discharge Passage

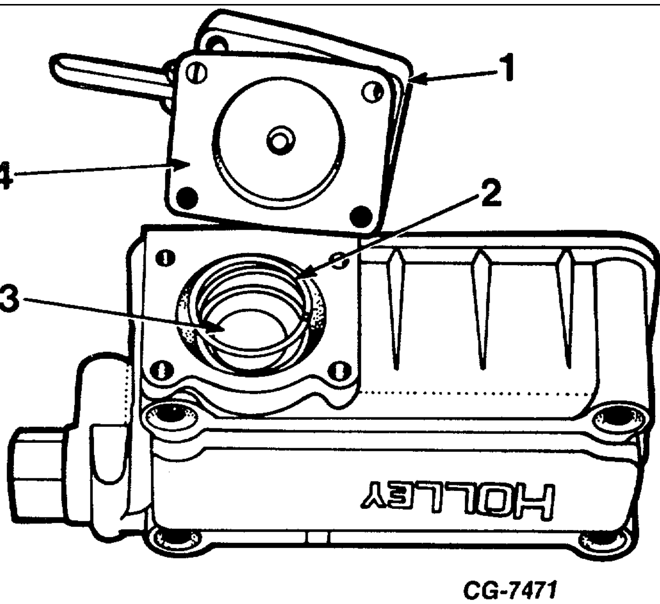


Figure 15 Acceleration Pump Assembly (shown with plastic pump inlet valve used on later model carburetors).

1. Diaphragm Cover
2. Diaphragm Return Spring
3. Plastic Valve
4. Diaphragm Assembly

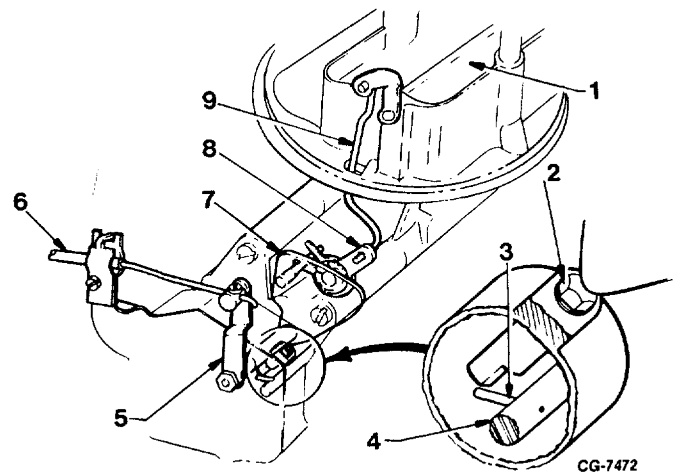


Figure 16 Manual Choke System

1. Choke Plate
2. Fast Idle Adjusting Screw
3. Fast Idle Pin
4. Throttle Shaft
5. Choke Lever
6. Choke Cable
7. Fast Idle Cam
8. Choke Rod Lever
9. Choke Rod

diaphragm. Hydraulic pressure forces fuel in the pump cavity and channels past the needle check valve and out the pump discharge nozzles into the air stream.

Upon return of the throttle lever toward idle position, the diaphragm spring returns the diaphragm and the resultant pressure differential causes the discharge valve to close and the inlet ball or plastic check valve to open, allowing the pump cavity to refill with fuel from the bowl.

Choke System

The function of the choke system is to provide a rich air/fuel mixture necessary for cold starting and engine warm-up (Fig. 16).

The choke plate, which is manually operated on governor type carburetors, may be closed during the engine cranking period and partially opened during the warm-up period. This induces a low pressure on the fuel metering system, causing both the main and idle systems to discharge more fuel producing mixtures rich enough to insure smooth power as the engine warms up.

During the full choke period, the high point of the fast idle cam is in contact with the fast idle adjusting screw which sets the throttle plates at a predetermined angle causing engineRPM to be high upon starting. As the choke is manually opened, the cam moves rotationally away from the fast idle adjusting screw allowing the engine to resume its normal idle speed setting.

Throttle Modulator-1970-1971 Vehicles Under 6000 Lbs. GVW

To provide acceptable exhaust emission levels, the carburetors of certain vehicles require the use of a throttle modulator.

The throttle modulator is vacuum operated and functions above a predetermined road speed to aid in the control of exhaust emission during engine deceleration.

Fig. 17 shows throttle modulator diagram. A speed sensor (spinner valve) is driven by the speedometer cable. A vacuum source and bleed line are piped into the speed sensor. The sensor is designed to open the bleed line to the vacuum source when vehicle road speed is below the predetermined cutoff speed (approximately 24 MPH). As long as the bleed line is open, no vacuum is available to extend the modulator.

When the vehicle passes the road speed cutoff point, the bleed line is closed, making vacuum available to actuate the modulator.

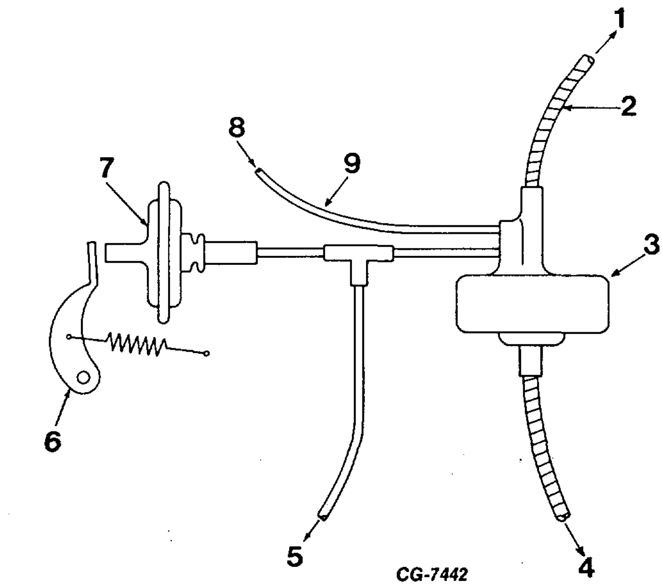


Figure 17 Throttle Modulator Diagram

1. To Speedometer
2. Bleed Line Open to Vacuum Source Below Cutoff Speed

   Bleed Line Closed To Vacuum Source Above Cutoff Speed
3. Spinner Valve Speed Sensor
4. To Transmission
5. To Vacuum Source
6. Throttle Lever
7. Throttle Modulator
8. To Air Cleaner
9. Bleed Line

The throttle plate is held in a partially open position during vehicle deceleration to aid combustion and provide an acceptable exhaust emission level.

When the vehicle decelerates to the cutoff speed, the vacuum bleed line is opened by the speed sensor, causing the modulator to retract and allow the throttle lever to close the throttle plate to curb idle position.

The speed sensor and throttle modulator are serviced only as complete replacement units.

Deceleration Throttle Modulator System - 1973 California and 1974 thru 1980 Federal Vehicles Over 6000 Lbs. GVW

The deceleration throttle modulator system (DTM) consists basically of a vacuum operated throttle modulator unit on the carburetor, a solenoid vacuum valve and engine speed sensor unit (Fig. 18).

Normally an engine will emit relatively high levels of unburned hydrocarbons during "closed throttle" deceleration. This is because the intake of air/fuel mixture is not sufficient to support complete combustion and the engine "misfires" resulting in fuel being passed through the engine unburned. The deceleration throttle modulator system overcomes this condition by maintaining a slightly greater throttle opening (high idle) during initial deceleration which permits intake of just enough additional air/fuel mixture to promote combustion and eliminate misfire.

The engine speed sensor is calibrated to activate or deactivate (extend or retract) the throttle modulator unit at approximately 1850 RPM engine speed.

Above 1850 RPM engine speed, the solenoid vacuum valve is activated (held open) by electrical current from the engine speed sensor unit. This permits manifold vacuum to act upon the diaphragm of the throttle modulator unit extending the modulator unit to the high idle position. Upon deceleration, the returning carburetor throttle lever contacts the extended modulator, thus holding the throttle in high idle position.

When engine speed drops below 1850 RPM, the speed sensor unit deactivates the solenoid vacuum valve allowing the valve to close and bleed the vacuum from the throttle modulator diaphragm spring to retract the modulator unit and allow the throttle lever to return to normal curb idle position.

For deceleration throttle modulator service instructions, see CGES-215 Emission Control Systems.

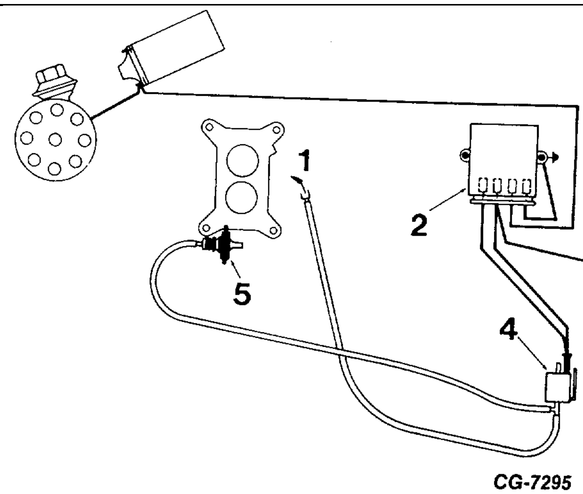


Figure 18 Deceleration Throttle Modulator System (Typical)

1. To Intake Manifold
2. Engine Speed Sensor Unit
3. From Ignition Switch
4. Solenoid Vacuum Valve
5. Throttle Modulator

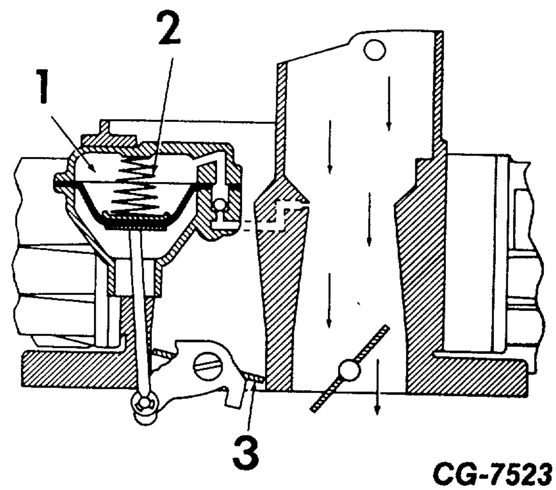


Figure 19 Secondary Throttle Operation (Low Speed or Light Load)

1. Secondary Diaphragm Chamber
2. Diaphragm Spring Holds Throttle Plate Closed
3. Secondary Throttle Plate

Secondary Throttle Operation

The secondary throttle plates are operated by a spring-loaded diaphragm which is controlled by vacuum from the right primary venturi (Fig. 19 and 20). The secondary diaphragm spring tends to hold the secondary throttle plates closed. When engine air requirements approach the capacity of the two primary venturis, increased vacuum from the right primary venturi moves the secondary diaphragm, compressing the diaphragm spring and opening the secondary throttle plates (Fig. 20). As the secondary throttle plates open, the secondary fuel system begins to discharge fuel and the engine is supplied by all four carburetor venturis. When engine speed is reduced, primary venturi vacuum acting upon the secondary diaphragm is lessened, and the diaphragm spring starts closing the secondary throttle plates. When the primary throttle plates are fully closed, the secondary throttle plates are held closed mechanically by design of the secondary connecting rod.

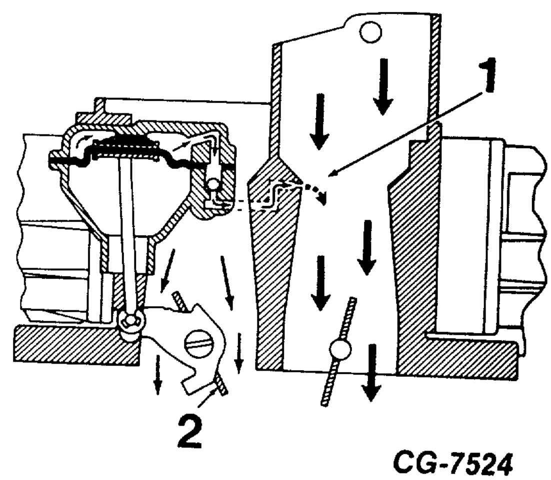


Figure 20 Secondary Throttle Operation (High Speed or Heavy Load)

1. Increased Vacuum Moves Diaphragm Opening Secondary Throttle Plates
2. Secondary Throttle Plate

Governor (Distributor Spinner Controlled)

Internal Vacuum Type 4150G

A vacuum operated engine speed governor (Figures 21 and 22) is incorporated on the carburetor as a positive means of controlling engine speed. The governor contains a throttle-actuating mechanism attached to the primary throttle of the carburetor through an overriding clutch. The throttle-actuating mechanism consists of a diaphragm assembly, governor spring and governor lever assembly. Below governing speeds the operator, through a simple clutch arrangement on the throttle body of the carburetor, controls the throttle body of the carburetor and throttle plates in the usual manner. When governing speed is reached, a combination of venturi and manifold vacuum acts on the governor diaphragm to close the throttle plates.

Two calibrated bypass jets in the vacuum passages meter the vacuum from the venturi and the manifold to provide the correct balance for proper operation of the governor. At speeds below governing RPM this vacuum is weakened by air bleeding through the governor valve in the governor spinner so that no premature governing action will occur.

Filtered air from the carburetor air cleaner enters the governor system through a passage in the main body and then into the governor vent tube. The air flows through an air line to the housing enclosing the governor rotor or spinner valve, located in the distributor.

A combination of low pressure from the venturi and manifold transmitted through the governor system passages draws the air past the governor valve and through another air line to the throttle actuating unit on the carburetor.

In the controlling unit centrifugal force acting on the rotor, which has kept pace with engine speed, overcomes the tension of the valve spring and tends to close the governor valve when governing speed is reached. This greatly restricts the amount of air bleeding through to the diaphragm on the carburetor, thus allowing the combined venturi and manifold pressure differential to operate the diaphragm. As the pressure differential across the diaphragm increases, the diaphragm moves the governor lever against the tension of the governor spring to close the throttle plates.

The governed engine speed is held constant by centrifugal force on the valve balanced against the tension of the valve spring. Any slight change in engine speed due to load variation will cause the governor valve to react immediately, either increasing or decreasing the amount of air bleeding through the governor valve orifice. A change in the amount of air bleed will, in turn, cause an instant response from the diaphragm to increase or decrease the throttle plate opening.

When the accelerator is released, control is taken from the governor by the external throttle lever and the return spring in the accelerator pedal linkage closes the throttle plates to bring the engine to any desired lower speed.

A secondary control valve is used in conjunction with the governor. The purpose of the secondary control valve (Figures 23 and 24) is to close the secondary throttle plates when governed speed is reached, so that the engine cruises at governed speed operating only the primary venturis. The secondary control valve is operated by governor vacuum acting upon the control valve diaphragm. Below governed speed air flow through the governor ("spinner") valve weakens the vacuum acting upon the control valve diaphragm. The diaphragm spring holds the valve closed against its seat. Primary venturi vacuum acting on the secondary diaphragm controls position of the secondary throttle plates. When governed speed is reached and the governor ("spinner") valve closes (restricting the air flow), increased vacuum moves the secondary control valve diaphragm compressing the valve spring and opens the valve. This permits a flow of fresh air through the valve into the secondary diaphragm chamber. The flow of air weakens the vacuum acting on the secondary diaphragm and allows the diaphragm spring to close the secondary throttle plates.

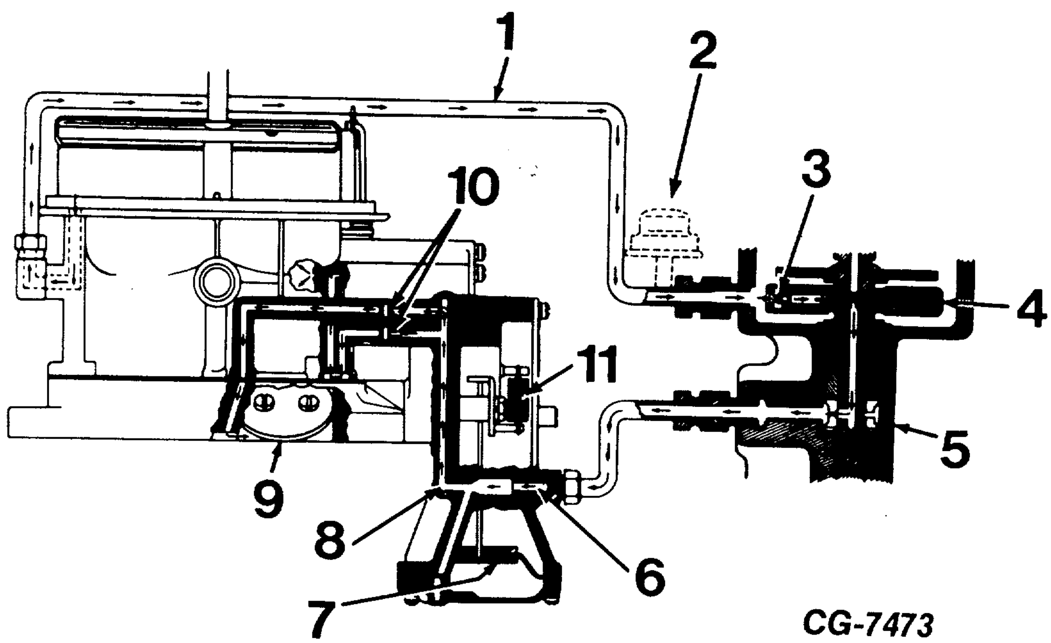


Figure 21 Governor Operation Below Governed Speed

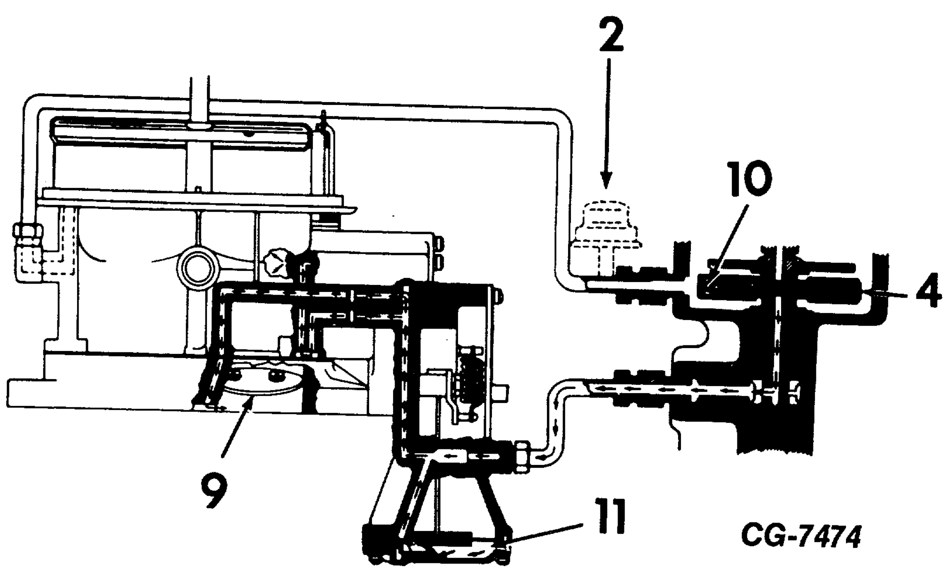


Figure 22 Governor Operation at Governed Speed

1. Fresh Air Passage
2. Atmospheric Air Filter (Some Carburetors)
3. Governor Control Valve Open (Permitting Flow of Fresh Air)
4. Plug
5. Distributor Housing
6. Flow of Fresh Air (Weakens Vacuum in Diaphragm Chamber and Governor Spring Tends to Open Throttle Plates)
7. Diaphragm
8. Vacuum Passage
9. Throttle Plate
10. Governor Control Valve Closed (Centrifugal Force Closes Valve and Stops Flow of Air)
11. Increased Vacuum in Diaphragm Chamber Overcomes Governor Spring Tension and Partially Closes Throttle Plates

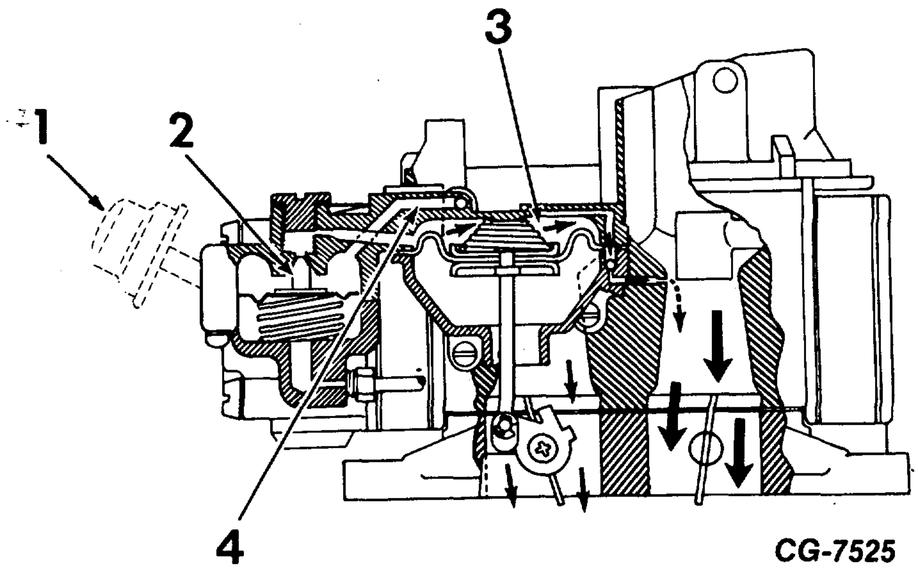


Figure 23 Secondary Control Valve Operation Below Governed Speed

1. Air Filter (Some Carburetors)
2. Control Valve (Closed by Diaphragm Spring Tension)
3. Increased Vacuum From Primary Venturi Opens Secondary Throttle Valve
4. Fresh Air Passage

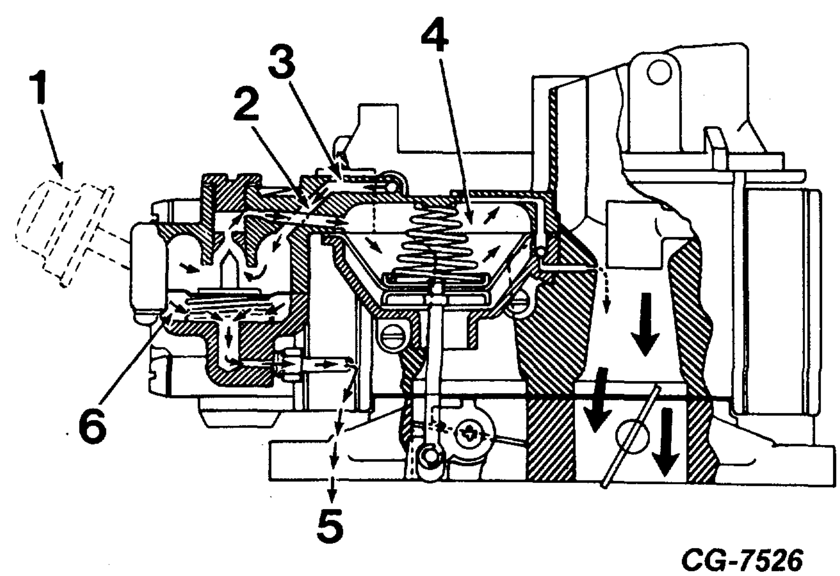


Figure 24 Secondary Control Valve Operation at Governed Speed

1. Air Filter
2. Fresh Air Passage
3. Air Passage Removed When Air Filter Used
4. Air Flow Weakens Vacuum in Diaphragm Chamber and Spring Closes Secondary Throttle Plates
5. To Governor Vacuum Passage
6. When Governor "Spinner" Valve Closes, Governor Vacuum Opens Control Valve Diaphragm and Valve. Fresh Air Flows into Secondary Diaphragm Chamber

Electronic Vacuum Modulating Governor System (EVM)

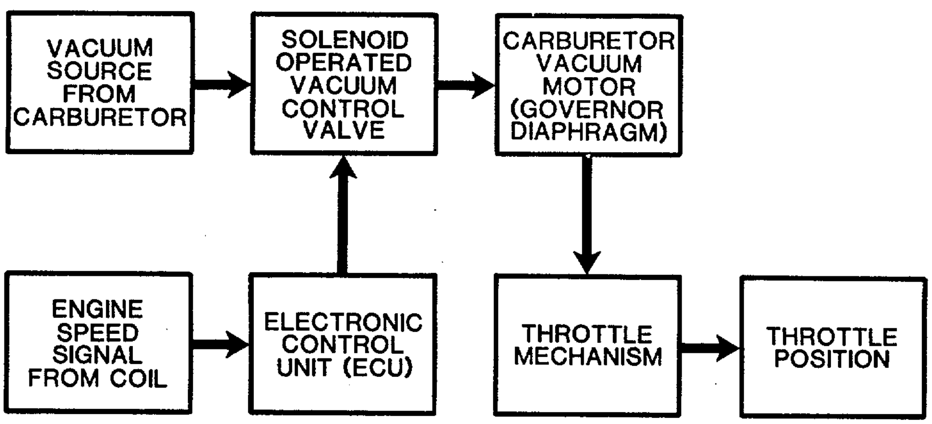
The electronic vacuum modulating governor system consists of a remote mounted electronic control unit (ECU), a threeway solenoid vacuum valve and a vacuum diaphragm attached to the carburetor throttle plates. The solenoid vacuum valve and vacuum diaphragm are an integral part of the carburetor. The ECU receives the engine speed signal from the negative side of the ignition coil. This engine speed signal switches the ECU (when governed engine speed is reached) to allow current to flow through the solenoid vacuum valve. The solenoid vacuum valve provides correct governor vacuum to the vacuum diaphragm. The vacuum diaphragm acting against the governor spring thereby controls the throttle position to regulate engine speed (Fig. 25).

Internal clean air is supplied to both the solenoid side of the solenoid valve and to the high pressure side of the governor diaphragm. The cone-tipped side of the solenoid valve connects the venturi and intake manifold vacuum to the low pressure side of the governor diaphragm. In an underspeed or current off condition, the solenoid return spring closes the source vacuum port, thereby venting the low pressure side of the governor diaphragm directly to the clean air source. In this mode, the zero or near zero pressure differential across the governor diaphragm prevents any governing action.

As the engine approaches governed speed, current is applied to the solenoid which pulls the valve against the return spring, closes the port to clean air and connects the governor diaphragm to source vacuum. Modulation between the extremes of solenoid valve full-off and full-on is accomplished by varying the percentage on-time of the current to the solenoid. This results in an average valve opening that is proportional to percent on-time and provides the desired governing action. The speed is factory preset within the electronic control unit.

Legend for Figure 25

1. Clean Air Port Open
2. Battery Supply
3. To Negative Side of Coil
4. Vacuum Port Closed
5. Low Pressure Side
6. Vacuum
7. Throttle Control Governor Diaphragm
8. High Pressure Side
9. Internal Clean Air
10. Clean Air Port Closed
11. Vacuum Port Open



Electronic Vacuum Modulating (EVM) Governor System Block Diagram

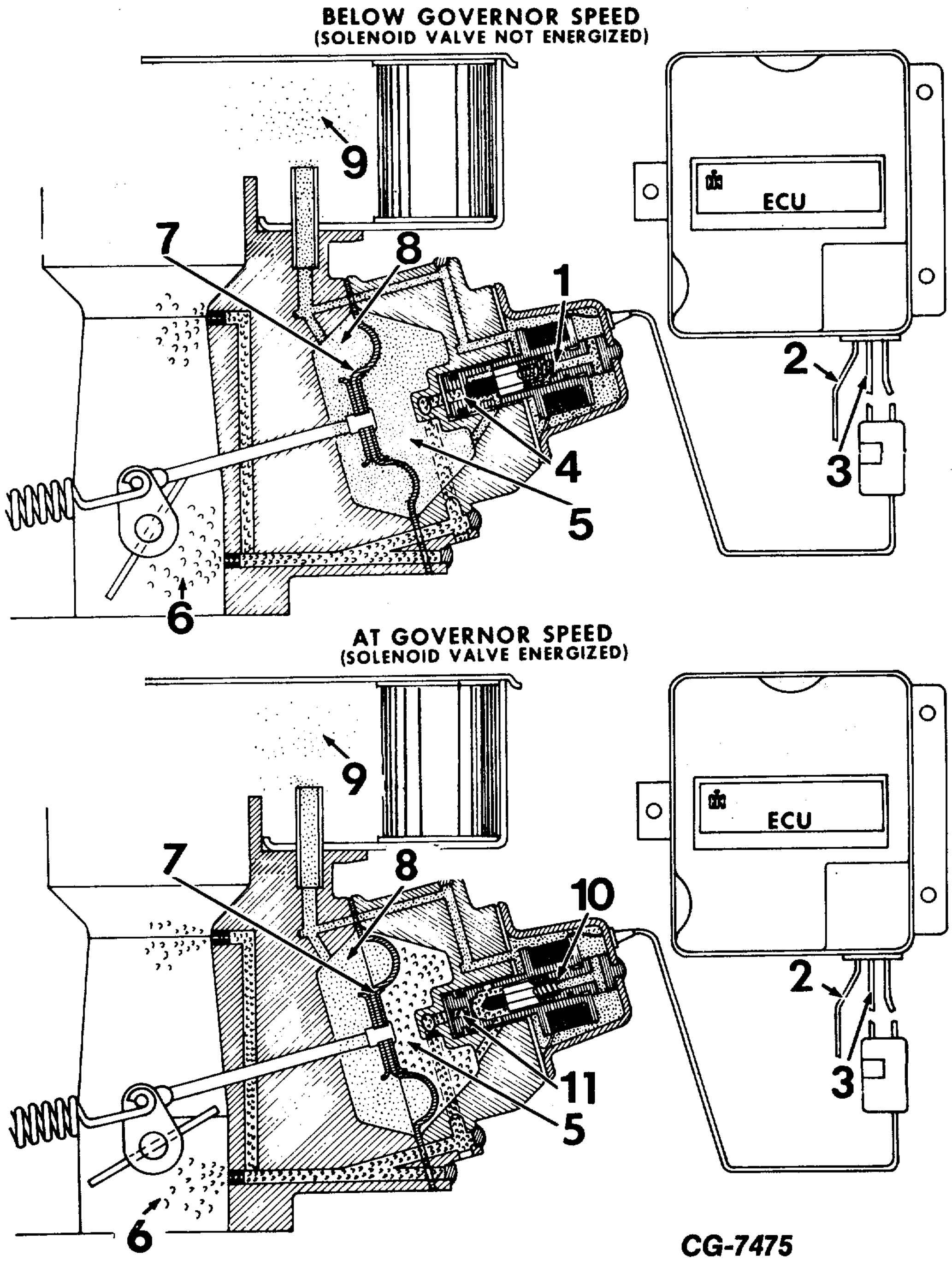


Figure 25 EVM Governor Operation

Redundant Throttle Closing Linkage

The model 4150G carburetor, appearing on vehicles produced after September 1, 1973, are equipped with redundant throttle closing linkage as an added safety feature. The purpose of this redundant linkage is to return the throttle to the idle position in the event throttle return spring becomes disconnected or linkage breaks.

The redundant linkage consists of a safety spring, trip lever, retaining lever and throttle lever as shown in Fig. 26. Under normal operation the safety spring is held in a coiled (loaded) position by the notch in the retaining lever and tab of the trip lever. The throttle return spring supplies the force necessary to keep the notch and tab engaged. In the loaded position, the throttle lever may be operated with the usual restraining force of the throttle return spring.

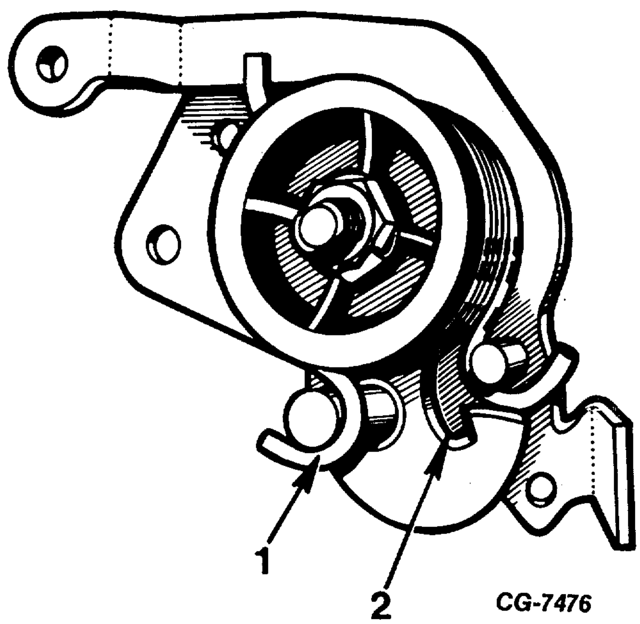


Figure 26 Redundant Throttle Closing
1. **Spring**
2. **Notch and Tab Engaged**

If the throttle return spring becomes disconnected, the notch and tab will become disengaged allowing the force of the loaded safety-spring to snap the throttle to the idle position. Although vehicle may be driven in this condition, the redundant throttle closing linkage should be reloaded as soon as possible

CAUTION: Additional care should be exercised when servicing 4150 model carburetors equipped with redundant throttle closing linkage. Whenever the throttle return spring is disconnected at either end, the throttle linkage at the carburetor will snap to a closed position under a spring force sufficient to cause personal injury. It is essential, to prevent personal injury, that all instructions be followed in the stated order and hands be kept clear of carburetor throttle linkage when connecting or disconnecting the throttle return spring.

Special Tools

The overhaul procedure which follows can be accomplished with ordinary tools. However, the use of carburetor tool set SE-1772 is strongly recommended. Use of the tools in this set not only protects parts which ordinary tools might damage, but also saves time as well.

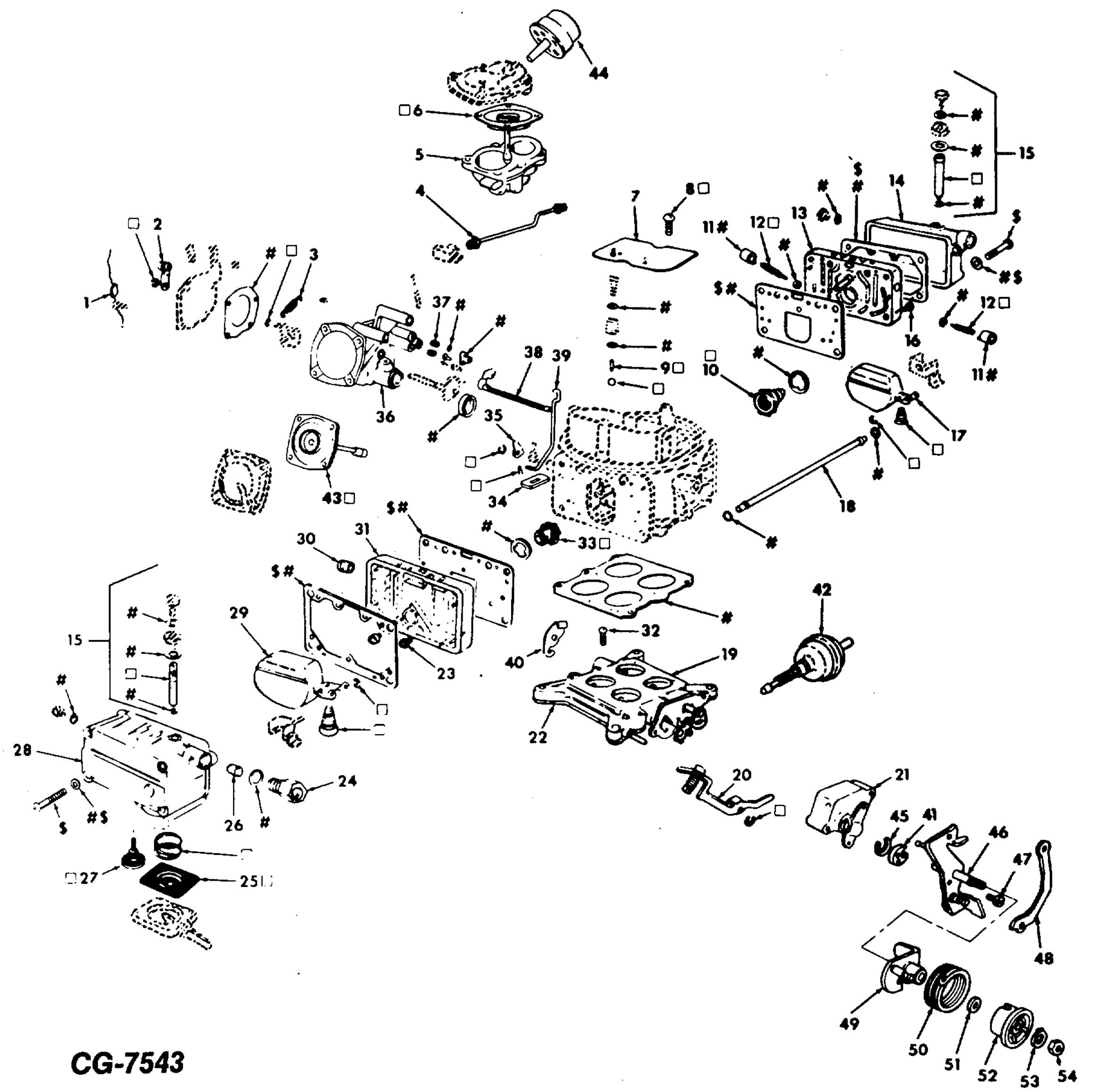


Figure 27 Exploded View of Carburetor (Typical)

Legend for Figure 27

Key	Description	Key	Description
1	WIRE, Governor Cover	28	BOWL, w/Plugs Float-- Primary
2	LEVER, w/Swivel, Choke	29	FLOAT, Fuel Primary
3	SPRING, Governor	30	ELBOW
4	PIPE, Fuel Control Valve		
5	PUMP, Secondary Accel.	31	BODY
6	DIAPHRAGM, Accel. Pump Secondary	32	SCREW, Throttle Plate
7	PLATE, Choke	33	VALVE, Power Jet Primary
8	SCREW, Choke Plate	34	SEAL, Choke Rod
9	NEEDLE, Pump Discharge Nozzle	35	LEVER, w/Bushing, Choke Rod
10	NOT USED	36	GOVERNOR, w/Diaphragm Assy.
11	STOP, Adjusting Needle	37	NOT USED
12	NEEDLE, Idle Adjusting	38	SHAFT, w/Lever, Choke
13	BODY, Not Serviced Separately	39	ROD, Choke
14	BOWL, w/Plugs, Float -- Secondary	40	LEVER, Diaphragm Assy.
15	VALVE, Carb. Fuel Inlet, Assy.	41	CAM, Accelerator Pump Operating
16	JET, Main Secondary	42	CHAMBER, Vacuum Throttle Modulator
17	FLOAT, Fuel Secondary	43	DIAPHRAGM, Governor Assy.
18	TUBE, Fuel Level Secondary	44	CLEANER, Air
19	BODY, Not Serviced Separately	45	RETAINER, Throttle Operating Shot
20	LEVER, Accelerator Pump, Assy.	46	LEVER, Throttle Operating
21	HOUSING, Throttle Operator Shaft Assy.	47	SCREW, Accel. Pump Cam
22	GASKET, Carburetor Mounting	48	LEVER, Trip
23	JET, Main Primary	49	LEVER, Catch
24	FITTING, Fuel Inlet	50	SPRING, Redundant
25	DIAPHRAGM, Accel. Pump Assy.	51	WASHER, (Spacer)
26	SCREEN, Fuel Filter	52	BUSHING, Spring
27	VALVE, Accel. Pump Check	53	LOCK, Washer
		54	NUT

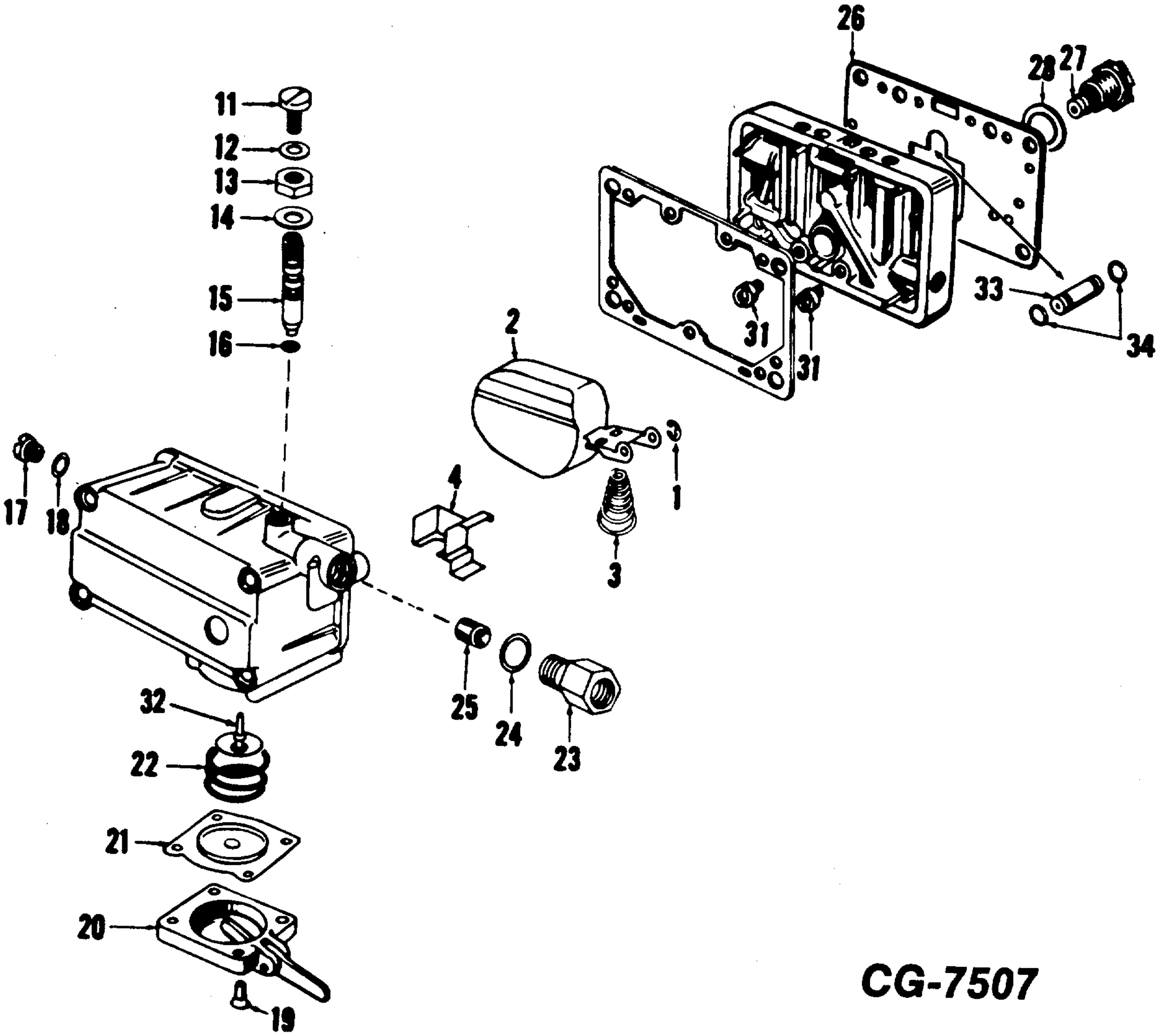


Figure 28 Exploded View of Fuel Bowl and Metering Block

1	RETAINER, Float Shaft	20	COVER, Accelerating Pump, Assembly
2	FLOAT, Assembly	21	DIAPHRAGM, Accelerating Pump
3	SPRING, Float	22	SPRING, Accelerating Pump Diaphragm
4	PLATE, Baffle	23	FITTING, Fuel Inlet
11	SCREW, Lock, Fuel Valve Seat	24	GASKET, Fuel Inlet Fitting
12	GASKET, Fuel Valve Seat Screw	25	SCREEN, Filter, Fuel Inlet
13	NUT, Adjusting, Fuel Valve Seat	26	GASKET, Metering Body
14	GASKET, Fuel Valve Seat Adjusting Nut	27	VALVE, Power, Assembly
15	SEAT, Fuel Valve, Assembly	28	GASKET, Power Valve
16	"O" RING, Fuel Valve Seat	31	JETS, Main
17	PLUG, Check, Fuel Level	32	VALVE, Synthetic
18	GASKET, Fuel Level Check Plug	33	TUBE, Fuel Pump Transfer
19	SCREW, Fuel Pump Cover	34	"O" RING, Fuel Pump Transfer Tube

To facilitate working on the carburetor and to prevent damage to the throttle plates, install bolts about 2¼" long of the correct diameter through the carburetor retaining bolt holes with a nut above and below the flange (or install carburetor legs).

Use a separate container for the component parts of the various assemblies to facilitate cleaning, inspection and assembly.

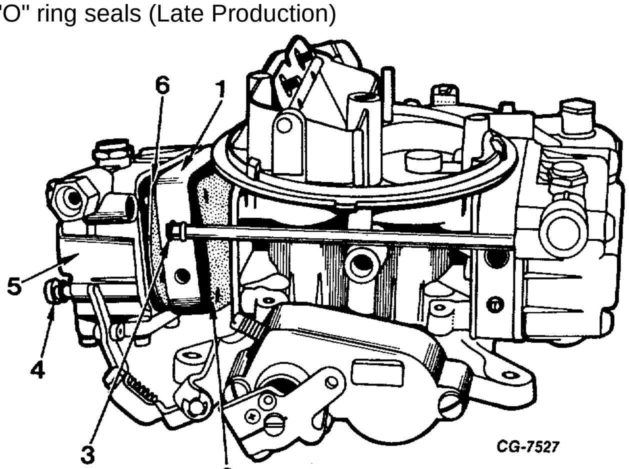
The following is a step-by-step sequency of operations for completely overhauling the carburetor; however, certain components of the carburetor may be serviced without disassembling the entire unit. For a complete carburetor overhaul, follow all the steps. To partially overhaul the carburetor or to install a new gasket kit, follow only the applicable steps.

Fuel Bowls and Metering Blocks

1. Remove four spring loaded primary fuel bowl mounting screws (Fig. 29).

2. Remove the primary fuel bowl and gasket and the metering block and gasket. Discard the gaskets. Also remove fuel bowl transfer tube and "O" rings. Discard "O" rings.

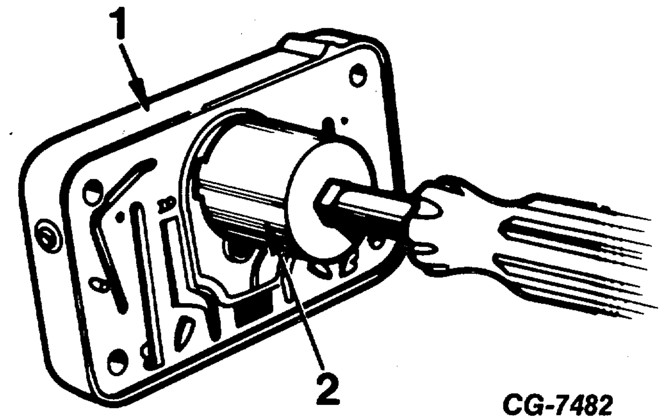
3. Remove the fuel pump transfer tube and discard the "O" ring seals (Late Production)



1. Metering Block
2. Metering Block Gasket
3. Transfer Tube "O" Ring
4. Fuel Bowl Screw
5. Fuel Bowl
6. Fuel Bowl Gasket

Figure 29 Removal of the Fuel Bowl and Metering Block (Typical)

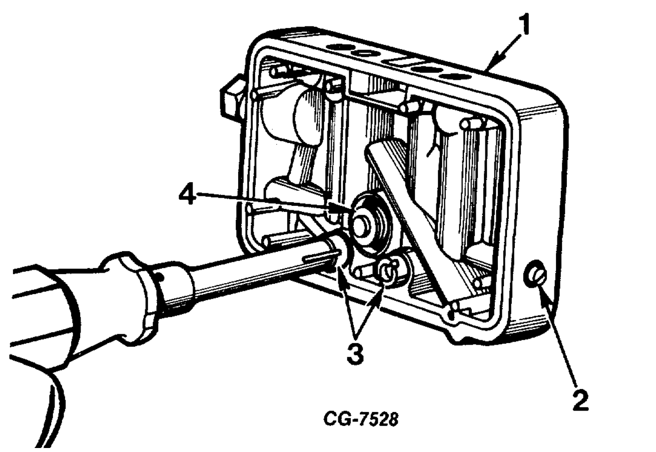
4. Using a socket wrench, SE-1772-1, remove the power valve and gasket (Fig. 30)



1. Metering Block
2. Power Valve Socket

Figure 30 Using Socket Wrench SE-1772-1 to Remove Power Valve

5. Using a jet wrench, SE-1772-6, remove the main jets (Fig. 31).

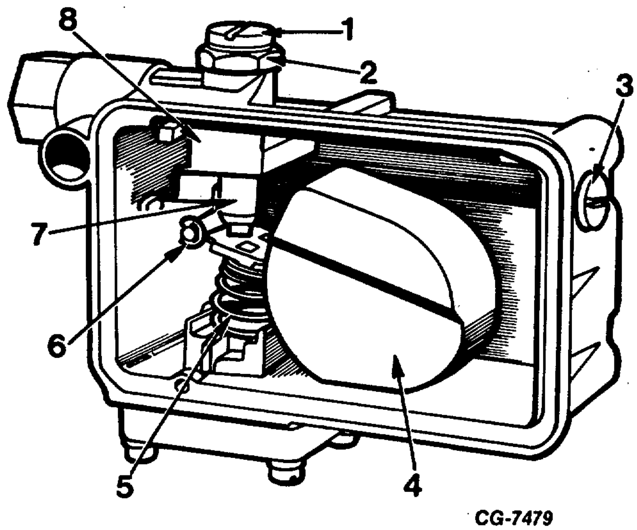


1. Main Metering Body
2. Idle Fuel Adjustment
3. Main Jets
4. Power Valve

Figure 31 Using Jet Wrench SE-1772-6 to Remove Main Jets

6. Remove the distributor vacuum fitting or plug from the metering block (where used).

7. Remove the fuel level adjustment lock screw and gasket. Turn the adjusting nut counterclockwise and remove the lock nut and gasket. Remove the fuel inlet needle and seat assembly. Do not disassemble the fuel inlet needle and seat. They are matched assemblies and are replaced as an assembly (Fig. 32).



1. Lock Screw
2. Adjusting Nut
3. Sight Plug
4. Float
5. Float Spring
6. Float and Hinge Retainer
7. Fuel Inlet Valve and Seat
8. Fuel Inlet Baffle

1.

Figure 32 Fuel Bowl and Components

8. Remove the fuel level sight plug and gasket.

9. Remove the fuel inlet fitting, gasket and filter screen.

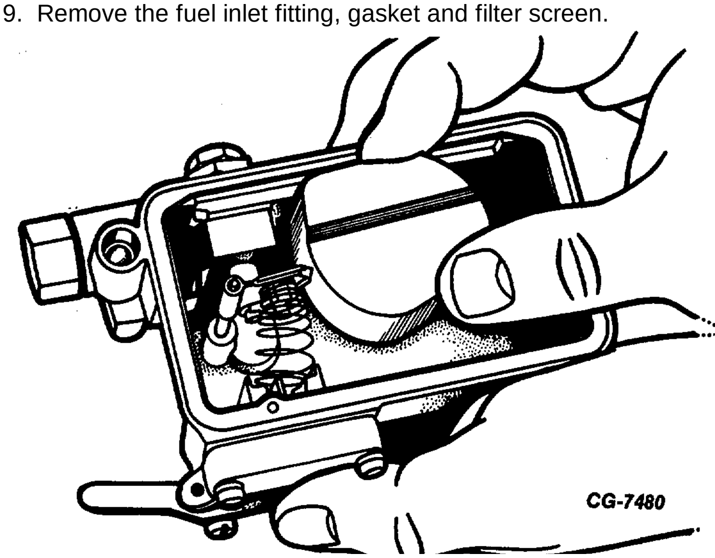
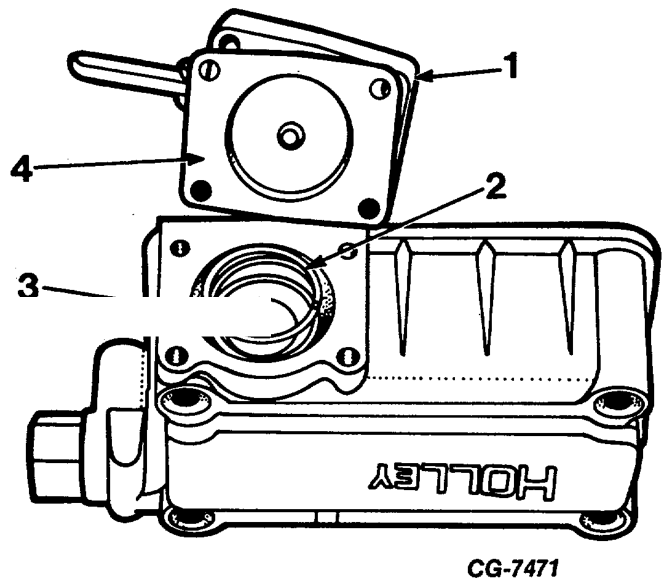


Figure 33 Removing Float and Hinge Assembly

10. Remove the baffle plate from the fuel bowl.
11. Using needle nose pliers, remove the float retainer (Fig. 33). Slide the float (noting color) off the shaft. Remove the spring from the float.

12. Remove the four pump diaphragm cover screws. Lift off the pump diaphragm cover, diaphragm assembly and return spring (Fig. 34). If it is necessary to remove the accelerator pump synthetic valve (where used), grasp it firmly and pull it out. If the valve tip breaks off during removal, be sure to remove the tip from the fuel bowl. Removal of the valve necessitates replacement with a new valve.



1. Diaphragm Cover
2. Diaphragm Return Spring
3. Plastic Valve
4. Diaphragm Assembly

13. Remove the secondary fuel bowl and gasket and the metering block and gasket. Discard the gaskets.

14. Remove the following parts from the secondary metering block: Using a jet wrench, SE-1772-6, remove the main jets (Fig. 31). Using a socket wrench, SE-1772-1, remove the power valve and gasket (where used). Discard the gasket. Remove the idle adjusting needles and gaskets. Discard the gaskets (Fig. 31).

15. Disassemble the secondary fuel bowl by following Steps 7, 8, 9, 10 and 11. Refer to Fig. 28 for complete disassembly of fuel bowl and metering block.

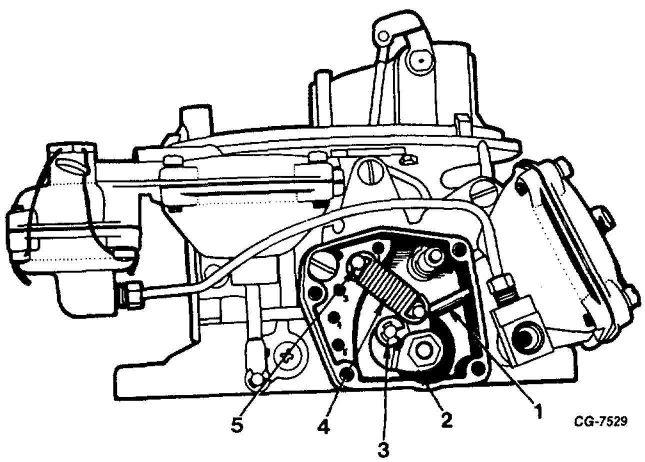
Main Body

1. Remove the air cleaner anchor stud and remove the secondary control valve tube located between governor and secondary control valve.

2. Remove the choke control lever and the governor housing cover.

3. Remove the nut and lock washer retaining the governor lever to the throttle shaft, then remove the governor housing assembly (Fig. 35).

4. Remove the secondary diaphragm link retainer.



1. Diaphragm Rod
2. Governor Lever
3. Rod Retainer
4. Governor Spring
5. Governor Spring Post

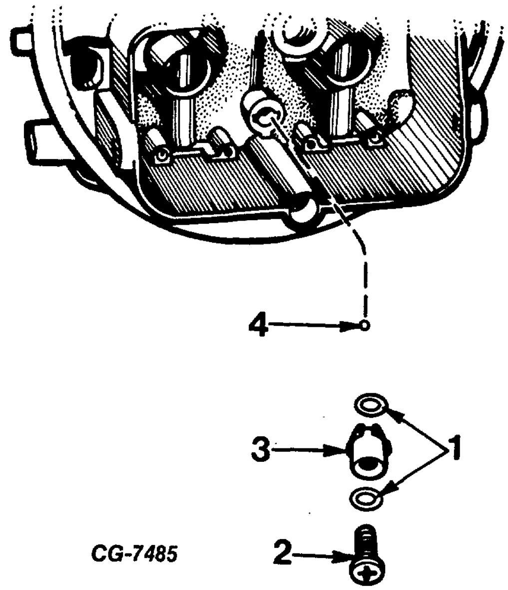
Figure 35 Interior View of governor Housing

5. Invert the carburetor and remove the throttle body to main body screws and lock washers. Lift off the main body and remove the main body gasket. Discard the gasket.

6. Remove the retainer securing the choke rod to the choke rod lever and bushing assembly, then remove the lever retainer and remove the lever and lever spring.

7. Remove the secondary diaphragm housing and gasket from the main body.

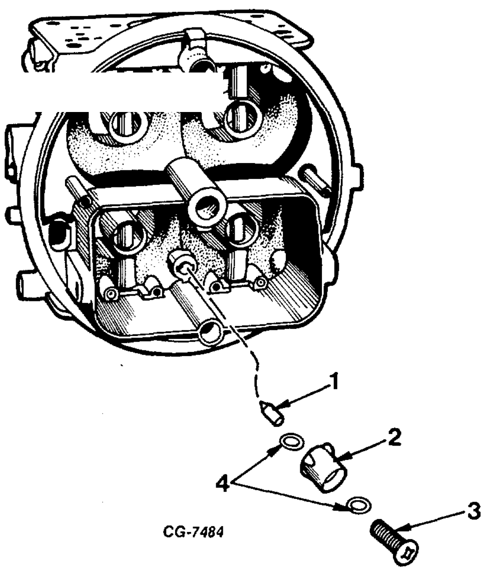
8. Remove the accelerating pump discharge nozzle screw, then lift the pump discharge nozzle and gasket out of the main body. Invert the main body and let the discharge ball fall into the hand (Fig. 36).



1. Gasket
2. Screw
3. Discharge Nozzle
4. Check Ball

Figure 36 Removing Pump Discharge Check Ball (4150 and 4150C Only)

9. Models 4150G and 4150EG use a pump discharge needle in lieu of a ball as shown in Fig. 37.



1. Discharge Needle
2. Discharge Nozzle
3. Screw
4. Gasket

Figure 37 Removing Pump Discharge Needle (4150G and 4150EG Only

10. Lightly scribe a mark along the choke shaft on the choke plate to insure proper positioning of choke plate during reassembly.

11. File off the staking from choke plate retaining screws to prevent damaging choke shaft threads during screw removal. Remove the two choke plate screws and slide choke plate out of choke shaft.

12. Slide choke shaft out of main body. Use new screws during reassembly. Throttle Operating Housing

1. Straighten lock tab on throttle operating shaft nut lock and remove nut, lock and washer.

2. Hold redundant spring concentric with throttle operating shaft and remove spring drum.

3. Remove "spacer" washer.

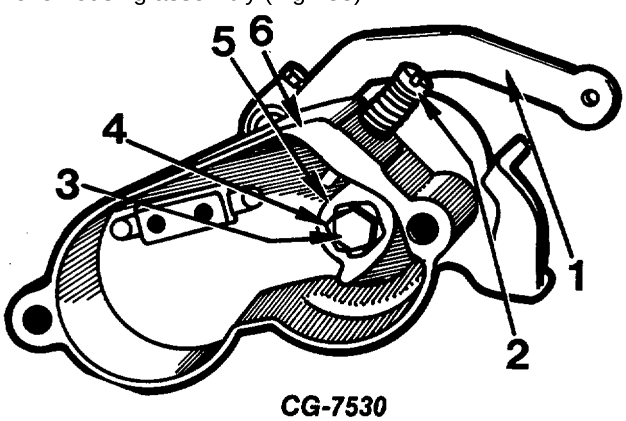
4. Release redundant spring from long spring perch and remove redundant spring.

5. Remove catch lever bushing and pin assembly.

6. Remove trip lever.

7. Remove accelerator pump operating lever assembly retainer.

8. Remove the two throttle operating housing screws and remove housing assembly (Fig. 38).



1. Trip Lever
2. Idle Screw and Spring
3. Driver Screw
4. Lock Washer
5. Throttle Shaft Driver
6. Throttle Operating Housing

Figure 38 Throttle Operating Housing Assembly

9. Straighten lock tabs on throttle operating driver (inside throttle operating housing). NOTE: Position the flats of the throttle shaft driver in relation with the idle adjusting screw.

10. Remove operating lever and shaft assembly.

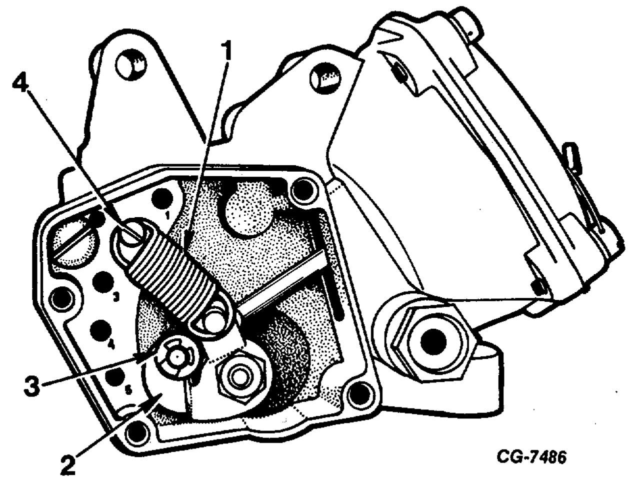
11. Remove pump cam retainer screw, noting hole position and reference number on cam and lever. The cast numbers on the cam are facing toward the throttle operating housing. Then remove cam (do not put cam in carburetor cleaner).

12. Remove the (hot engine) idle screw and spring.

Governor Housing

1. Remove and discard the governor housing seal.

2. Mark the governor spring pin hole to facilitate assembly. Remove the spring and pin if damaged (Fig. 39).



1. Governor Spring
2. Governor Lever
3. Diaphragm Rod Retainer
4. Spring Post

Figure 39 Interior View of Governor Housing

3. Remove the diaphragm rod retainer and governor lever.

4. Remove the governor line fitting. Make a note of the governor bypass jet numbers and their positions. Remove the bypass jets, the diaphragm cover and the diaphragm.

5. Remove the fast idle camshaft retainer and slide the fast idle cam and shaft out of the housing.

6. Remove the cam plunger, spring and fast idle pin.

NOTE: Do not remove solenoid assembly from governor diaphragm cover unless solenoid is known to be inoperative (See Electronic Governor Trouble Shooting Procedures).

Secondary Throttle Diaphragm Assembly

1. Remove the diaphragm housing cover, then remove the spring, diaphragm and the secondary vacuum ball check. The secondary control valve is factory adjusted and should not have to be disassembled.

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CLEANING

Dirt, gum, water or carbon contamination in the carburetor or the exterior moving parts of the carburetor are often responsible for unsatisfactory performance. For this reason efficient carburetion depends upon careful cleaning and inspection.

The cleaning and inspection of only those parts not included in the carburetor overhaul repair kit are covered here. All gaskets and parts included in the repair kit should be installed when the carburetor is assembled and the old gaskets and parts should be discarded.

1. Soak all parts except throttle body bushings, dashpot, throttle modulator or governor solenoid in a standard carburetor cleaner. If a commercial solvent is not available, lacquer thinner or denatured alcohol may be used. Do not lower parts into sediment which settles to bottom of cleaning tank. Agitate parts while in solution to insure a thorough cleaning. After the parts have been sufficiently soaked, rinse them in hot water to remove all traces of the cleaning solution. Scrub away remaining foreign matter with a stiff brush (not wire) while rinsing parts and castings.

2. Dry all parts with compressed air. Also direct compressed air through jets, nozzles and passages in castings.

3. Always discard diaphragms. Reuse of old diaphragms may cause unsatisfactory carburetor performance.

4. Carburetor jets and passages should never be cleaned with a drill, wire or similar object. This method of cleaning will distort jets and passages. A buffing wheel, wire brush, file or other sharp instrument should not be used to remove carbon deposits, since these tools might also remove the protective plating on the carburetor parts. Parts such as "0" rings, gaskets, diaphragms and seals should never be exposed to solvent because of its deteriorating effect on them.

INSPECTION

1. Major Castings: Check for cracks, warpage, stripped screw threads or damaged mating surfaces. Passages in castings must be free of restrictions.

2. Float Assembly: Should be discarded if float is damaged in any way.

3. Choke Plate: Should be replaced if edges have been nicked or if protective plating has been damaged.

4. Choke Shaft: Should be replaced if bent or nicked.

5. Choke and Throttle Linkage: Discard and replace any linkages that are bent or worn.

6. Throttle Shaft: Check the throttle shaft(s) in its'bore for binding. Check the throttle plate(s) for burrs which prevent proper closure.

7. Springs: Distorted or broken springs must be replaced.

8. Governor: Check for cracks or stripped threads in housing and replace if any irregularities are found.

9. Screws, Lockwashers and Nuts: If stripped threads, distortion or other damage is found in any of these parts, discard and replace.

REASSEMBLY

Make sure all holes in the new gasket have been properly punched and that no foreign material has adhered to the gaskets. Make sure the accelerating pump diaphragm, secondary operating diaphragm and governor operating diaphragm are not cut or torn.

An exploded view of the carburetor is shown in Fig. 27.

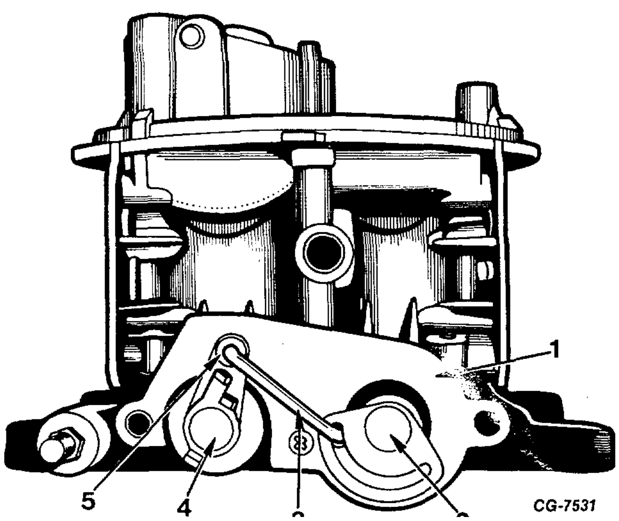
Throttle Operating Housing

Refer to Figs. 40 and 41 for the correct location of the parts.

1. Install the engine (HOT) idle screw and spring in the throttle operating housing. Turn the screw in until spring tension is felt.

2. Install the pump cam retainer screw noting hole position and reference number on cam and lever. The cast number on the cam should face toward the throttle operating housing. Then install the cam.

3. Install the operating lever and shaft assembly. Position the flats of the throttle shaft driver in relation with the hot idle adjusting screw.



1. Throttle Housing Plate
2. Secondary Throttle Shaft
3. Throttle Connecting Rod
4. Primary Throttle Plate
5. Spacer

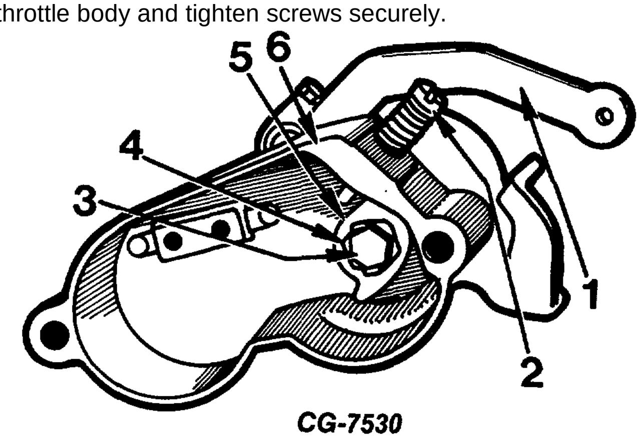
Figure 40 Throttle Operating Housing Plate

4. Bend locking tabs on throttle shaft driver lock washer.

5. Install the accelerating pump lever and the secondary throttle plate operating lever.

6. Install two throttle operating shaft housing assembly screws in throttle operating shaft housing.

7. While holding the primary throttle plate in the closed position, assemble the throttle operating shaft housing on the throttle body and tighten screws securely.



1. Trip Lever
2. Idle Screw and Spring
3. Driver Screw
4. Lock Washer
5. Throttle Shaft Driver
6. Throttle Operating Housing

Figure 41 Throttle Operating Housing Assembly

8. If the carburetor is equipped with a safety throttle redundant spring, install the catch lever assembly on throttle operating lever shaft.

9. Install the trip lever over the shaft redundant spring perch.

10. Install throttle operating shaft spacer on throttle operating shaft.

11. Install the curved end of the redundant spring on the short spring perch.

12. Install the short straight end of the redundant spring on the long spring perch.

13. Holding the redundant spring concentric with the throttle operating shaft, install the redundant spring bushing.

14. Install the throttle operating shaft nut lock washer on the throttle operating shaft.

15. Install the throttle operating shaft nut, tighten securely, and bend tab on lock washer to retain nut.

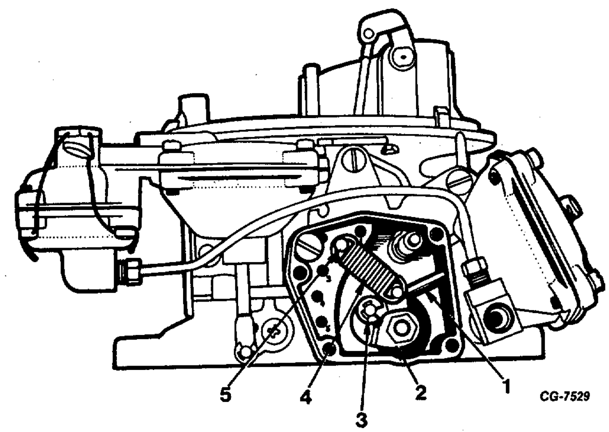
Governor Housing

1. Place the fast idle pin in position in the governor housing.

2. Insert the fast idle cam plunger spring in the plunger and install the assembly in the governor housing.

3. Slide the fast idle cam assembly into position and install the retainer.

4. Install the governor bypass jets and the governor line fitting.



1. Diaphragm Rod
2. Governor Lever
3. Rod Retainer
4. Governor Spring
5. Governor Spring Post

Figure 42 Interior View of Governor Housing

5. Install the governor spring pin in the same hole from which it was removed if it were removed.

6. Position the governor diaphragm in the governor housing. Position the diaphragm properly to avoid damage by the screws. Install the cover with the screws and tighten securely. Install new safety wire and a seal.

7. Place the governor lever in the housing and insert the diaphragm rod on the stud. Install the rod retainer.

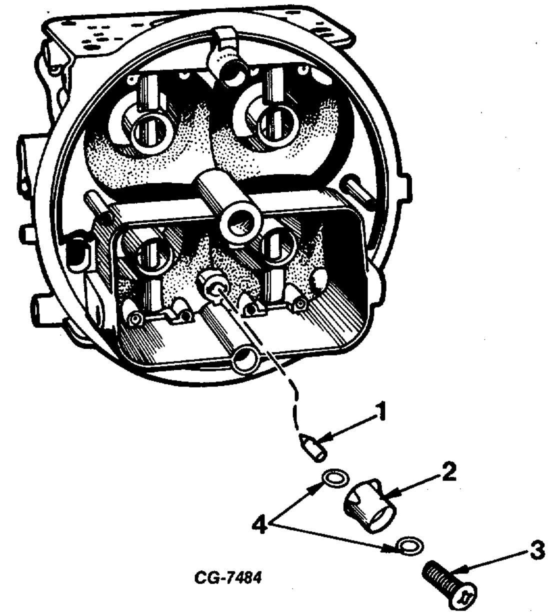
8. Housing is installed after the throttle body is assembled to the main body.

Main Body

1. Drop the accelerating pump discharge needle into its well (Fig. 43 governed carburetor).

On nongoverned carburetors drop check ball into its well (Fig. 44 nongoverned carburetor).

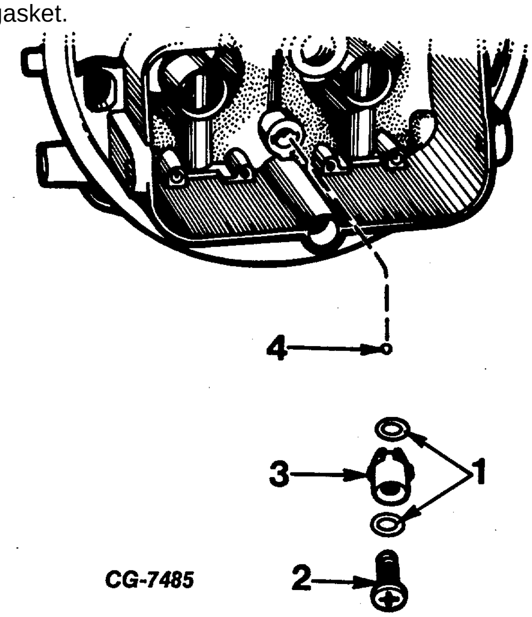
2. Seat the needle with a brass drift and light hammer. Make sure the needle is free.



1. Discharge Needle
2. Discharge Nozzle
3. Screw
4. Gasket

Figure 43 Installing Pump Discharge Needle

3. Position the accelerating pump discharge nozzle gasket and nozzle in the main body, then install the retaining screw and gasket.

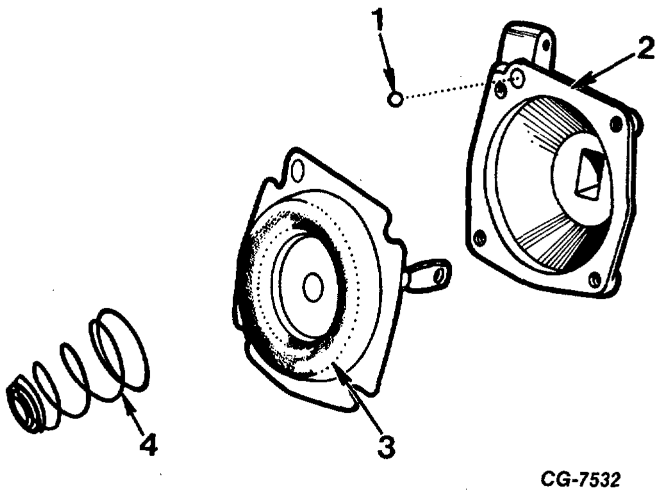


1. Gasket
2. Screw
3. Discharge Nozzle
4. Check Ball

Figure 44 Installing Pump Discharge Check Ball

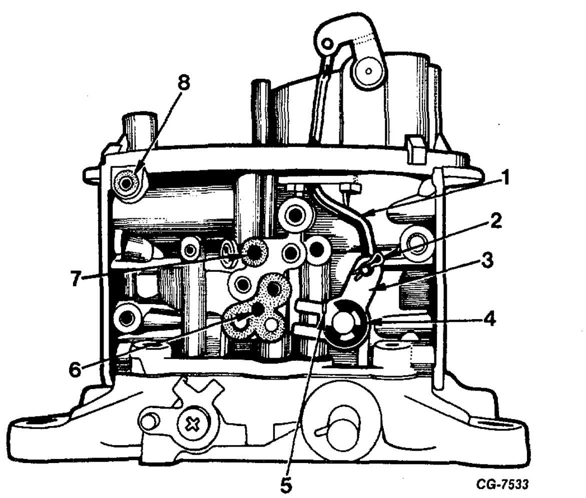
4. Drop the secondary vacuum ball check in the vacuum passage in the secondary diaphragm housing (Fig. 45).

5. Because calibration of the control valve requires special equipment, the secondary diaphragm cover (with secondary control valve) is assembled, calibrated and sealed at the factory and furnished for service only as an assembly. Control valve components are not serviced separately.



1. Secondary Ball Check
2. Secondary Housing
3. Diaphragm
4. Diaphragm Spring

Figure 45 Installing Secondary Diaphragm



1. Choke Rod
2. Retainer
3. Choke Rod Lever
4. "E" Clip
5 Choke Lever Spring
6. Governor Housing Gasket
7. Secondary Control Valve Gasket
8. Secondary Control Valve Clean Air Gasket

Figure 46 Components Location on Main Body

6. Place the gasket on the secondary vacuum and clean air passage openings on the main body (Fig. 46). Lay the diaphragm housing in position on the main body and install the lock washers and retaining screws.

7. Place the choke rod lever spring on the lever with the end of the spring with largest hook on the lever (Fig. 46).

8. Place the choke rod lever and spring assembly in position on the main body with the other end of the spring fitting in the groove in the main body. Install the choke lever retainer (Fig. 46).

9. Secure the choke rod to the lever with a pin retainer (Fig. 46).

10. Invert the main body and position the throttle body gasket on the main body. Slide the secondary diaphragm rod onto the operating lever as the throttle body is placed into position. Install the diaphragm operating rod retainer.

11. Install the throttle body to main body screws and lock washers.

12. Install the air cleaner anchor stud.

13. Position the governor housing gaskets on the main body. Install the governor body seal on the governor housing, then slide the housing on the throttle shaft so that with the choke plate closed the protruding stud on the fast idle cam lever is in the slot of the choke rod lever tang. As the governor body is placed into position, insert the end of the throttle shaft into the governor (Fig. 46).

14. Install the governor housing retaining screws and the governor lever lock washer and nut. The governor lever should hold the primary throttle plates wide open.

15. Be sure the primary throttle plates are closed and the choke plate is open. Adjust fast idle screw to the correct specification. See fast idle procedure setting.

16. Install the governor housing cover and the choke swivel. The choke swivel should open and close the choke plate.

17. Install seal wire through opposite screws on cover insert seal and crimp.

Fuel Bowls and Metering Blocks

Refer to Fig. 28 for the correct location of the fuel bowl parts.

The primary and secondary fuel bowls and metering blocks are installed on the main body in the same sequence.

Primary Fuel Bowl and Metering Block:

1. Using special socket SE-1772-1 install new gasket and power valve assembly in metering body.

2. Install the two main jets using special tool SE-1772-6.

3. Where used, install "0" rings, using petroleum jelly as a lubricant on accelerator pump fuel transfer tube and install tube in metering block.

4. Install fuel bowl to metering block gasket to metering block. Be sure all punchings are removed from gasket and pump passage and gasket aligns with pump passage in metering block.

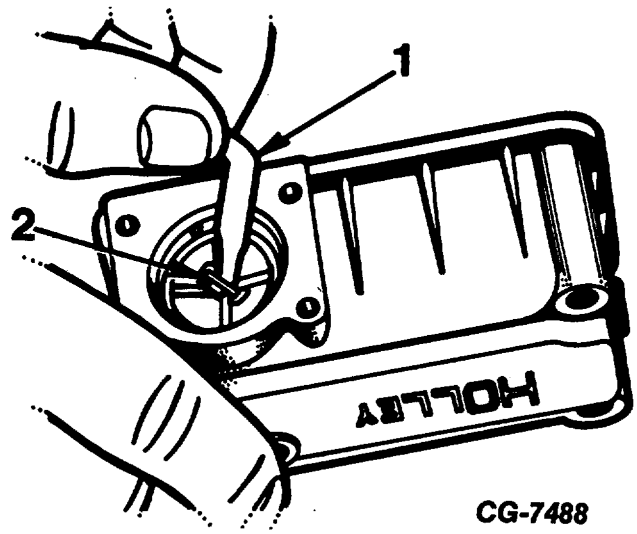
5. Install fuel filter screen, fuel inlet fitting and new fuel inlet fitting gasket.

6. Lubricate the tip of a new accelerator pump synthetic valve (where used) with a small amount of petroleum jelly and insert tip into accelerator pump cavity center hole. Using a pair of needle nose pliers reach into the fuel bowl and grasp the valve tip. Pull the valve in until it seats in the pump cavity wall and cut off the tip at the retaining shoulder.

In some 4150 carburetor fuel pump cavities there will be a very small bleed hole from the fuel bowl. This bleed hole allows vapor pressure to escape from the fuel pump cavity into the fuel bowl. This pressure bleed off prevents fuel spill over through the fuel pump discharge nozzles. The bleed hole must be checked to make sure it is not clogged.

7. Where used, check accelerator pump inlet check ball travel (Fig. 47). Clearance between ball and retainer bar is specified at .011 to .017". Best operation can be expected with clearance set at low end of specifications (.011"-.014").

Adjustment is made by bending retainer bar. If adjustment is necessary, extreme care must be taken to prevent possible damage to ball and/or seat.



1. Feeler Gauge 2. Retainer Bar

Figure 47 Checking Accelerator Pump Inlet Check Ball Clearance (Not used on All Carb.)

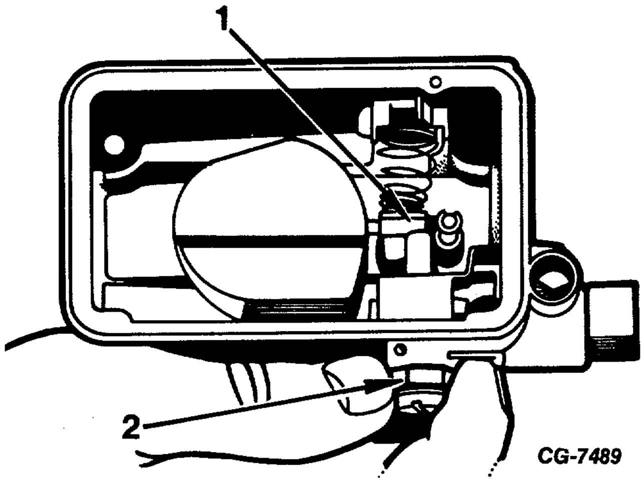
It is emphasized that the check ball setting mentioned above is a critical item in obtaining instant pump response to throttle movement. Ball travel in excess of .017" can easily cause a lag in fuel injection with consequent engine falter during throttle opening.

8. Position pump diaphragm spring in recess and install diaphragm assembly. Note that the flat rivet head faces up. Place pump diaphragm cover in position making sure the holes are aligned. Install the four screws and lock washers. Tighten them alternately to evenly compress the diaphragm.

9. Obtain new "O" ring and using petroleum jelly as a lubricant slide "O" ring into groove on needle and seat assembly. Install assembly in fuel bowl. Always use new gasket between adjusting nut and fuel bowl and also between lock screw and adjusting nut.

10. Insert fuel inlet baffle in bowl over needle and seat assembly.

11. Place conical spring on locator of float lever and slide the float with the spring onto shaft in fuel bowl. Secure with retainer.



1. Float Lever Position (Parallel with Bowl Floor)
2. Adjusting Nut

Figure 48 Bench Adjustment of Fuel Bowl Float

12. The float is made of cellular plastic material; its buoyancy is unaffected by leaks (sometimes experienced with hollow floats) or absorption. While the final fuel filter adjustment is made with the carburetor installed on the engine, a bench adjustment can be made before installing bowl as follows:

a. Loosen lock screw enough to allow adjusting nut to be turned.

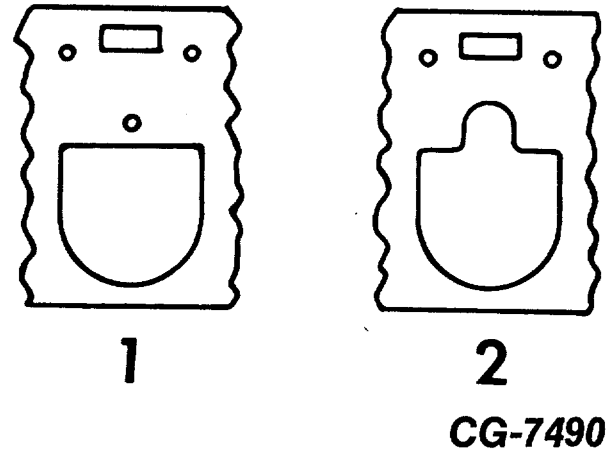
b. With fuel bowl inverted turn adjusting nut until float lever is parallel with floor of bowl (Fig. 48). Tighten lock screw.

13. Install fuel bowl screw gaskets on fuel bowl screws. This will prevent threads from shaving off gasket particles into fuel bowl.

14. Position metering body gasket (see Fig. 49) on the dowels on the back of the metering body. Assemble metering body on main body and fuel bowl on metering body. Insert four fuel bowl screws and tighten to 25-30 inch pounds.

15. When positioning fuel bowl the accelerating pump lever must be slightly depressed to clear the diaphragm pump lever. When spring loaded bowl screws are used the following procedure should be used:

Tighten each spring loaded bowl screw by rotating screw head until screw assembly bottoms in main body.



1. Early Production 2. Late Production

Figure 49 Both Metering Body Gaskets are Furnished in Carburetor Rebuild Kits

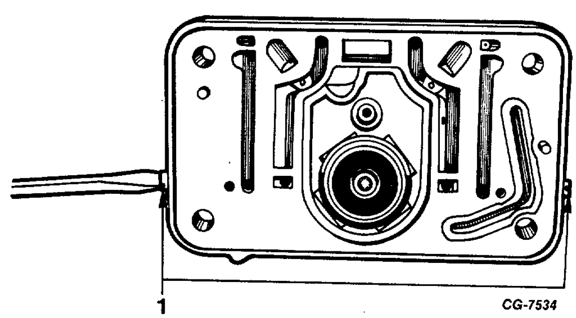
Bottoming of screw assembly is accomplished when screw head "springs back" about one quarter (¼) turn when screw driver is removed from slot. Excessive rotation of screw head can destroy spring.

16. Apply Vaseline to the fuel transfer tube "O" ring seals and place the seals against the flanges on both ends of the fuel transfer tube and install one end of the tube in the primary fuel bowl.

Secondary Fuel Bowl and Metering Block:

17. Assemble the secondary fuel bowl by following Steps 9 through 12. As a preliminary secondary float adjustment, adjust the float so that the top of the float is parallel to the bowl floor with the bowl in an inverted position (Fig. 48).

18. Install the following parts in the secondary metering block.



1. Idle Adjusting Screws

Figure 50 Secondary Metering Block

Using a jet wrench, SE-1772-6, install the secondary main jets (Fig. 31).

Using a socket wrench, SE-1772-1, install the power valve (where used) using a new gasket (Fig. 30). Both primary and secondary valves are stamped for identification. The proper power valve (where used) must be installed in each metering block.
Install the idle adjusting needles using new gaskets. Turn the needles in gently until they touch the seat, then back them out the correct amount of turns (Fig. 50). (See SPECIFICATIONS.) Do not force the needles against their seats. If a needle is damaged, it must be replaced before a proper idle mixture adjustment can be obtained.

Refer to Step 13 through 15 and install the metering block, fuel bowl, gaskets and spring loaded bowl screws.
When the preceding steps have been completed, the carburetor is ready for installation.

INSTALLATION AND ADJUSTMENTS

Off Engine Fast Idle Adjustment

If the carburetor was removed from the truck for replacement or overhaul procedures, it is recommended that a preliminary fast idle adjustment be performed as follows.

1. After carburetor is completely assembled open throttle with throttle lever and close the choke plate.

2. Invert carburetor. Insert gauge (from gauge set SE-2425 or drill of same diameter) upstream between throttle plate and throttle body of the primary bore (see Fig. 51).

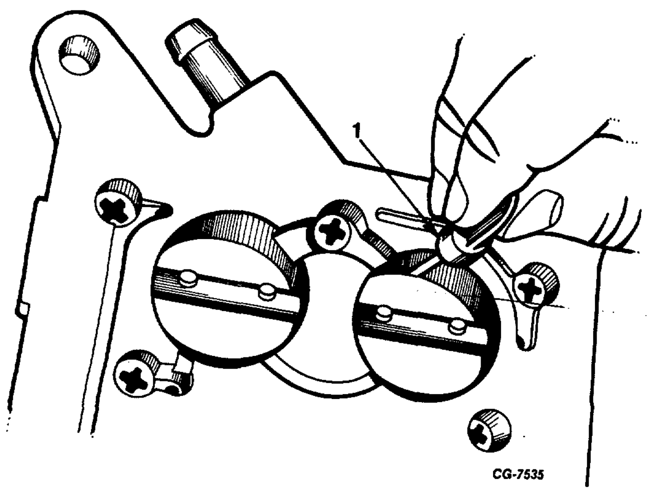


Figure 51 Checking Throttle Plate Clearance
1. Specified Drill or Gauge Size

Figure 51 Checking Throttle Plate Clearance

Fast Idle Throttle Plate Clearance

Engine Speed	(Gauge or Drill Sizes)
V-392 2000 RPM	.040
MV-404 2400 RPM	.045
MV-446 2400 RPM	.045
V-537 2000 RPM	.045
V-605 2000 RPM	.045

3. With gauge or drill held in place by the primary throttle plate against the bore, adjust the fast idle screw until the screw touches the cam lightly (see Fig. 54).

4. The gauge-or drill size dimension for the throttle plate clearance and fast idle speed are given above:

5. After the carburetor is installed on the engine, warm engine to operating temperature, connect tachometer and check fast idle reading with above specifications.

Installing Carburetor on Engine

Always make a thorough inspection of the carburetor before installing on the engine. Operate the choke and throttle levers to be sure choke and throttle plates function properly. Make sure unit is clean and undamaged in any way. Mating surface of intake manifold must also be <-f clean and free of burrs or damage. Use a new flange gasket and secure the carburetor to the intake manifold with mounting nuts and lock washers. Do not tighten nuts all the way down. Connect the fuel line, distributor vacuum line, governor lines (where used) and throttle and choke linkage. Tighten mounting nuts alternately and evenly in a criss-cross pattern to compress flange gasket. Draw nuts down tightly.

Loading the Throttle Redundant Safety Spring

Loading the linkage is accomplished by rotating the throttle lever to wide open throttle by moving accelerator control rod to the right. Do not rotate throttle lever directly, since it will snap to the closed position, then attach throttle return spring to the trip lever. Secure opposite end of throttle return spring to throttle return spring anchor bracket. Slowly return throttle lever to idle position.

CAUTION

Whenever throttle return spring is disconnected at either end, the throttle linkage at the carburetor will snap to the closed position with a spring force sufficient to cause possible personal injury.

ON ENGINE ADJUSTMENTS

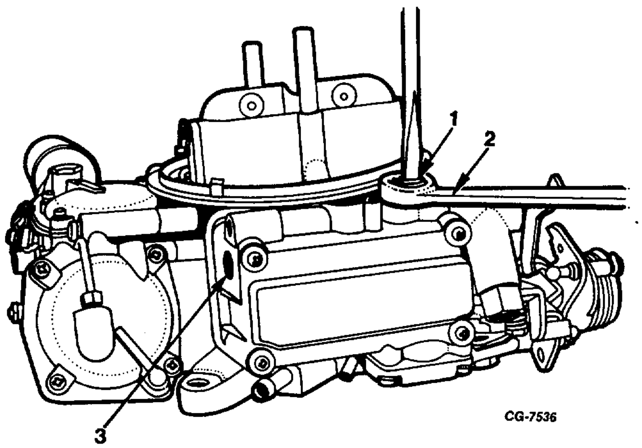
Fuel Level Adjustment

Position the truck on a level floor. Be sure the fuel pump pressure is within specifications. Operate the engine until the normal, stabilized operating temperature has been reached. Place a suitable container below the fuel level sight plug to collect any spill-over of fuel. Check each fuel bowl separately.

With the engine stopped remove the air cleaner assembly, fuel level sight plug and gasket and check the fuel level (Fig. 52). The fuel level within the bowl should be at the lower edge of the sight plug opening + 1/32". If the fuel level is satisfactory, install the sight plug.

If the fuel level is too high or low, install the sight plug, drain the fuel bowl by loosening one lower retaining bolt from the fuel bowl and drain the fuel into a suitable container. Install the bolt and the fuel level sight plug and start the engine to fill the fuel bowl. Check the fuel level again before altering the float setting. This will eliminate the possibility of foreign material causing a temporary flooding condition.

If the fuel level is still high or low, loosen the lock screw on the top of the fuel inlet seat and turn the adjusting nut in or out to correct the fuel level. 1/6 turn of the adjusting nut equals approximately 3/64" in fuel level. Remove the sight plug and recheck the fuel level. Repeat the foregoing procedure until the correct fuel level is obtained.



1. Screw Driver in Lock Screw
2. Wrench on Adjusting Nut
3. Sight Plug

Figure 52 Adjusting Fuel Level

It is important that the fuel level be maintained to specifications, as the fuel level is a part of the carburetor calibration.

CAUTION:

> Do not loosen the lock screw or attempt to adjust the fuel level with the sight plug removed and the engine running, as this creates a fire hazard.

Fast Idle Adjustment

Idle speed and fuel mixture settings must be made with the engine at normal operating temperature, parking brake applied and choke open. See "Specifications" for transmission shift selector position and air conditioner switch settings.

When making carburetor adjustments, disconnect vacuum hose from vapor storage canister and plug end of hose. After idle adjustments have been made, remove plug and reconnect hose to canister. To compensate for fuel and temperature variations when setting idle mixture, observe these precautions:

a. Do not idle engine continuously for more than three minutes at one time.

b. After each three minutes of idling increase engine speed to 2000 RPM for one minute.

c. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step "b".

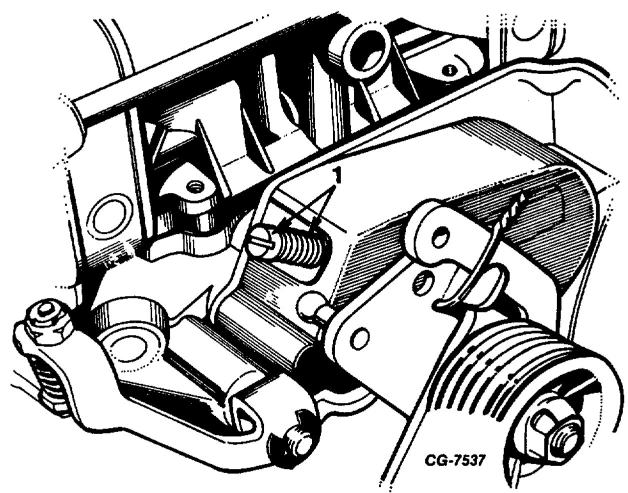
It is imperative that the precautions outlined above be followed on engines equipped with road speed controlled spark advance systems where extended idling could permit sufficient increase in engine coolant temperature to activate high temperature vacuum control valve and thereby affect engine timing and idle speed.

Fast idle adjustment is performed as follows:

1. Shut off engine, remove air cleaner, connect tachometer of known accuracy.

2. Depress accelerator pedal to floor. Close choke and release accelerator pedal.

3. Remove curb idle stop screw and spring, reinstall idle stop screw without spring (See Fig. 53).



1. Idle Speed Screw and Spring

Figure 53 Curb Idle Speed Screw and Spring

NOTE: Record the number of turns it takes to increase or decrease the engine RPM to the specified speed shown:

V-392	2000 RPM
MV-404, 446	2400 RPM
V-537, 605	2000 RPM

4. Run curb idle stop screw in until it contact the internal stop.

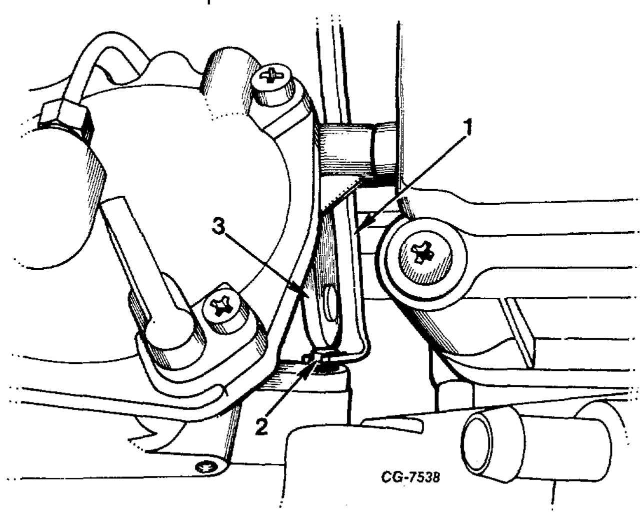
5. Release choke as it opens completely.

6. Start engine, observe and record (RPM) tachometer reading. If RPM reading does not correspond with fast idle speed specification chart, an adjustment should be made.

7. To increase RPM, continue to turn the curb idle screw until proper fast idle speed is reached (See Fig. 53).

8. Before shutting off engine back out curb idle screw until engine speed is reduced to curb idle speed to prevent engine dieseling. Shut off engine (See Fig. 42).

9. Depress accelerator pedal to floor. Close choke and release accelerator pedal.



1. Adjusting Wrench
2. Fast Idle Adjusting Screw
3. Fast Idle Cam

Figure 54 Adjusting Fast Idle Screw With SE-1772-18 Wrench

10. Reset curb idle screw until it lightly contacts the inner stop. Turn the idle screw in the number of additional turns recorded (in Step 8) to reach proper fast idle speed setting.

11. Adjust fast idle screw with special wrench SE-1772-18 until the screw just contacts the fast idle cam (See Fig. 54). Contact is established when visual clearance between the screw and the cam is eliminated or when the throttle lever starts to move.

12. To recheck adjustment, choke closed, back out idle screw two turns and then reset screw until lightly contacting internal stop.

13. Open choke, start engine, proper engine RPM should now be obtained.

14. Repeat Step No. 9.

15. Reinstall spring on idle speed screw and install screw with spring.

16. Reinstall air cleaner and adjust proper curb idle speed (See Specifications).

Idle Speed and Fuel Mixture Adjustment Procedure Without Exhaust Analyzer (Speed Drop Method)

1. Connect tachometer to engine (Tachometer should have expanded scale of 400-800 RPM or 0-1000 RPM and 1%-2% accuracy.)

2. Turn idle mixture screw(s) "out" (counterclockwise) against tab stop.

NOTE: If working with a unit rebuild which has not had the idle limiter caps installed, refer to specification for the initial idle setting.

3. Operate engine until thoroughly warmed up.

4. Adjust idle speed screw to give engine speed higher than specified idle speed. (See "Specifications".)

5. Turn idle mixture screws "in" (clockwise) slowly and equally until specified idle speed is obtained. The resulting idle fuel mixture is optimum for exhaust emission control.

NOTE: If working with unit rebuild, install idle limiter caps at this time.

6. If engine runs rough after obtaining specified idle speed or if specified idle speed cannot be obtained (per Steps 4 and 5), it will be necessary to remove the idle limiter caps and establish proper mixture screw setting as follows:

a. Remove limiter caps. To prevent damaging screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

b. With engine operating, adjust mixture screws to obtain "lean best idle" at the specified idle speed. ("Lean best idle" is the point at which engine speed drops approximately 10 RPM due to leanness.)

c. Install new idle limiter caps with tab fully counterclockwise against stop.
d. Make idle speed adjustment per Step 4 and to obtain recommended setting for optimum exhaust emission control.

7. If idle speed with automatic transmission in "DRIVE" is less than 550 RPM after the above adjustments have been made, readjust idle speed screw to obtain 550 RPM in "DRIVE."
8. Disconnect tachometer from engine.

Adjustment Procedure With Exhaust Analyzer

If exhaust analysis equipment is available, the following procedure can be used to establish the recommended idle settings. Exhaust analysis equipment must have a "Percent of Carbon Monoxide" meter which gives accurate readings in the 0-5% CO range.

NOTE: Exhaust analysis equipment is not recommended for use with winter grade gasolines. These fuels, being more volatile, yield vapors which can cause excessively rich analyzer meter readings. Where winter grade fuels are used, it is recommended that the Speed Drop Method be utilized to obtain correct idle mixture settings.

1. Connect test tachometer to engine. (Tachometer should have an expanded scale of 400-800 or 1-1000 RPM and 1% to 2% accuracy.)
2. On engines equipped with air injection system, disconnect air injection hoses from air manifold check valves.
3. Adjust idle mixture screws full rich against tab stop by turning screws counterclockwise "out."

NOTE: If working with a unit rebuild which has not had idle limiter caps installed, refer to specifications for the initial idle setting.

4. Operate engine until it reaches normal operating temperature.
5. Adjust idle speed screw to obtain specified idle speed.
6. Prepare exhaust analyzer and insert exhaust sample probe into vehicle's tail pipe. (Refer to test equipment manufacturer's instructions for preparation and hook-up procedures.)
7. Observe percent of carbon monoxide (% CO) indicated on analyzer dial.

a. Adjust idle mixture screws "in" (clockwise) by 1/16 turn increments to obtain specified CO setting. (See Carburetor Specifications.)
b. Readjust idle speed if necessary and readjust mixture screws to provide the specified CO setting at specified curb idle speed.

NOTE: If working with unit rebuild, install idle limiter caps at this time.

8. If specified CO setting cannot be obtained per Step 7, it will be necessary to remove the plastic idle limiter caps and establish proper mixture screw setting as follows:

a. Remove limiter caps. To prevent damage to screw threads or seat, file or grind away the side of the cap. Do not pry cap off.
b. With engine operating, adjust mixture screws to obtain "lean best idle" at specified curb idle speed. ("Lean best idle" is the point at which engine speed drops approximately 10 RPM due to leanness.)
c. Install new idle limiter caps with tab fully counterclockwise against stop.
d. Make idle mixture adjustment per Step 7 to obtain recommended CO setting.

9. If idle speed with automatic transmission in "DRIVE" is less than 550 RPM after the above adjustments have been made, readjust idle speed screw to obtain 550 RPM in "DRIVE."
10. Disconnect test equipment from engine. Reconnect air injection hose to air manifold check valves where equipped.

If unsatisfactory idle operation persists after completing idle adjustment per the above procedures, recheck ignition system components, timing advance, crankcase ventilation system and air induction system.

Accelerating Pump Lever Adjustment

1. Using a feeler gauge and with the throttle plates in the wide-open position, there should be the specified clearance of .015" minimum between the accelerating pump operating lever adjustment screw and the pump arm when the pump arm is depressed manually (Fig. 55).
2. If adjustment is required, loosen the adjusting screw lock nut and turn the adjusting screw in to increase the clearance and out to decrease the clearance. One-half turn of the adjusting screw is equal to approximately .015".

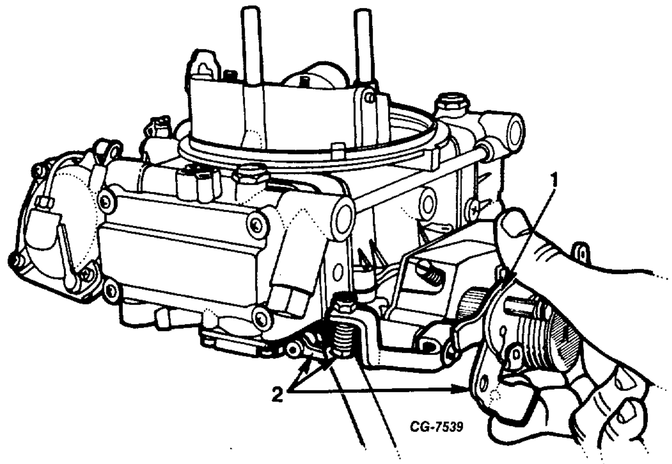


Figure 55. Accelerating Pump Lever Adjustment
1. Location of Pump Cam
2. Clearance Between Pump Lever and Adjusting Screw With Throttle Wide Open

Accelerating Pump Stroke Adjustments

To satisfy acceleration requirements in various climates, the accelerating pump discharge can be adjusted (Fig. 55).

The bottom hole (No. 2) in the acceleration pump cam and the throttle lever provides the maximum pump discharge for extreme cold weather and the top hole (No. 1) provides the minimum pump discharge for warm weather operation. If a change in the adjustment is required, make certain the proper hole (top or bottom) in plastic accelerating pump cam, located behind the throttle lever, is properly aligned (indexed) with the numbered hole (top or bottom) in the throttle lever before installing the retaining screw.

Dashpot

With engine temperature normalized and engine operating at specified curb idle speed, depress dashpot plunger and measure distance between plunger and throttle lever (see SPECIFICATIONS). The shank of a new drill may be used to check this adjustment.

To adjust the setting, loosen locknut and screw the dashpot in or out as required. When the desired setting is obtained, tighten locknut on dashpot against the bracket. Recheck idle speed.

Throttle Modulator

With vacuum applied to throttle modulator loosen locknut and adjust modulator until engine operates at specified RPM (see SPECIFICATIONS).

Governor Adjustment (Spinner Type)

The procedure outlined below should be followed when making a governor spinner adjustment. It is necessary to use a tachometer to adjust engine RPM.

Adjust the governor spinner so that engine speed will cut off within the engine no load cutoff range (see SPECIFICATIONS).

1. Turn off ignition. Engine must be completely stopped.
2. Remove governor clamp and gasket assembly.
3. Turn engine over until adjusting screw whole plug appears in the opening.
4. Remove plug with 1/8" Allen Wrench (Fig. 56). Figure 56 Using Allen Wrench to Remove Governor Plug

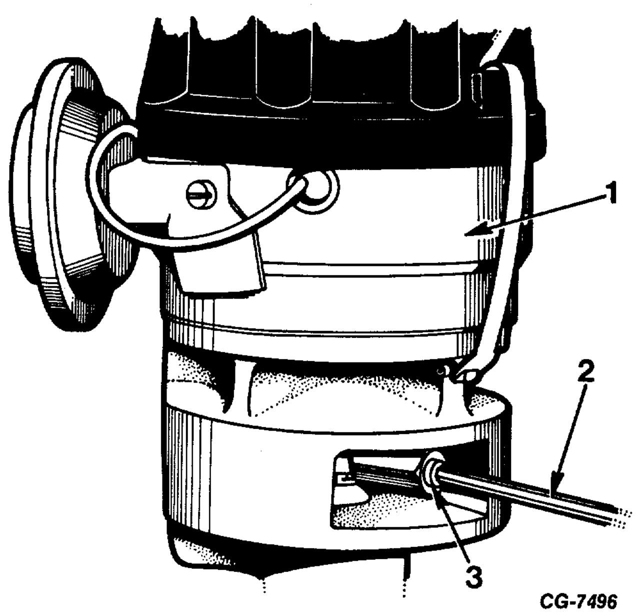


Fig. 56. Using Allen Wrench to Remove Governor Plug
1. Distributor 2. Allen Wrench
3. Governor Plug

5. Insert slotted end of SE-2072-2 governor adjusting tool firmly in hole, engaging adjusting tang (Fig. 57). Turn the handle clockwise to decrease speed and counterclockwise to increase speed; ¼ turn will change the speed approximately 100 RPM.
6. The adjusting screw is of a special design. The spinner cannot be adjusted with a screwdriver or by any device other than this tool.
7. Reinstall plug with 1/8" Allen Wrench before checking governor speed.

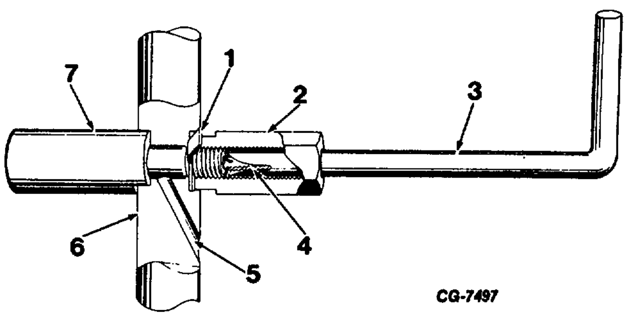


Figure 57. Adjusting Governor Using Tool SE-2072-2

1. Lock
2. Counterweight
3. Adjusting Tool
4. Screw (Tang)
5. Vertical Hole
6. Distributor Shaft
7. Governor Valve Body

8. Reinstall governor clamp and gasket assembly.
9. Reinstall governor seal.
10. On distributors so equipped, be sure the governor spinner valve air cleaner is cleaned or replaced at regular intervals depending on severity of operation.

Automatic Choke

The automatic choke assembly consists of a bimetallic thermostat spring and vacuum piston. The automatic choke assembly is mounted on the carburetor main body. A passage through the main body connects the vacuum system to the manifold area. When the engine is cold, the bimetal spring closes the choke plate for starting. When the engine starts, manifold vacuum is applied to the choke piston through a passage in the main body and with the help of air flow on the offset choke plate, opens the choke against the tension of the bimetal spring.

A heat stove is installed in the exhaust manifold and an asbestos-covered tube connects the heat stove to the choke housing. As the engine is warmed up, hot air is circulated to the choke housing to warm up the bimetal spring. As the spring warms up, its tension will be released on the choke shaft and allow it to open gradually. The warm air then passes through a hole in the choke piston and down the passage in the main body to the manifold vacuum passage.
A choke lever is provided on the side of the carburetor which actuates a fast idle cam during choking. The fast idle cam has a series of stops on one side which are designed to increase the engine idle RPM for smoother running when the

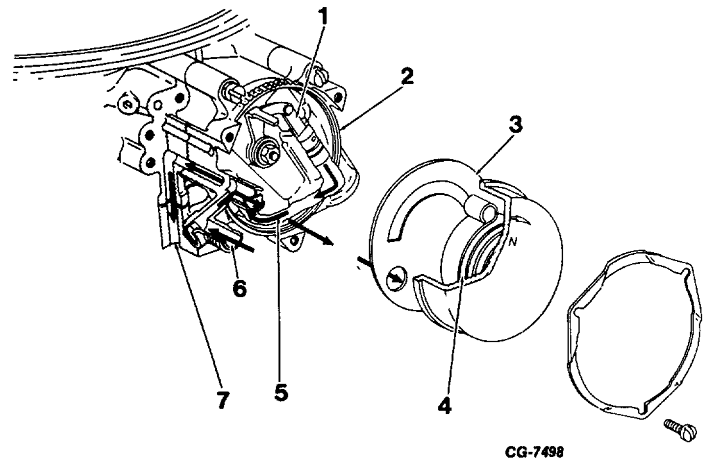


Figure 58. Automatic Choke Assembly

1. Piston and Lever Assembly
2. Choke Housing
3. Choke Housing Plate
4. Thermostat Spring
5. Vacuum Passage
6. From Heat Tube
7. Vacuum Passage

engine is cold. As the engine is warmed up and the choke opens, each step on the fast idle cam permits the engine to run at a slower RPM.

An adjustable piston stop screw controls the initial travel of the choke piston. The piston, in turn, controls the initial opening of the choke plate or choke qualifying dimensions. To check the choke qualifying dimension, follow the procedure outlined below:

1. Bend a paper clip as shown in insert in Fig. 59).
2. Place bent end of clip on top of piston and depress piston until it bottoms on stop screw (Fig. 59).
3. Rotate choke lever tang counterdockwise until choke piston link touches top of piston (Fig. 59).
4. Measure clearance on lower edge of choke plate at inner wall of air horn. See SPECIFICATIONS for correct setting.
5. Adjust clearance by moving adjusting screw in or out.
6. After adjustment has been established, seal off head of adjusting screw with sealing compound.

A small unloader lever is provided on the throttle shaft which will manually open the choke plate when the throttle lever is at the wide open position. This permits the operator to relieve an over choke condition. To overcome a flooded

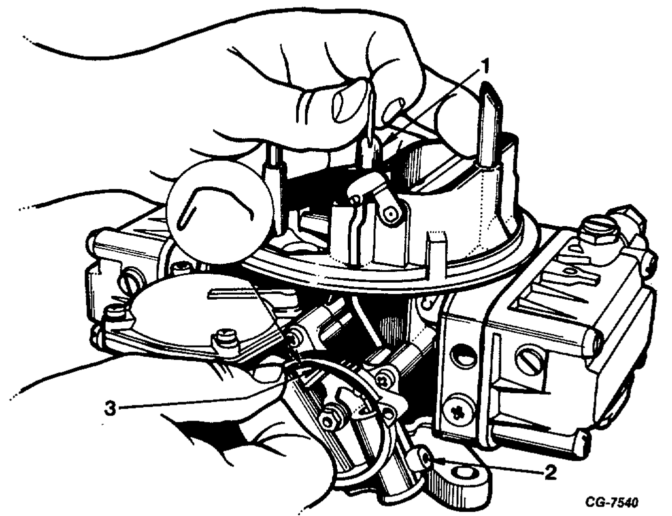


Figure 59. Checking Choke Qualifying Dimension

1. *Specified Drill or Gauge Size*
2. *Adjusting Screw*
3. *Paper Clip*

condition, hold accelerator to floor (do not pump accelerator until engine starts).

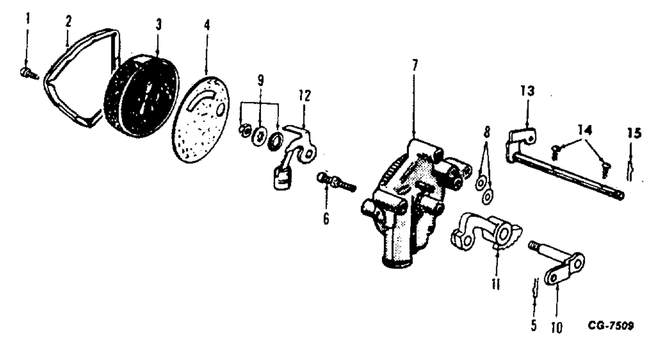
Service of the automatic choke carburetor is identical to the hand choke model with the following exceptions:

> The choke cover should not be immersed in carburetor cleaner. It can be rinsed in solvent or fuel and carefully blown out. The bimetal spring should not be bent, stretched or tampered with.
>
> New gaskets must be installed between the carburetor body and choke housing.

If for some reason a richer or leaner mixture during the warmup period is desired, it can be obtained by rotating the thermostat cover. Never set the index mark on the cover more than two graduations off the specified settings.

Figure 60 Exploded View of Automatic Choke Assembly
Legend for Fig. 66 Key Description

1	SCREW, Fil. Hd. No. BNC x 7/16
2	CLAMP, Thermostat Housing
3	HOUSING, Thermostat Assembly
4	GASKET, Thermostat Housing
5	PIN, Choke Rod Retainer
6	SCREW, Choke Housing WASHER, Lock, Choke Housing
7	HOUSING, Choke Assembly
8	GASKET, Choke Housing WASHER, Lock, Internal Tooth (No. 8)
9	NUT, Choke Shaft SPACER, Choke Thermostat Lever
10	ASSEMBLY, Shaft and Lever
11	CAM, Fast Idle
12	LEVER, Thermostat with LINK
13	SHAFT, Carburetor Choke
14	SCREWS, Choke Plate
15	RETAINER, Choke Rod

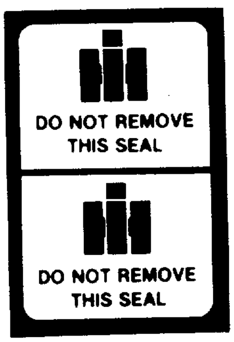


ELECTRONIC VACUUM MODULATING (EVM) GOVERNOR SYSTEM TROUBLE SHOOTING PROCEDURE

The following procedure presents a J systematic method of diagnosing and trouble shooting the Electronic Vacuum Modulating (EVM) Governor System. Each trouble shooting step has a chart to locate the component and illustrate the test. Test instruments used consist of a volt-meter and a tachometer.

It is recommended that the tachometer used for testing governor no load speed be an instrument with a high percentage of accuracy. The governed no load speed should be within a 100 RPM tolerance.

If engine speed reading is more than 100 RPM high or lower than the specified governed no load speed, make sure the tachometer being used has been properly calibrated before condemning the ECU or vacuum solenoid valve.



CG-7510

Figure 61 Anti Tamper Proof Seal

Electrical connections on the EVM system are sealed with an anti-tamper proof seal tape which is placed on the connectors at the time of assembly. The production seal tape can be identified by its white color with black print. If the connector seal tape is tampered with the word VOID will appear.

After service is performed, a service anti-tamper proof tape which is white in color with red print should be installed. This difference in print color will show the system has been serviced.

1. Visually inspect condition of wiring connections and components.

2. Disconnect wire at electronic control unit (ECU). Check for battery voltage with ignition turned on. If battery voltage is not found, refer to Service Manual, ELECTRICAL, for repair. If battery voltage is found, proceed to Step 3.

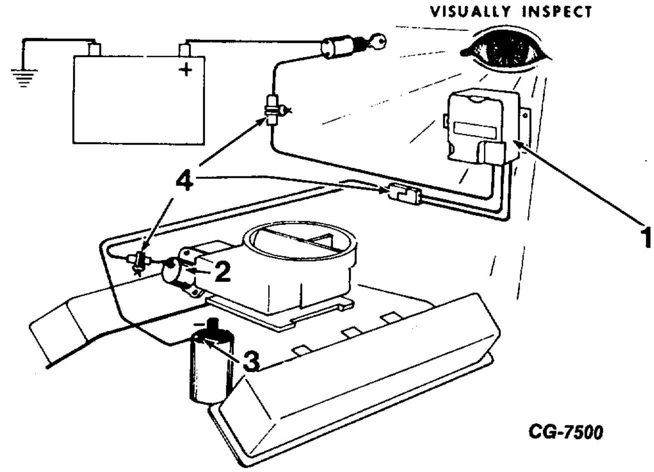


Figure 62. Step 1

1. Electronic Control Unit (ECU)
2. Solenoid Vacuum Valve
3. Ignition Coil
4. Cable Connections Figure

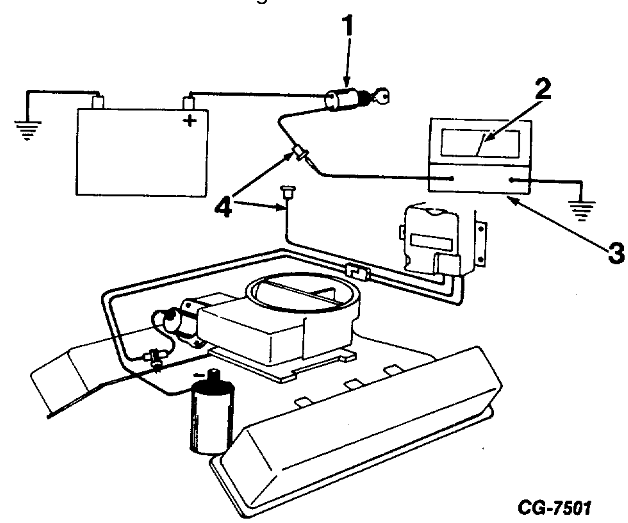


Figure 63. Step 2

1. Ignition Switch “ON”
2. Battery Voltage
3. Volt Meter
4. Battery Source to ECU Cable

3. Disconnect ECU signal cable at terminal connector as shown.
   a. Check continuity of cable from negative side of coil to ECU end. If reading indicates an open circuit, replace cable.

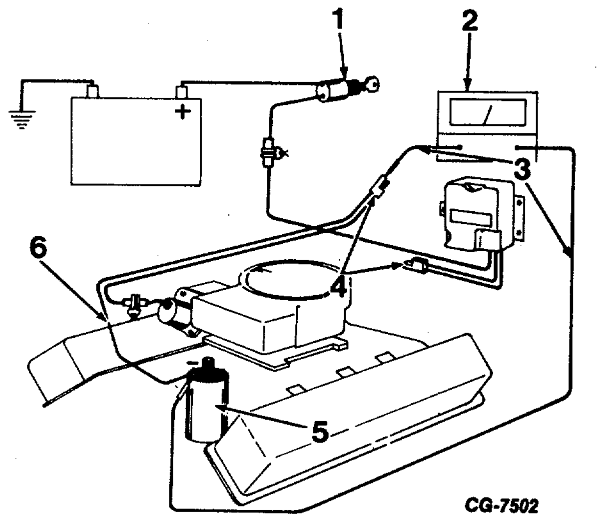
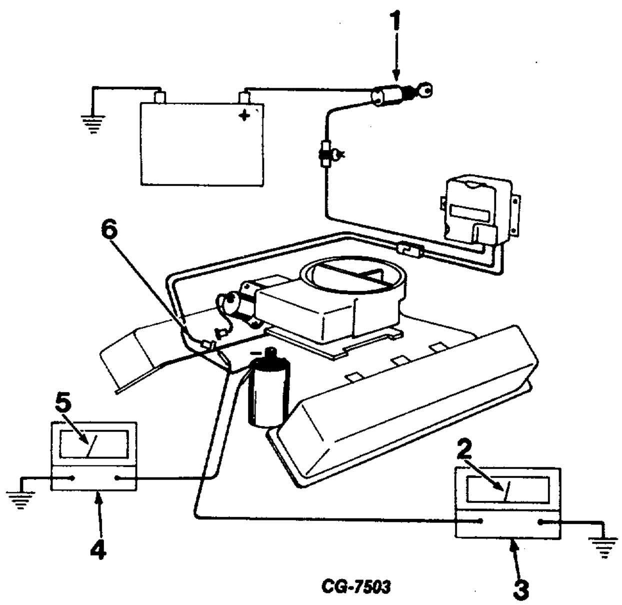


Figure 64 Step 3

1. Ignition Switch “OFF”
2. Ohmmeter
3. Meter Leads
4. ECU Terminals
5. Ignition Coil
6. Engine Speed Signal to ECU Cable

b. If normal, reconnect cable and proceed to next step.



CG-7503. Figure 65 Step 4

1. Ignition Switch “ON” Engine Running
2. Battery Voltage
3. Voltmeter
4. Tachometer
5. Governor Speed
6. ECU to Solenoid Cable

4. Disconnect cable terminal connector between ECU and solenoid valve (on carburetor). Connect tachometer and voltmeter. Start engine, increase speed until governor no load rpm is reached (see specifications). Battery voltage should be obtained at ECU side of connector.

a. If battery voltage is not obtained, replace ECU.

b. If battery voltage is obtained, stop engine and proceed to next step.

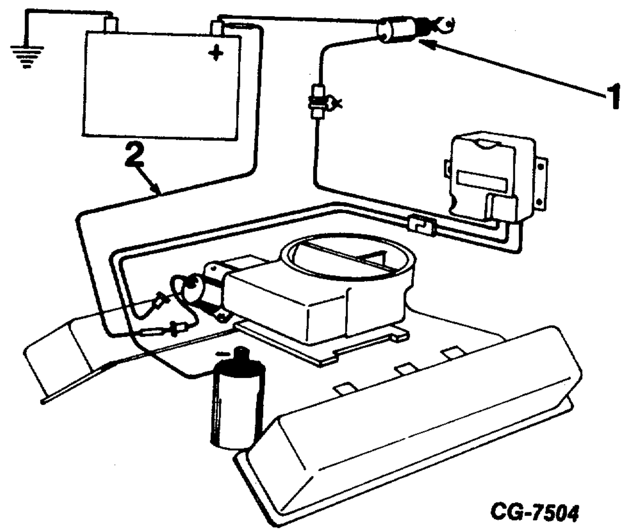


Figure 66 Step 5

1. Ignition Switch “OFF”
2. Jumper Wire CG-7505

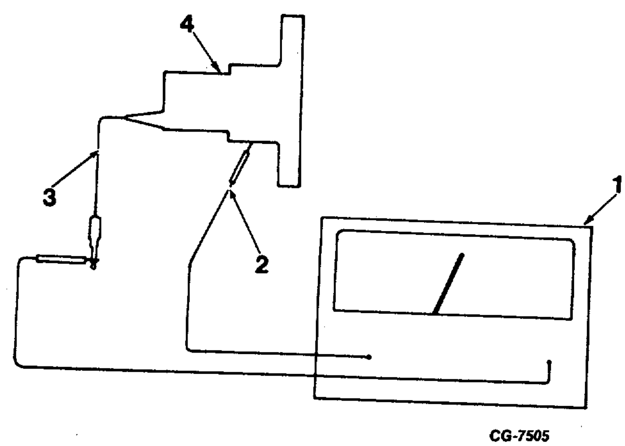


Figure 67. Step 5b

1. Ohmmeter
2. To Solenoid Case
3. Solenoid Cable
4. Solenoid Assembly

5. Apply battery voltage to solenoid valve side of cable as shown. The solenoid valve should make a slight noise or movement felt when current is applied and released indicating the solenoid valve plunger is operating.

a. If the solenoid is operating properly, proceed to step 6.

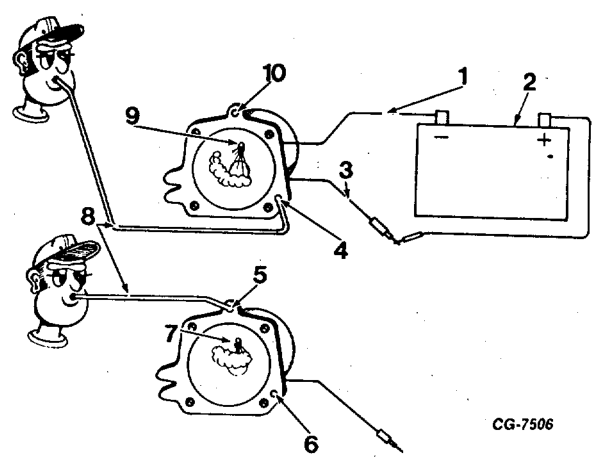


Figure 68. Step 6

1. To Solenoid Valve Case
2. Battery, 12 Volt
3. Solenoid Cable
4. "A" Port Open
5. "B" Port Open Closed
6. "A" Port Closed
7. Air Output
8. Use Vacuum Hose for Air Input Test
9. Air Output 10. "B" Port

b. If the noise is not heard or movement felt, remove solenoid valve and cover assembly from carburetor. Make a resistance check with an ohmmeter from the solenoid valve cable to the valve assembly case as shown. The ohmmeter should read approximately 50 + 10 ohms. If resistance is zero or a very high reading, the solenoid valve assembly must be replaced.

c. If resistance is 50 + 10 ohms, the solenoid valve windings are good. Remove solenoid valve from cover. Check to see if valve seat is sticking, keeping solenoid valve plunger from operating.

6. If Steps 1 through 5 have proved that the electrical portion of governor system is operating properly, the trouble must be in the cover vacuum passages on the carburetor.

a. With solenoid valve assembled to cover, apply air through a small diameter hose as shown to port "A," then port "B" to insure passages are clear. With battery voltage applied: Port "B" should be closed. Port "A" should be open. Without battery voltage applied: Port "B" should be open. Port "A" should be closed.

b. If solenoid valve plunger is not seating properly, replace solenoid valve.

c. If vacuum passages in the cover are clogged, clean (cover only) with commercial carburetor cleaning solvent.

7. Some carburetor malfunctions that are not a part of the EVM governor system may affect governor action. These malfunctions can be corrected by using the CLEANING AND INSPECTION portion of this service manual.

SECONDARY CONTROL VALVE TROUBLE SHOOTING

Malfunction of the secondary control valve can cause fluctuation of engine speed ("surging") when the governor is in effect or failure of the governor to limit engine speed.

Because calibration of the control valve requires special equipment, the secondary diaphragm cover (with secondary control valve) is assembled, calibrated and sealed at the factory and furnished for service only as an assembly. Control valve components are not serviced separately.

Outlined in the following paragraphs are procedures for testing the secondary control valve. These procedures are used to determine if the control valve is satisfactory or if it should be replaced.

Bench Test

The following "bench" test procedure can be used to check functioning of the control valve. It is recommended that this check be made at the time of carburetor overhaul or if improper valve operation is suspected.

1. Connect a controllable vacuum source to the vacuum inlet of the control valve diaphragm chamber, as shown in Fig. 69. (Distributor tester SE-1925 or SE-1979 can be used as a vacuum source.) Apply 6 inches of vacuum

to the diaphragm chamber. If vacuum holds, the control valve diaphragm is satisfactory. If vacuum cannot be maintained, diaphragm is faulty and the complete secondary diaphragm assembly should be replaced.

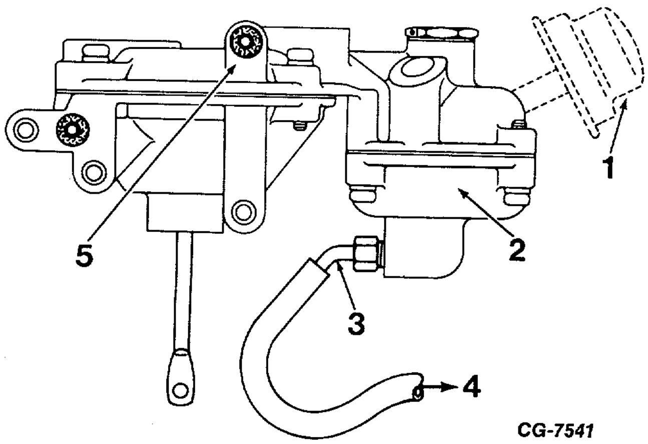


Figure 69 Vacuum Connection for Checking Secondary Control Valve Diaphragm

1. Air Filter (Where Used)
2. Diaphragm Chamber
3. Adapter Fitting
4. To Vacuum Source (6" G)
5. Not Used When Air Filter is Used

2. Connect the vacuum source to the venturi vacuum pickup passage on the back of the cover assembly, as shown in Fig. 70. Tightly cover the fresh air passage also on the back of the cover assembly. Apply 6 inches of vacuum. If secondary diaphragm moves (compresses spring) and vacuum holds, secondary diaphragm is satisfactory. If diaphragm does not move or if vacuum cannot be maintained, secondary diaphragm is faulty P-d should be replaced.

3. With vacuum applied as in Step 2, uncover the fresh air passage. If vacuum holds, control valve needle and seat are satisfactory. If vacuum cannot be maintained, control valve is faulty and the complete secondary diaphragm assembly should be replaced.

On the Vehicle Test

The "on the vehicle" test outlined below can be used to help locate the cause for loss of governor control.

1. With the vehicle on the service floor accelerate the engine to check governor operation.

a. Governor should limit engine speed to 150-250 initial overrun. Adjust governor if necessary.

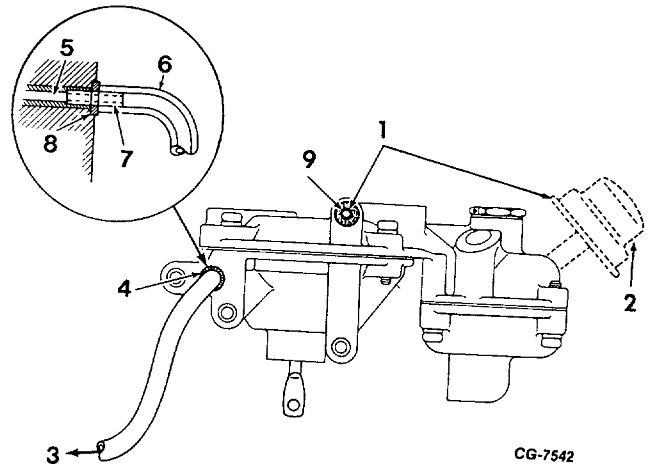


Figure 70 Vacuum Connection for Checking Secondary Control Valve and Diaphragm

1. To Check Diaphragm Cover Passage
   To Check Needle and Seat Uncover Passage
2. Air Filter (Where Used)
3. To Vacuum Source (6" HG)
4. Venturi Vacuum Passage
5. Vacuum Passage
6. Hose .125 I.D.
7. Tube .125 O.D.
8. Gasket
9. Fresh Air Passage

NOTE: Initial overrun means that under acceleration the engine will momentarily exceed governed speed by approximately 150-250 RPM and then settle to governed speed.

b. If there is no governor control, proceed with Step No. 2 below.

c. If the engine governs at light load and does not govern at wideopen throttle, the problem is probably in the secondary control valve. Proceed with Step No. 4 below.

2. Disconnect the vacuum line (distributor to governor throttle actuating unit) from the fitting at the governor unit. Leave the secondary control valve vacuum line connected. Operate the engine at 2200 RPM, wet your finger and hold it over the opening in the fitting. If the engine speed slows to approximately 1000 RPM, the governor trouble is in the governor control ("spinner") valve or the lines or connections to the governor control valve. If the engine does not slow down, proceed with Step No. 3.

3. Disconnect the secondary control valve vacuum line from the fitting and remove the fitting. Again, operate the engine at 2200 RPM and place a wet finger over the vacuum passage in the governor throttle unit. If the engine now slows to approximately 1000 RPM, the problem is in the secondary control valve or its vacuum line. If the engine does not slow down, the problem is in the governor throttle unit or the vacuum passages behind it.

4. When the problem is suspected to be in the secondary control valve, operate the vehicle on the

highway and check governor operation. The governor should limit engine speed to 3600 RPM plus 150-250 RPM initial overrun. If the engine does not govern, disconnect the secondary throttle diaphragm link from the secondary throttle shaft lever. Operate the vehicle again on only the primary carburetor venturis. If the engine governs now, the problem is in the secondary control valve. Some 4150G carburetors will be equipped with a secondary throttle diaphragm assembly air filter. If the air filter becomes clogged the governor will not operate properly. To check the filter for restriction, blow through filter tube. If air does not pass freely, replace filter.

NOTE: Check air filter every 24,000 miles or 24 months whichever occurs first. In vehicles operated in dusty conditions, check for filter restrictions more frequently.

Correct operation of the secondary throttle system and the governor depends upon proper functioning of the secondary control valve. Use of the test procedures described will assist in diagnosing governor problems and checking secondary control valve operation.

ENGINE DIVISION SERVICE MANUAL

SPECIFICATIONS

1969 SPECIFICATIONS (MANUAL CHOKE)
(Exhaust Emission Controlled and Non-Emission Controlled Engines)

Engine Model		V-392					
Carburetor Model		4150				4150G	
Manual Trans., Manual Choke:							
Production Number		379283-C91	--	379287-C91	--	379483-C91	--
List Number		4237	--	4318	--	4323	--
Service Number		379283-C92	--	443281-C91	--	379483-C92	--
List Number		4237	--	4318-1	--	4323-4	--
Service Number		443279-C91	--	--	--	442170-C91	--
List Number		4237-1	--	--	--	4323-5	--
Service Number		454605-C91	--	--	--	454603-C91	--
List Number		4237-2	--	--	--	4323-7	--
Auto. Trans., Manual Choke:							
Production Number		--	379284-C91	--	379288-C91	--	379484-C91
List Number		--	4264	--	4320	--	4324
Service Number		--	379284-C92	--	443282-C91	--	379484-C92
List Number		--	4264-1	--	4320-1	--	4324-4
Service Number		--	443280-C91	--	--	--	442171-C91
List Number		--	4264-1	--	--	--	4324-5
Service Number		--	--	--	--	--	454604-C91
List Number		--	--	--	--	--	4324-7
Fuel Level:	Primary	12.7 mm @ 34.47 kPa (1/2" @ 5 psi)		9.53 mm @ 34.47 kPa (3/8" @ 5 psi)		9.53 mm @ 34.47 kPa (3/8" @ 5 psi)	
	Secondary	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)		15.9 mm @ 34.47 kPa (5/8" @ 5 psi)		15.9 mm @ 34.47 kPa (5/8" @ 5 psi)	
Main Jet:	Primary	#51		#53		#58	
	Secondary	#53		#53		#57	
Accelerator Jet		.635 mm (.025")				.635 mm (.025")	
Fuel Valve Seat:	Primary	2.464 mm (.097")				2.464 mm (.097")	
	Secondary	2.464 mm (.097")				2.464 mm (.097")	
Initial Idle Needle Setting (Approx. turns off seat)		1-1/2		4		1-1/2	
Dashpot Setting		None	1.52 - 2.29mm	None	1.52 - 2.29mm	None	
Fast Idle Setting		.635 mm (.025") Clearance Between Stop Screw & Cam					
Idle Speed, RPM		700	* 550	450 - 500		450 - 500	
Air/Fuel Ratio (Idle)		13.4 - 13.6 (3% CO)		12.0 - 13.0		13.4 - 13.6 (3% CO)	
Upper Orifice, mm (in.)		None				.914 (.036)	
Lower Orifice, mm (in.)		None				1.10 (.043)	
Governor Spring		None				Black	
Post Position		None				#1	
Governed Speed, RPM							
Full Speed - No Load		None				3800	
Full Speed - Full Load		None				3600	
Power Valve: **	Primary	Stamped 8	Stamped 8	Stamped 65	Stamped 65	Stamped 5	Stamped 5
	Secondary	Stamped 35	Stamped 35	Stamped 85	Stamped 85	Stamped 25	Stamped 25

* Automatic transmission in gear.

** Power valve identification number is stamped on a flat on the base of the valve.

ENGINE DIVISION SERVICE MANUAL

SPECIFICATIONS

1969 SPECIFICATIONS (AUTOMATIC CHOKE)
(Exhaust Emission Controlled and Non-Emission Controlled Engines)

Engine Model		V-392			
Carburetor Model		4150C			
Manual Trans., Auto. Choke:					
Production Number		379285-C91	379289-C91	379290-C91	--
List Number		4312	4319	4321	--
Service Number		379286-C92	--	443283-C91	
List Number		4313-1	--	4321-1	--
Service Number		442167-C91	--	--	--
List Number		4313-2	--	--	--
Service Number		454584-C92	--	--	--
List Number		4313-3	--	--	--
Auto. Trans., Auto. Choke:					
Production Number		--	--	379290-C91	379286-C91
List Number		--	--	4321	4313
Service Number		--	--	443283-C91	379286-C92
List Number		--	--	4321-1	4313-1
Service Number		--	--	--	442167-C91
List Number		--	--	--	4313-2
Service Number		--	--	--	454584-C92
List Number		--	--	--	4313-3
Automatic Choke Setting		1st Notch Lean	3rd Notch Lean	3rd Notch Lean	1st Notch Lean
Fuel Level:	Primary	12.7mm @ 34.47 kPa (1/2" @ 5 psi)	9.53 mm @ 34.47 kPa (3/8" @ 5 psi)		12.7mm @ 34.47 kPa (1/2" @ 5 psi)
	Secondary	15.9mm @ 34.47 kPa (5/8" @ 5 psi)	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)		15.9mm @ 34.47 kPa (5/8" @ 5 psi)
Main Jet:	Primary	#51	#53	#53	#51
	Secondary	#53	#53	#53	#53
Accelerator Jet		.635 mm (.025")			
Fuel Valve Seat:	Primary	2.464 mm (.097")			
	Secondary	2.464 mm (.097")			
Initial Idle Needle Setting (Approx. turns off seat)		1-1/2	4	4	1-1/2
Dashpot Setting		None	None	1.52 - 2.29 mm (.060" - .090")	
Fast Idle Setting		.635 mm (.025") Clearance between Stop Screw & Cam			
Idle Speed		700	450 - 500	450 - 500	* 550
Air/Fuel Ratio (Idle)		13.4 - 13.6 (3% CO)	12.0 - 13.0	12.0 - 13.0	13.4 - 13.6 (3% CO)
Choke Qualification Setting		4.70 - 5.46 mm (.185" - .215") Measured on Downstream Side of Choke Plate			
Power Valve: **	Primary	Stamped 8	Stamped 65	Stamped 65	Stamped 8
	Secondary	Stamped 35	Stamped 85	Stamped 85	Stamped 35

* Transmission in Drive range, Air Conditioning "OFF"
** Power valve identification number is stamped on a flat on base of valve.

SPECIFICATIONS

CARBURETOR SPECIFICATIONS

1970 - 1971 Exhaust Emission Controlled and Non-Emission Controlled Engines

Engine Model	V-392				
Carburetor Model	4150C				
Manual Trans., Auto. Choke:					
Production No.	398245-C91	----	379285-C91	----	----
List No.	4599	----	4312	----	----
Service No.	398247-C92	----	279286-C92	----	----
List No.	4602-1	----	4313-1	----	----
Service No.	443285-C91	----	442167-C91	----	----
List No.	4602-2	----	4313-2	----	----
Service No.	----	----	454584-C92	----	----
List No.	----	----	4313-3	----	----
Auto. Trans., Auto. Choke:					
Production No.	----	398247-C92	379286-C92	398247-C91	379286-C91
List No.	----	4602-1	4313-1	4602	4313
Service No.	----	443285-C91	442167-C91	----	----
List No.	----	4602-2	4313-2	----	----
Service No.	----	----	454584-C92	----	----
List No.	----	----	4313-3	----	----
Automatic Choke Setting	Index	Index	2nd notch lean	Index	2nd notch lean
Fuel Level: Primary	12.7 mm @ 34.47 kPa (1/2" @ 5 psi)				
Fuel Level: Secondary	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)				
Main Jet: Primary	#50	#50	#51	#50	#51
Main Jet: Secondary	#51	#51	#53	#51	#53
Accelerator Jet	.625 mm (.025")				
Fuel Valve Seat: Primary	2.464 mm (.097")				
Fuel Valve Seat: Secondary	2.464 mm (.097")				
Initial Idle Needle Setting (approx. turns off seat)	3	3	3	3	1-1/2
Dashpot Setting	None	2.3-3.0 mm (.090-.120")	1.5-2.3 mm (.060-.090")	2.3-3.0 mm (.090-.120")	1.5-2.3 mm (.060-.090")
Throttle Modulator Setting	1150-1250	None	None	None	None
Fast Idle Setting - *	2000 RPM - Top Step (Hot)				
Idle Speed - *	700 RPM				
Air/Fuel Ratio (Idle)	14.4 - 14.6	14.4 - 14.6	13.4 - 13.6 (3% CO)	14.4 - 14.6	13.4 - 13.6 (3% CO)
Choke Qualification Setting	4.7 - 5.46 mm (.185 - .215") Measured on downstream side of choke plate.				
Power Valve - ** Primary	Stamped 16	Stamped 16	Stamped 8	Stamped 16	Stamped 8
Power Valve - ** Secondary	Stamped 85	Stamped 85	Stamped 35	Stamped 85	Stamped 35

* Transmission in neutral, air conditioning off.

** Power valve identification number is stamped on a flat on the base of the valve.

ENGINE DIVISION SERVICE MANUAL

SPECIFICATIONS

CARBURETOR SPECIFICATIONS
1970 - 1971 Exhaust Emission Controlled and Non-Emission Controlled Engines

Engine Model	V-392					V-392
Carburetor Model	4150					4150G
Manual Trans. Manual Choke:						
Production No.	398244-C92	----	379283-C91	----	----	379483-C91
List No.	4572-1	----	4237	----	----	4323
Service No.	398246-C92	----	379283-C92	----	----	379483-C92
List No.	4601-1	----	4237	----	----	4323-4
Service No.	443284-C91	----	443279-C91	----	----	442170-C91
List No.	4601-2	----	4237-1	----	----	4323-5
Service No.	----	----	454605-C91	----	----	454603-C91
List No.	----	----	4237-2	----	----	4323-7
Auto. Trans., Manual Choke:						
Production No.	----	398246-C92	----	398246-C91	379284-C91	379484-C91
List No.	----	4601-1	----	4601	4264	4324
Service No.	----	443284-C91	----	----	379284-C92	379484-C92
List No.	----	4601-2	----	----	4264-1	4324-4
Service No.	----	----	----	----	443280-C91	442171-C91
List No.	----	----	----	----	4264-1	4324-5
Service No.	----	----	----	----	----	454604-C91
List No.	----	----	----	----	----	4324-7
Fuel Level:						
Primary	12.7 mm @ 34.47 kPa (1/2" @ 5 psi)					
Secondary	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)					
Main Jet:						
Primary	#50	#50	#51	#50	#51	#59
Secondary	#51	#51	#53	#51	#53	#56
Accelerator Jet	.635 mm (.025")					
Fuel Valve Seat:						
Primary	2.464 mm (.097")					
Secondary	2.464 mm (.097")					
Initial Idle Needle Setting (approx. turns off seat)	3	3	3	3	3	3
Dashpot Setting, mm Dashpot Setting, (in)	None	2.3 - 3.0 (.090-.120)	None	2.3 - 3.0 (.090-.120)	1.5 - 2.3 (.060-.090)	None
Throttle Modulator Setting	1150-1250	None	None	None	None	None
Fast Idle Setting	1.75 mm (.070") Clearance	1.75 mm (.070")* Clearance	.625 mm (.025") Clearance	2000 RPM Top Step Hot	2000 RPM Top Step Hot	**
Idle Speed, RPM ***	700	700	700	700	700	450 - 500
Air/Fuel Ratio (Idle)	14.4-14.6	14.4-14.6	13.4-13.6 (3% CO)	14.4-14.6	13.4-13.6 (3% CO)	13.4-13.6 (3% CO)
Upper Orifice, mm (in.)	None					.914 (.036)
Lower Ofifice, mm (in.)	None					1.10 (.043)
Governor Spring	None					Black
Post Position	None					#1
Governed Speed, RPM						
Full Speed - No Load	None					3800
Full Speed - Full Load	None					3600
Power Valve ****						
Primary	Stamped 14	Stamped 14	Stamped 8	Stamped 14	Stamped 8	Stamped 5
Secondary	Stamped 36	Stamped 35	Stamped 35	Stamped 35	Stamped 35	Stamped 25

* 1.016 mm (.040") clearance between stop screw and cam (California only).
** .25 - .375 mm (.010 - .015") clearance between stop screw and cam.
*** Transmission in neutral, air conditioning off.
**** Power valve identification number is stamped on a flat on the base of valve.

ENGINE DIVISION SERVICE MANUAL

SPECIFICATIONS

1972 SPECIFICATIONS
(Exhaust Emission Controlled and Non-Emission Controlled Engines)

Engine Model	V-392	V-392	
Carburetor Model	4150G	4150C	
Manual Trans., Manual Choke Production (List) Numbers Service (List) Numbers Service (List) Numbers	 379483-C92 (4323-3,4) 442170-C91 (4323-5) 454603-C91 (4323-7)	 --- --- ---	 --- --- ---
Auto. Trans., Manual Choke Production (List) Numbers Service (List) Numbers Service (List) Numbers	 379484-C92 (4324-3,4) 442171-C91 (4324-5) 454604-C91 (4324-7)	 --- --- ---	 --- --- ---
Manual Trans., Auto. Choke Production (List) Numbers Service (List) Numbers Service (List) Numbers Service (List) Numbers	 --- --- --- ---	 428113-C91 (6390-1) 442162-C91 (6390-2S) 454602-C91 (6390-3) ---	 *379285-C92 (4312-1) *379286-C91 (4313-1) *442167-C91 (4313-2) *454584-C92 (4313-3)
Auto. Trans., Auto. Choke Production (List) Numbers Service (List) Numbers Service (List) Numbers	 --- --- ---	 428113-C91 (6390-1) 442162-C91 (6390-2S) 454602-C91 (6390-3)	 379286-C92 (4313-1) 442167-C91 (4313-2) 454584-C92 (6313-3)
Automatic Choke Setting: Summer Winter	 --- ---	 4 Notches Lean 1 Notch Lean	2nd Notch Lean
Fuel Level: Primary Secondary	9.53 mm @ 34.47 kPa (3/8" @ 5 psi) 15.9 mm @ 34.47 kPa (5/8" @ 5 psi)	12.7 mm @ 34.47 kPa (1/2" @ 5 psi) 15.9 mm @ 34.47 kPa (5/8" @ 5 psi)	
Main Jet: Primary Secondary	#59 #56	#50 #51	#51 #53
Accelerator Jet	.635 mm (.025")	.635 mm (.025")	
Fuel Valve Seat: Primary Secondary	2.464 mm (.097") 2.464 mm (.097")	2.464 mm (.097") 2.464 mm (.097")	
Initial Idle Needle Setting (Approx. turns off seat)	3	3	3
Dashpot Setting	---	1.91-2.67 mm (.075-.105")	1.52-2.29 mm (.060-.090")
Fast Idle Setting	.254 - .381 mm (.010 - .015")	2000 RPM Top Step (Hot)	
Idle Speed, RPM	700 **	700 **	700 **
Air/Fuel Ratio (Idle)	1.0 - 2.0% CO	1.0 - 1.5% CO	1.0 - 2.0% CO
Choke Qualification Setting		4.70 - 5.46 mm (.185" - .215") Measured on Downstream Side of Choke Plate	
Governor Upper Orifice	.914 mm (.036")	---	---
Governor Lower Orifice	1.10 mm (.043")	---	---
Governor Spring	Black	---	---
Post Position	#1	---	---
Governed Speed, RPM Full Speed - No Load Full Speed - Full Load	 3800 3600	 --- ---	 --- ---
Power Valve: *** Primary Secondary	Stamped 5 Stamped 25	Stamped 16 Stamped 85	Stamped 8 Stamped 35

* Dashpot Setting = None
** Automatic Transmission in Neutral with Air Conditioning On.
*** Power Valve Identification Number is stamped on a flat on the base of the valve.

ENGINE DIVISION SERVICE MANUAL

SPECIFICATIONS

1973 SPECIFICATIONS
(Exhaust Emission Controlled and Non-Emission Controlled)

Engine Model		V-392	V-392
Carburetor Model		4150G	4150C
Manual or Automatic Trans. W/Manual Choke: Production (List) Numbers Service (List) Numbers Service (List) Numbers Service (List) Numbers		 442170-C91 (4323-5,6) 454603-C91 (4323-7) 451869-C91 (6803) 451869-C92 (6803-1)	 --- --- --- ---
Manual Transmission W/Automatic Choke: Production (List) Numbers Service (List) Numbers		 --- ---	 442166-C91 (4312-2) 442167-C91 (4313-2)
Automatic Transmission W/Automatic Choke: Production (List) Numbers Service (List) Numbers		 --- ---	 442167-C91 (4313-2) 454584-C92 (4313-3)
Automatic Choke Setting		---	2nd Notch Lean
Fuel Level:	Primary	9.53 mm @ 34.47 kPa (3/8" @ 5 psi)	12.7 mm @ 34.47 kPa (1/2" @ 5 psi)
	Secondary	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)
Main Jet:	Primary Secondary	#59 #56	#51 #53
Accelerator Jet		.635 mm (.025")	.635 mm (.025")
Fuel Valve Seat:	Primary Secondary	2.464 mm (.097") 2.464 mm (.097")	2.464 mm (.097") 2.464 mm (.097")
Initial Idle Needle Setting (Approx. turns off seat)		3	3
Dashpot Setting		---	1.52 - 2.29 mm (.060" - .090")
Fast Idle Setting		.254 - .381 mm (.010 - .015)	2000 RPM Top Step (Hot)
Idle Speed, RPM		700 *	700 *
Air/Fuel Ratio (Idle)		2.0% CO Max.	2.0% CO Max.
Choke Qualification Setting			4.70 - 5.46 mm (.185" - .215") Measured on Downstream Side of Choke Plate
Governor Upper Orifice		.914 mm (.036")	---
Governor Lower Orifice		1.10 mm (.043")	---
Governor Spring		Black	---
Post Position		#1	---
Governor Speed, RPM (On Road) Full Speed - No Load Full Speed - Full Load		 3800 3600	 --- ---
Power Valve: **	Primary Secondary	Stamped 5 Stamped 25	Stamped 8 Stamped 35

* Automatic Transmission in Neutral with Air Conditioning On.

** Power valve identification number is stamped on a flat on the base of the valve.

ENGINE DIVISION SERVICE MANUAL

SPECIFICATIONS

1974 SPECIFICATIONS
(Exhaust Emission Controlled and Non-Emission Co.trolled)

Engine Model	V-392	V-392
Carburetor Model	4150G	4150C
Manual or Automatic Trans. W/Manual Choke: Production Number List Number Service Number List Number	 451869-C91 6803 451869-C92 6803-1	 - - - - - - - - - - - -
Manual Transmission W/Automatic Choke: Production Number List Number Service Number List Number	 - - - - - - - - - - - -	 454583-C92 4312-3 461291-C91 7035
Automatic Transmission W/Automatic Choke: Production Number List Number Service Number List Number	 - - - - - - - - - - - -	 454584-C92 4313-3 461291-C91 7035
Automatic Choke Setting	- - -	2nd Notch Lean
Fuel Level: Primary Secondary	9.53 mm @34.47 kPa (3/8" @5 psi) 15.9 mm @34.47 kPa (5/8" @5 psi)	12.7 mm @34.47 kPa (½" @5 psi) 15.9 mm @34.47 kPa (5/8" @5 psi)
Main Jet: Primary Secondary	#59 #56	#51 #53
Accelerator Jet	.635 mm (.025")	.635 mm (.025")
Fuel Valve Seat: Primary Secondary	2.464 mm (.097") 2.464 mm (.097")	2.464 mm (.097") 2.464 mm (.097")
Initial Idle Needle Setting (Approx. turns off seat)	3	3
Dashpot Setting	- - -	1.52-2.29 mm(.060"-.090")
Fast Idle Setting	.254-.381mm (.010-.015)	2000 RPM Top Step (Hot)
Idle Speed, RPM	700*	700*
Air/Fuel Ratio (Idle)	2.0% Max.	2.0% Max.
Choke Qualification Setting		4.70-5.46 mm (.185"-.215") Measured on Downstream Side of Choke Plate
Governor Upper Orifice	.914 mm (.036")	- - -
Governor Lower Orifice	1.10 mm (.043")	- - -
Governor Spring	Black	- - -
Post Position	#1	- - -
Governed Speed, RPM (On Road) Full Speed - No Load Full Speed - Full Load	 3800 3600	
Power Valve: ** Primary Secondary	Stamped 8 Stamped 35	Stamped 8 Stamped 35

* Automatic Transmission in Neutral with Air Conditioning On.
** Power Valve identification number is stamped on a flat on the base of the valve.

ENGINE DIVISION SERVICE MANUAL

SPECIFICATIONS

CARBURETOR SPECIFICATIONS

1975, 1976, 1977, 1978 Federal (Not California) Heavy Duty Engines

Carburetor Model		4150G	4150EG	4150G	4150G	
Engine Model		V-392		MV-404	MV-446	
Carburetor:	Part Number List Number	461292-C92, 6803-3	487849-C91 8233	465530-C91 7215	467026-C91 7251	484814-C91 7997
Throttle Body Bore:	Primary Secondary	36.51 mm (1-7/16") 36.51 mm (1-7/16")				
Venturi:	Primary Secondary	30.16 mm (1-3/16") 26.99 mm (1-1/16")				
Main Jet:	Primary Secondary	#581 #562		#572 #572		
Fuel Level:	Primary Secondary	9.53 mm @ 34.47 kPa (3/8" @ 5 psi) 15.90 mm @ 34.47 kPa (5/8" @ 5 psi)				
Fast Idle Setting, RPM		2000		2400		
High Idle Speed, RPM (Throttle Modulator Extended)		N/A		1300 ± 50		
Curb Idle Speed, RPM - *		650-700		525-575		
Idle Mixture Setting, % CO		2.0 Max.		0.5 - 2.5		
Governor Upper Orifice		.914 mm (.036")	.094 mm (.037")	.711mm (.028")		
Governor Lower Orifice		1.09mm (.043")	1.32mm (.052")	1.09mm (.043")	1.09mm (.043")	1.32mm (.052")
Governor Spring (Color)		Black	Plain	Black	Black	Pink
Governor Spring Post Position		#1	#2	#3	#3	#2
Governed Speed, RPM*** Full Speed, No Load		3800		3800	3800	2600
Full Speed, Full Load		3600		3600	3600	2400
**Power Valve:	Primary Secondary	Stamped 5 Stamped 25		Stamped 13 --	Stamped 11 --	

*Transmission in Neutral, Air Conditioning OFF.

**Power valve identification number is stamped on a flat on the base of the valve.

***4150 EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

N/A - Not Available

ENGINE DIVISION SERVICE MANUAL

SPECIFICATIONS

CARBURETOR SPECIFICATIONS

1975, 1976, 1977, 1978 Federal (Not California) Heavy Duty Engines

Carburetor Model		4150G	4150G
Engine Model		V-537	
Carburetor:	Part Number List Number	448314-C91 6911	487895-C91 8139
Throttle Body Bore:	Primary Secondary	36.51 mm (1-7/16") 36.51 mm (1-7/16")	
Venturi:	Primary Secondary	30.16 mm (1-3/16") 26.99 mm (1-1/16")	
Main Jet:	Primary Secondary	#58 #58	
Fuel Level:	Primary Secondary	9.53 mm @ 37.92 kPa (3/8" @ 5.5 psi) 15.90 mm @ 37.92 kPa (5/8 @ 5.5 psi)	
Fast Idle Setting		2000 RPM	
High Idle Speed, RPM (Throttle Modulator Extended)		1300 - 1400	
Curb Idle Speed, RPM - *		500 - 550	
Idle Mixture Setting, % CO		1.5 - 3.0	
Governor Upper Orifice		.91 mm (.036")	
Governor Lower Orifice		1.10 mm (.043")	
Governor Spring Post Position		#3	
Governed Speed, RPM*** Full Speed, No Load Full Speed, Full Load		 3400 3200	
**Power Valve (Primary)		Stamped 9	

* Transmission in Neutral, Air Conditioning OFF.

** Power valve identification number is stamped on a flat on the base of the valve.

CARBURETOR SPECIFICATIONS

1975, 1976, 1977, 1978 California Heavy Duty Engines

Carburetor Model		4150G		4150EG
Engine Model		V-392		
Carburetor:	Part Number List Number	461310-C91 7028	476056-C91 7579	487859-C92 8243/8243-1
Throttle Body Bore: mm (in.)	Primary Secondary	36.51 (1-7/16) 36.51 (1-7/16)		
Venturi: mm (in.)	Primary Secondary	30.16 (1-3/16) 26.99 (1-1/16)		
Main Jet:	Primary Secondary	#581 #512		
Fuel Level: mm (in.)	Primary Secondary	9.52 @ 34.34 kPa (3/8 @ 5 psi) 15.88 @ 34.45 kPa (5/8 @ 5 psi)		
Fast Idle Setting, mm (in.)		.38 - .51 (.015 - .020)*		
High Idle Speed, RPM		1400 ± 50 RPM		
** Curb Idle Speed, RPM		625 - 675		
Idle Mixture Setting, % CO		0.5 - 1.5%		
Governor Upper Orifice, mm (in.)		.91 (.036)		0.94 (.037)
Governor Lower Orifice, mm (in.)		1.09 (.043)		1.32 (.052)
Governor Spring (Color)		Brown		Plain
Governor Spring Post Position		#2		
Governed Speed, RPM: **** Full Speed, No Load Full Speed, Full Load		 3800 3600		
***Power Valve	Primary Secondary	Stamped 13 Stamped 25		Stamped 11 Stamped 25

* Clearance between stop screw and fast idle cam with choke open and curb idle speed set correctly.

** Transmission in Neutral, Air Conditioning OFF.

*** Power valve identification number is stamped on a flat on the base of the valve.

****4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

CARBURETOR SPECIFICATIONS

1975, 1976, 1977, 1978 California Heavy Duty Engines

Carburetor Model		4150G		4150EG
Engine Model		MV-446		
Carburetor:	Part Number List Number	461313-C91 7029	461313-C92 7029-1	487863-C91 8247
Throttle Body Bore: mm (in.)	Primary Secondary	36.51 (1-7/16) 36.51 (1-7/16)		
Venturi: mm (in.)	Primary Secondary	30.16 (1-3/16) 26.99 (1-1/16)		
Main Jet:	Primary Secondary	#602 #572	#593 #572	
Fuel Level: mm (in.)	Primary Secondary	9.52 @ 34.45 kPa (3/8 @ 5.0 psi) 15.88 @ 34.45 kPa (5/8 @ 5.0 psi)		
Fast Idle Setting, RPM		2400		
High Idle Speed, RPM (Throttle Modulator Extended)		1350 ± 50		
Curb Idle Speed, RPM		525-575		
Idle Mixture Setting, % CO		.5 - 2.5%		
Fuel Bowl Vent Adj. Clearance		-----		
Pump Piston Stroke Adjustment		-----		
Governor Upper Orifice, mm (in.)		.71 (.028)		.037
Governor Lower Orifice, mm (in.)		1.09 (.043)		.052
Governor Spring (Color)		Black		Red Stripe
Governor Spring Post Position		#3		#2
Governed Speed, RPM** Full Speed, No Load Full Speed, Full Load		 3800 3600		
*Power Valve	Primary	Stamped 10		

* Power valve indentification number is stamped on a flat on the base of the valve.

** 4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

CARBURETOR SPECIFICATIONS

1975, 1976 California Heavy Duty Engines

Carburetor Model		4150G
Engine Model		V-537
Carburetor: Production Part No. List No.		448315-C91 6974
Throttle Body Bore: mm (in.)	Primary Secondary	36.51 (1-7/16) 36.51 (1-7/16)
Venturi: mm (in.)	Primary Secondary	30.16 (1-3/16) 26.99 (1-1/16)
Main Jet:	Primary Secondary	602 592
Fuel Level: mm (in.)	Primary Secondary	9.52 @ 37.92 kPa (3/8 @ 5.5 psi) 15.88 @ 37.92 kPa (5/8 @ 5.5 psi)
Automatic Choke Setting		----
Automatic Choke Qualification		----
Choke Unloader Setting		----
Dashpot Setting		----
Fast Idle Setting		2000 RPM
High Idle Speed, RPM (Throttle Modulator Extended)		1300 - 1400
*Curb Idle Speed, RPM		500-550
Idle Mixture Setting, % CO		1.0-2.0%
Governor Upper Orifice, mm (in.)		.91 (.036)
Governor Lower Orifice, mm (in.)		1.09 (.043)
Governor Spring (Color)		Brown
Governor Spring Post Position		#3
Governed Speed, RPM: Full Speed, No Load Full Speed, Full Load (On Road)		 3400 3200
**Power Valve	Primary	Stamped 13

* Transmission in Neutral, Air Conditioning OFF.

** Power valve identification number is stamped on a flat on the base of the valve.

CARBURETOR SPECIFICATIONS

1979, 1980 FEDERAL (NOT CALIFORNIA) HEAVY DUTY ENGINES

Carburetor Model	4150 EG		
Engine Model	V-392	MV-404	MV-446
Carburetor: PART NUMBER LIST NUMBER	500176-C91 8737	481873-C91 7921	500180-C91 8740
Throttle Body Bore Primary Secondary	36.51 mm (1.437") 36.51 mm (1.437")		
Venturi Primary Secondary	30.16 mm (1.187") 26.99 mm (1.062")		
Main Jet Primary Secondary	#581 #512	#601 #572	#593 #572
Fuel Level Primary Secondary	9.52 mm @ 34.45 kPa (.375" @ 5 PSI) 15.88 mm @ 34.45 kPa (.625" @ 5 PSI)		
Fast Idle Setting	.38-.51 mm (.015-.020")*	2400 RPM	2400 RPM
High Idle Speed (Throttle Modulator Extended)	1400 ± 50 RPM	1350 ± 50 RPM	1300 ± 50 RPM
Curb Idle Speed	625 - 675 RPM+	525 - 575 RPM	525 - 575 RPM
Idle Mixture Setting, % CO	0.5 - 1.5%	0.5 - 2.5%	0.5 - 2.5%
Governor Upper Orifice	0.94 mm (.037")		
Governor Lower Orifice	1.32 mm (.052")		
Governor Spring (Color)	PLAIN	PLAIN	RED STRIPE
Governor Spring Post Position	#2		
Governed Speed, RPM*** Full Speed - No Load Full Speed - Full Load	3800 RPM 3600 RPM		
Power Valve - Primary ** Secondary	STAMPED 13 STAMPED 25	STAMPED 10	STAMPED 10

* Clearance between stop screw and fast idle cam with choke open and curb idle speed set correctly.

** Power valve identification number is stamped on a flat on the base of the valve.

*** 4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

+Transmission in Neutral, Air Conditioning OFF.

CARBURETOR SPECIFICATIONS
1979, 1980, 1981 CALIFORNIA HEAVY DUTY ENGINES

Carburetor Model	4150 EG				
Engine Model	V-392		MV-404	MV-446	
Carburetor: Part Number / List Number	1701024-C91 9560	487859-C92 8243-1	487862-C91 8246	487863-C91 8247	1700426-C91 9077
Throttle Body Bore: Primary / Secondary	36.51mm (1.437") 36.51mm (1.437")				
Venturi: Primary / Secondary	30.16mm (1.187") 26.99mm (1.062")				
Main Jet Primary / Secondary	622 552	#581 #512	#601 #572	#593 #572	#632 #572
Fuel Level: Primary / Secondary	9.52mm @ 34.45 kPa (.375" @ 5 PSI) 15.88mm @ 34.45 kPa (.625" @ 5 PSI)				
Fast Idle Setting	.38-.51mm*** (.015-.020") 2400 RPM				
High Idle Speed, RPM (Throttle Modulator Extended)	1450 ± 50	1400 ± 50	1350 ± 50	1300 ± 50	1400 ± 50
Curb Idle Speed, RPM	625 - 675		525 - 575		
Idle Mixture Setting, % CO	1.5 - 3.0%	0.5 - 1.5%	.5 - 2.5%	.5 - 2.5%	1.0-2.5%
Governor Upper Orifice	0.94mm (.037")				
Governor Lower Orifice	1.32mm (.052")				
Governor Spring (Color)	PLAIN			RED STRIPE	
Governor Spring Post Position	#2				
Governed Speed, RPM** Full Speed, No Load / Full Speed, Full Load	3800 RPM 3600 RPM				
*Power Valve Primary / Secondary	Stamped 2	Stamped 11 Stamped 25	Stamped 10	Stamped 10	None

*Power valve identification number is stamped on a flat on the base of the valve.

**4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

***Clearance between stop screw and fast idle cam with choke open and curb idle speed set correctly.

CARBURETOR SPECIFICATIONS

1979, 1980 Canadian Heavy Duty Engines

Carburetor Model		4150EG	4150EG	4150EG	4150EG
Engine Model		V-392	MV-404	MV-446	V-537
Carburetor:	Part Number List Number	487849-C92 8233-1	1700161-C91 8922	1700162-C91 8923	1700163-C91 8924
Throttle Body Bore:	Primary Secondary	36.51 mm (1-7/16") 36.51 mm (1-7/16")			
Venturi:	Primary Secondary	30.16 mm (1-3/16") 26.99 mm (1-1/16")			
Main Jet:	Primary Secondary	#581 #562	#572 #572	#572 #572	#573 #542
Fuel Level:	Primary Secondary	9.53 mm @ 34.47 kPa (3/8" @ 5 psi) 15.90 mm @ 34.47 kPa (5/8" @ 5 psi)			
Fast Idle Setting, RPM		2000	2400	2400	2000
High Idle Speed, RPM (Throttle Modulator Extended)		N/A	1350 ± 50	1300 ± 50	1350 ± 50
Curb Idle Speed, RPM - *		650-700	525-575	525-575	500-550
Idle Mixture Setting, % CO		2.0 Max.	0.5-2.5	0.5-2.5	1.5 - 3.0
Governor Upper Orifice		0.94 mm (.37")	0.94 mm (.037")	0.94 mm (.037")	0.94 mm (o.37")
Governor Lower Orifice		1.32 mm (.052")	1.32 mm (.052")	1.32 mm (.052")	1.39 mm (.055")
Governor Spring (Color)		Plain	Plain	Plain	Red Stripe
Governor Spring Post Position		#2	#2	#2	#2
Governed Speed, RPM*** Full Speed, No Load Full Speed, Full Load		 3800 3600	 3800 3600	 3800 3600	 3400 3200
**Power Valve:	Primary Secondary	Stamped 5 Stamped 25	Stamped 13	Stamped 11	Stamped 9

* Transmission in Neutral, Air Conditioning OFF.

** Power valve identification number is stamped on a flat on the base of the valve.

*** 4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

N/A - Not Available

ENGINE
1980
EMISSION CONTROL SYSTEMS
FOR
HEAVY DUTY EMISSION
GASOLINE ENGINES

This Service Manual contains 1980 Emission Control Systems used on International gasoline engines. Part I includes exhaust emission effects and maintenance interval charts along with complete tune-up specifications. Part II is a troubleshooting guide with reference (IH Engine Division Service Manual and IH Truck Service Manual) CGES numbers and CTS numbers for individual engine accessory servicing.

The illustrations and specifications in this service manual are based on the latest information available at the time of publication approval.

CONTENTS
PART I

CONTENTS (Continued)

PART II

PART I

EMISSION CONTROL SYSTEMS

AND

SERVICE OPERATIONS

In compliance with various government air polution regulations, the IH engine is equipped with emission control systems that effectively reduce the flow of exhaust gas contaminants below permissible limits.

To function effectively, these emission control systems must be properly maintained and it is important that maintenance operations be performed at specified intervals as indicated under Required Maintenance Operations.

Service intervals given are based upon average operating conditions. Where dusty, frequent start and stop or heavily laden operations are encountered, more frequent servicing will be required.

The engine (vehicle) owner is responsible for performance of all scheduled Required Maintenance Operations and any other non-scheduled maintenance needed, to ensure proper operation of the exhaust emission control system(s).

Required maintenance operations should be performed by an International Harvester dealer, or other service outlet equipped and qualified to perform such services. Any replacement parts used for required maintenance services or repairs of emission control systems should be equivalent in quality and performance to genuine IH parts. Use of inferior replacement parts may result in improper operation of emission control systems.

As shown on the exhaust emission effects chart, engines sold for use in the U.S.A. (49 States and California) are equipped with emission controls that are not the same as those used on engines sold for use in Canada. This is because of the different air polution standards in effect.

The following chart shows the exhaust emission effects for 1980 International Gasoline engines:

EXHAUST EMISSION EFFECTS

Vehicle Model	Engine	Carb-uretor	Electronic Ignition	Decel Throttle Modulator	Elect. Choke	In-tegral Choke	Remote Choke	Evap. Canister	Air Pump	Exhaust Gas Re-circulation	Ported Spark	Modulated Air Cleaner
USA EXCEPT CALIFORNIA	V-345	2300EG	Optional	Yes	No	No	Manual	No	One	Yes	No	Modulated
	V-345	2210C	Optional	Yes	No	No	Yes	No	One	Yes	Yes	Modulated
	V-392	4150EG	Optional	Yes	No	No	Manual	No	One	Yes	*No	Modulated
CARGOSTAR	MV-404	2210C	Yes	Yes	No	No	Yes	No	One	Yes	Yes	Modulated
	MV-404	2300EG	Yes	Yes	No	No	Manual	No	One	Yes	Yes	Modulated
AND	MV-404	4150EG	Yes	Yes	No	No	Manual	No	One	Yes	Yes	Modulated
	MV-446	4150EG	Yes	Yes	No	No	Manual	No	One	Yes	No	Modulated
S-SERIES	V-537	2300EG	Yes	Yes	No	No	Manual	No	One	Yes	No	Modulated Dry
CALIFORNIA	V-345	2300EG	Yes	Yes	No	No	Manual	Yes	Two	No	No	Modulated Dry
CARGOSTAR &	MV-404	2300EG	Yes	Yes	No	No	Manual	Yes	Two	No	Yes	Modulated Dry
S-SERIES	MV-446	4150EG	Yes	Yes	No	No	Manual	Yes	Two	No	No	Modulated Dry
CANADA	4-196	1940	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Modulated Dry
SCOUT	V-304	2210C	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Modulated Dry
	V-345	2210C	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Modulated Dry
	V-345	2300EG	Optional	Yes	No	No	Manual	No	No	Yes	Yes	Modulated
	V-345	2210C	Optional	Yes	No	No	Yes	No	No	Yes	Yes	Modulated
	V-392	4150G	Optional	No	No	No	Manual	No	No	No	Yes	Modulated
CARGOSTAR	MV-404	2210C	Yes	Yes	No	No	Yes	No	No	No	No	Modulated
AND	MV-404	2300EG	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
S-SERIES	MV-404	4150G	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
	MV-446	4150G	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
	V-537	2300EG	Yes	Yes	No	No	Manual	No	No	No	No	Modulated Dry
	V-537	4150G	Yes	Yes	No	No	Manual	No	No	No	No	Modulated Dry

*Spark Vacuum Common with EGR Signal Vacuum.

REQUIRED MAINTENANCE OPERATIONS

Each numbered maintenance step under Required Maintenance Operations on the Chart is completely explained under the corresponding number in the following text.

MAINTENANCE INTERVALS

REQUIRED MAINTENANCE OPERATIONS	(Mileage, Months or Operation Hours, Whichever Occurs First)														
KM	6400	12800	19200	25600	32000	38400	44800	51200	57600	64000	70400	76800	83200	89600	96000
Miles	4000	8000	12000	16000	20000	24000	28000	32000	36000	40000	44000	48000	52000	56000	60000
Mos.	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
Hours	125	250	375	500	625	750	875	1000	1125	1250	1375	1500	1625	1750	1875
1. Change Engine Oil and Oil Filter.	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
2. Check and clean Dist. Cap & Rotor or replace, if necessary. Replace Breaker Points & Condenser, where used.			I			I			I			I			I
3. Check Ignition Cables & Measure Resistance and Replace if necessary.			I			I			I			I			I
4. Replace all Spark Plugs, Check Required Voltage, Replace any Defective Plugs.			R			R			R			R			R
5. Replace Fuel Filter.			R			R			R			R			R
6. Clean or Replace Air Cleaner Filter.			I			I			I			I			I
7. Replace Filter at Bottom of Evaporative Vapor Storage Canister (where used).			R			R			R			R			R
8. Check Engine Bolt Torque and Tighten if necessary.			I			I			I			I			I
9. Check Exhaust Gas Control Valve for Free Operation & Service or Replace if necessary (where used).			I			I			I			I			I
10. Check Coil Output Voltage & Replace Coil if necessary.			I			I			I			I			I
11. Check Initial Advance and Adjust if necessary.			I			I			I			I			I
12. Check Operation of Inlet Air System Valve and Service or Replace if necessary.			I			I			I			I			I
13. Check PCV System Hoses & Replace if necessary; Clean PCV Valve if necessary.			I			I			I			I			I
14.*Remove and Check EGR Valve and Clean or Replace if necessary. V-345/392 only.			I			I			I			I			I
15.*Check EGR System with Functional Test & Clean or Replace if necessary. V-345/392 only.			I			I			I			I			I
16. Check Curb Idle Speed and Air/Fuel Mixture and Adjust as necessary.			I			I			I			I			I

R = Replace **I = Inspect, Correct, Replace if necessary**

*** Not Used In California**

1. Change Engine Oil and Filter

a. Remove oil drain plug from bottom of oil pan and drain oil.

b. Service oil filter.

Procedure for servicing the spin-on type oil filter is as follows:

(1) Remove oil filter assembly by turning counterclockwise with the hands or a suitable tool. Clean filter mounting pad.

(2) Coat the gasket on the new filter with a film of grease.

(3) Place the new filter in position on the center tube. Hand tighten 1/2 to 3/4 of a turn after gasket first contacts base of mounting pad.

c. Add sufficient oil to bring the oil level between "ADD" and "FULL" marks on oil dipstick (Fig. 2).

d. Start engine and run for at least five minutes to warm oil and check for leaks. Recheck and add sufficient oil to bring oil level between "ADD" and "FULL" marks on the oil dipstick.

Oil types and grades recommend for IH engines are as follows:

GASOLINE ENGINES

Temperature	Straight Viscosity Grade	Multi-Viscosity Grade
20 to 120F (-7 to 49C)	SAE 30	SAE 10W-30, 10W-40, 20W-40, 20W-30
0 to 90 F (-18 to 32C)	SAE 20W	SAE 10W-30, 10W-40, 20W-40, 20W-30
-10 to 70F (-23 to 21C)	SAE 10W	SAE 10W-30, 10W-40
Below -10F (23C)	-------	SAE 5W-10, 5W-30

Use engine oils meeting service classification "SE" or "CC" (MIL-L-46152).

IMPORTANT

When a universal engine oil (SE-CD) is preferred, the engine oil must have passed the Volvo B-20 cam and tappet test and contain a minimum 0.1% alkyl zinc. IH No. 1 engine oil meets this requirement.

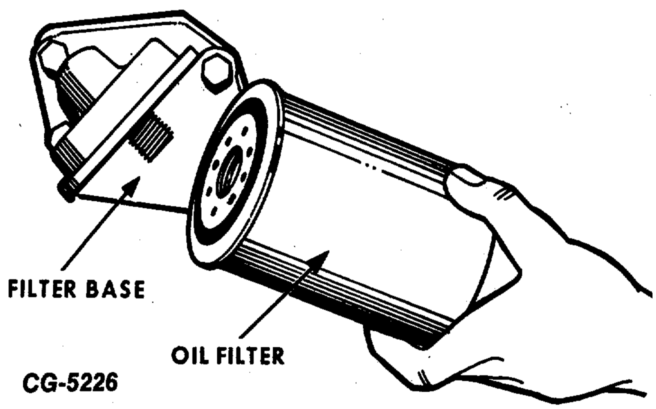


Fig. 1 Typical Spin-On Type Oil Filter

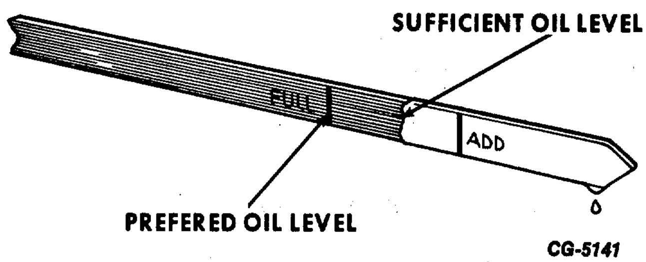


Fig. 2 Proper Oil Level

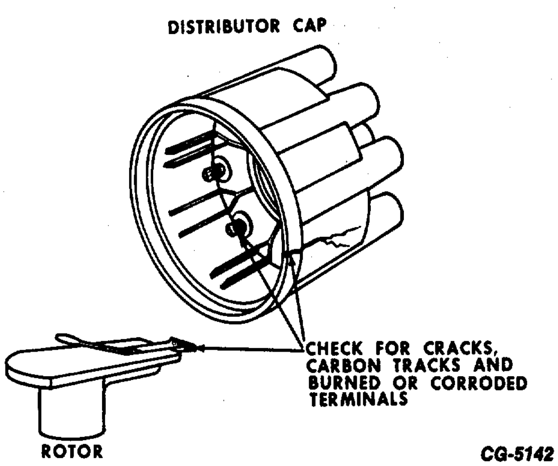


Fig. 3 Inspect Distributor Cap and Rotor

2. Check and Clean Distributor Cap and Rotor or Replace, If necessary. Replace Breaker Points and Condenser, where used.

a. Remove distributor cap and rotor.

b. Clean and inspect distributor cap and rotor for cracks, carbon tracks and burned or corroded terminals.

c. Replace breaker points, where used. See Tune-Up Specifications for gap or dwell. Lubricate Distributor cam.

d. Replace rotor, if defective, and install in distributor.

e. Replace cap, if defective, and connect high tension cables to cap.

3. Check Ignition Cable and Measure Resistance and Replace, if necessary.

a. Remove high tension cables from spark plugs.

b. Using Engine Performance Tester No. SE-2576 or equivalent, measure resistance of each cable by connecting ohmmeter leads to spark plug end of cable and terminal inside distributor cap.

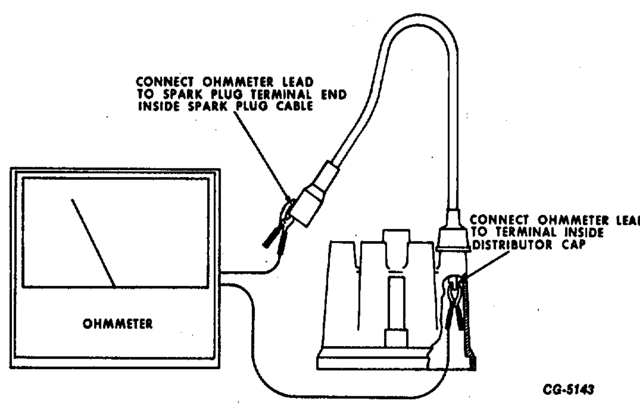


Fig. 4 Checking Ignition Cables With Ohmmeter

c. If resistance exceeds specifications (see Emission Control System Tune-Up Specifications), replace high tension cable(s).

d. Reinstall cap onto distributor.

e. Inspect high tension ignition cables for cracks or deterioration and replace defective cables.

4. Replace all Spark Plugs, Check Required Voltage and Replace any Defective Plugs.

a. Remove used spark plugs.

b. Check gap of new spark plugs (see Emission Control System Tune-Up Specifications) and adjust gap, if necessary.

Continuous light load operation may produce spark plug fouling, necessitating more frequent spark plug changes than are indicated in the Maintenance Intervals. A change in plug heat range will not correct fouling under these conditions.

To change spark plug gap, bend the outer electrode; never bend the center electrode. Be accurate use a round wire gauge to check the electrode gap. Check the gap of new spark plugs before installation and tighten to specified torque.

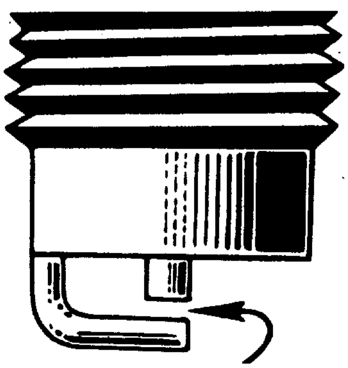


Fig. 5

IH Branches and Dealers are equipped with spark plug cleaning and testing equipment which renders dependable service.

c. Install new spark plugs and torque to specifications (see Emission Control System Tune-Up Specifications.

d. Install high tension spark plug cables onto spark plug terminal.

IMPORTANT

When replacing high tension spark plug cables, be sure cables are routed to proper spark plugs (refer to firing order cast into intake manifold).

e. Connect Tune-Up Scope Tester No. SE-2440, or equivalent.

f. Start and operate engine until normal operating temperatures are reached. Then operate engine at 1000 RPM.

g. Observe required voltage (see Emission Control System Tune-Up Specifications).

h. If required voltage is out of specifications on any cylinder, replace spark plug and repeat Steps a through g.

5. Replace Fuel Filter.

Inline fuel filters are used on most IH engines (Fig. 6). This type of filter is inexpensive and easy to replace when needed.

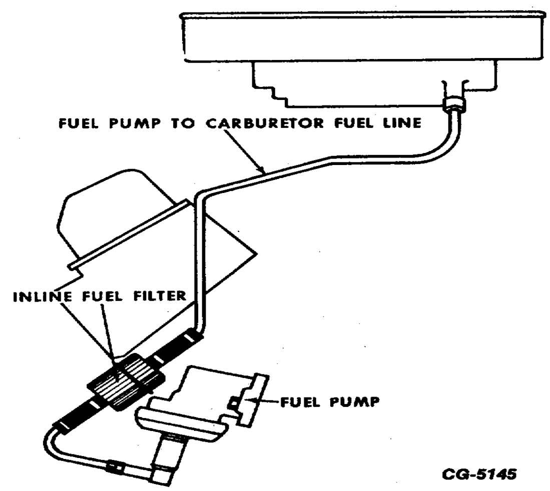


Fig. 6 Inline Fuel Filter Typical on Most Gasoline Engines

6. Clean or Replace Air Cleaner Filter.

a. Dry Type - Remove air cleaner element, clean any accumulation of dirt from air cleaner housing. Tap element lightly on a flat surface or use low air pressure to remove dirt particles. Blow air from inside filter element to outside. Check element for punctures or splits by looking through filter paper toward light held in center of element. Do not wash element. Replace with new element, if necessary.

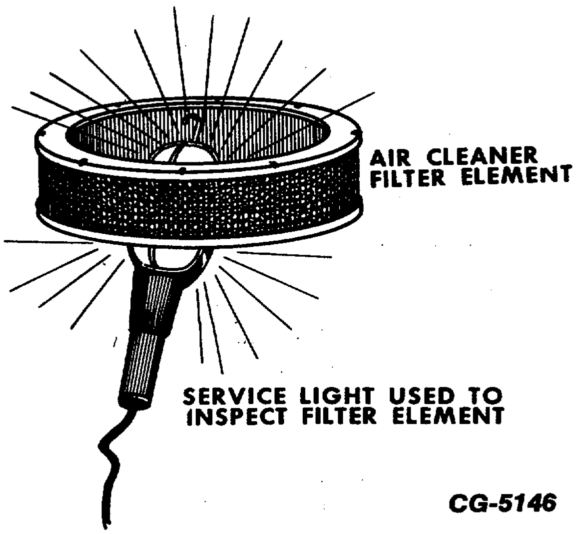


Fig. 7 Dry Type Air Cleaner Filter

b. Foam Wrap Dry Type Remove air cleaner element assembly, clean any accumulation of dirt from air cleaner housing. Remove foam wrap from element, and tap element lightly on a flat surface or use low air pressure to remove dirt particles. Blow air from inside filter element to outside. Check element for punctures or splits by looking through filter paper toward light held in center of element. Do not wash element. Replace with new element, if necessary. Wash foam wrap in soap and water and dry with compressed air. Submerge foam wrap in light engine oil and squeeze excess oil from wrap. Replace damaged wrap, if necessary. Install foam wrap on element and reassemble air cleaner.

c. Oil Bath Type - Remove air cleaner from engine. Remove oil sump and drain oil. Wash sump and mesh filter element in solvent and dry with compressed air. Refill sump and oil mesh element with engine oil of same viscosity used in the engine. Allow excess oil to drip from element before reassembly. Reinstall air cleaner.

7. Replace Filter at Bottom of Evaporative Vapor Storage Canister (where used).

The air filter located at the bottom of the vapor storage canister (Fig. 8) should be replaced at the interval shown on the Maintenance Intervals Chart, or more frequently under severe dusty conditions.

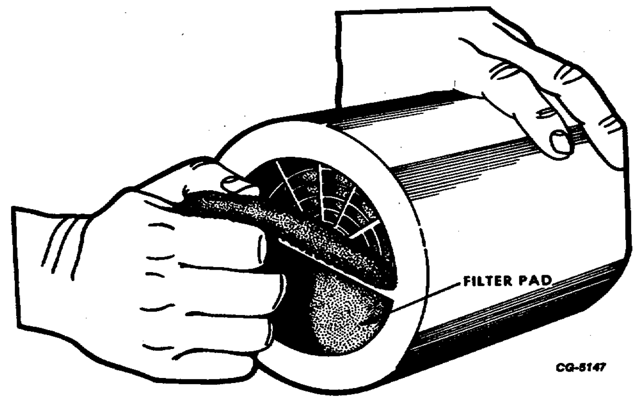


Fig. 8 Vapor Storage Canister Air Filter Location

7A. Gasoline Evaporative Loss Control System

In compliance with California air pollution control regulations, all IH gasoline powered vehicles sold in California will utilize gasoline evaporative loss control system which reduces the amount of gasoline vapors entering the atmosphere from the vehicle's fuel system. Below is a schematic view of a typical gasoline evaporative loss control system.

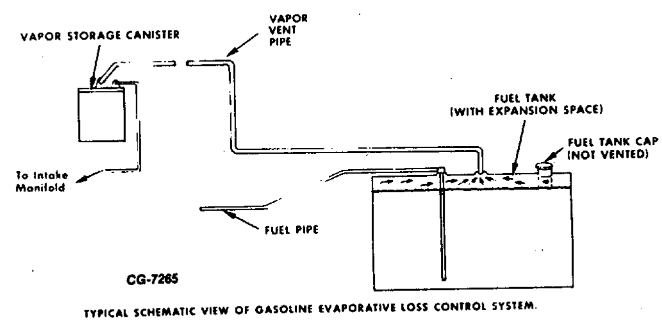


Fig. 9 Typical Schematic View of Fuel Tank Gasoline Evaporative Loss Control System

To accomplish evaporative control the system must perform three basic functions:

1. Provide space for gasoline expansion due to temperature rise.

2. Limit escape of gasoline vapors to the atmosphere by collecting and storing vapors generated while vehicle is parked with engine shut off.

3. Burn off stored gasoline vapors when engine is operating.

Vapor Storage Canister

When vehicle is parked and engine shut off, gasoline vapors from the carburetor fuel bowl and the fuel tank will be temporarily stored in the charcoal canister-until the engine is started. When the engine is started the vapors are drawn from the canister into the engine and burned.

When a vehicle is parked continuously for more than one day, the odor of fuel vapors may be noticed. This is caused by fuel vapors passing out of the canister(s) due to oversaturation of the charcoal. Operating the engine a few minutes will purge the canister(s) of fuel vapors and restore its holding capacity.

Two types of vapor storage canister systems are used in 1980 California vehicles.

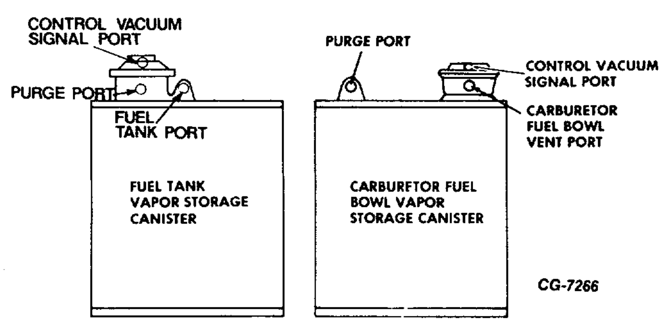


Fig. 10 Vapor Storage Canisters Used on MediumHeavy Duty Vehicles With Single Tank of 35 Gallon Capacity and Less

1. Two vapor storage canisters are used on medium-heavy duty vehicles with single fuel tanks of 35 gallon capacity or less. One canister is used for storing fuel tank vapors only. The other canister is used for carburetor fuel bowl vapors only. This vapor storage canister and its operation is shown in Fig. 12.

2. Three vapor storage canisters are used on medium-heavy duty vehicles with single fuel tank greater than 35 gallon capacity and all multi-tank vehicles. As shown in Figure 10, the fuel tank vapor storage canisters consist of one canister with a vacuum controlled purge valve and one two-port canister which is connected to the bottom of the vacuum controlled purge canister. The two-port canister adds vapor storage capacity for large fuel tank(s) systems.

   The operation of the vacuum controlled purge canister is shown in Figure 13.

   The function of the third vapor storage canister (shown in Fig. 11) is to store carburetor fuel bowl vapors only. The operation of this canister is shown in Fig. 12.

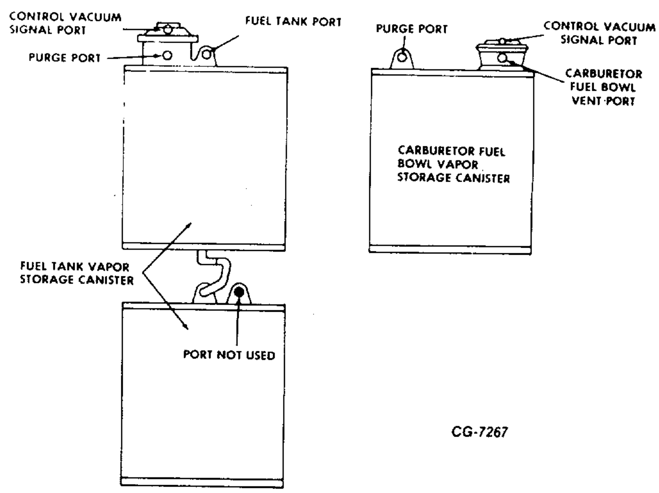


Fig. 11 Vapor Storage Canisters Used on Medium-Heavy Duty Vehicles With Single Fuel Tank Greater Than 35 Gallon Capacity and All Multi-Tank Installations

Canister Operation Test

Disconnect control vacuum and purge hoses from canister(s). With engine running at high idle speed and normal operating temperature, a vacuum pull should be felt at each hose end. If no vacuum is felt, reconnect hoses to the proper port on the canister(s) and disconnect at vacuum source on engine. Inspect for obstruction in hoses and hose connecting fittings. Also inspect hoses for cracks, damage or deterioration and replace if necessary.

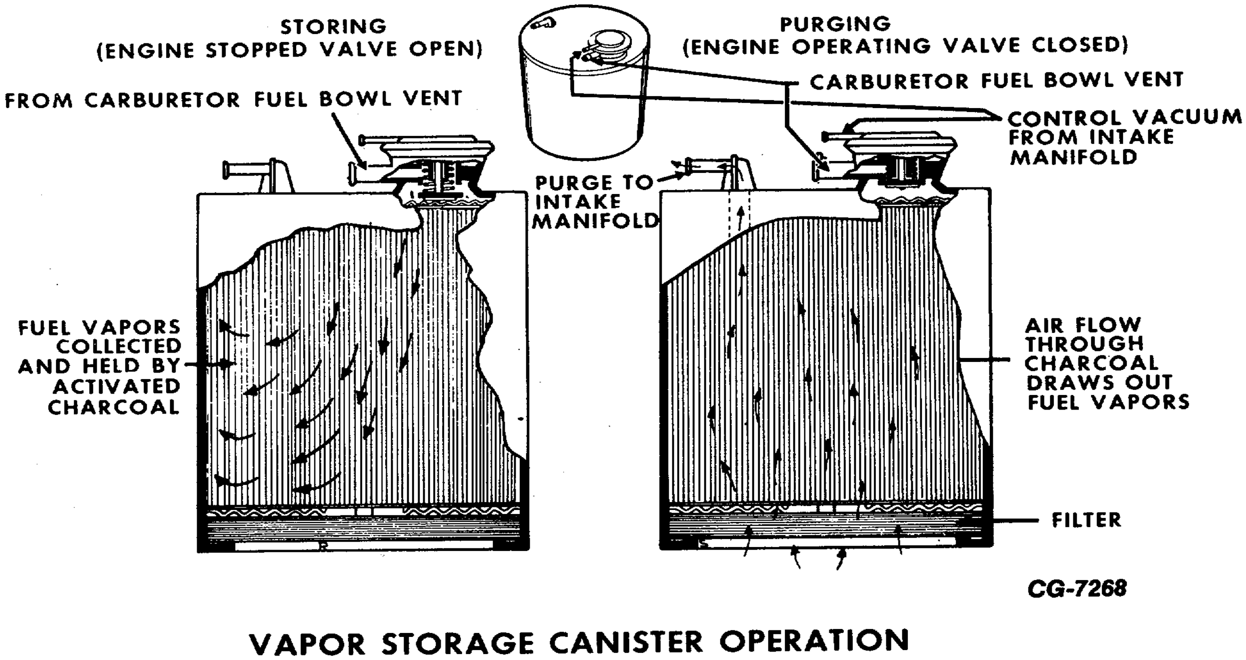


Fig. 12 Vapor Storage Canister With Vacuum Controlled Carburetor Fuel Bowl Vent Valve

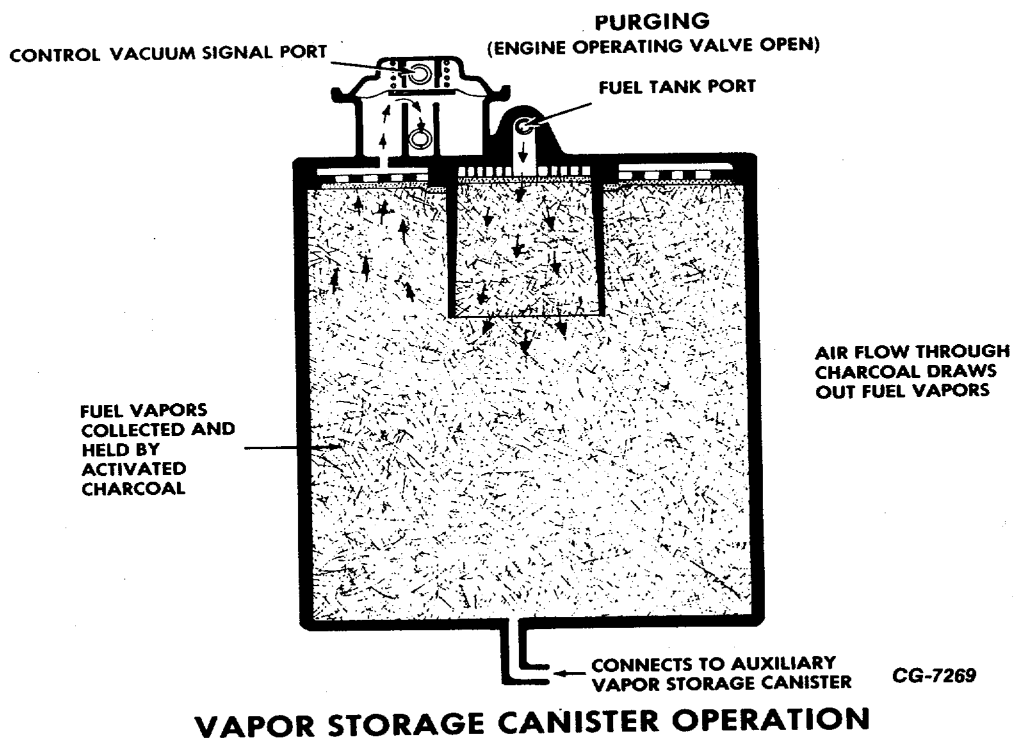


Fig. 13 Vapor Storage Canister With Vacuum Controlled Purge Valve

It is important that canister hoses be connected to the proper manifold fitting.

Canister Control Valve Test

Before starting the following test with hand operated vacuum pump (SE-2499), check pump for leakage (Fig. 14) by placing a finger over the vacuum port and pump until full or near full scale is reached. Watch pump gauge. If vacuum drops rapidly, pump is leaking and should not be used for test. If a very slow leak is indicated, the pump may be used if the degree of pump leakage is kept in mind.

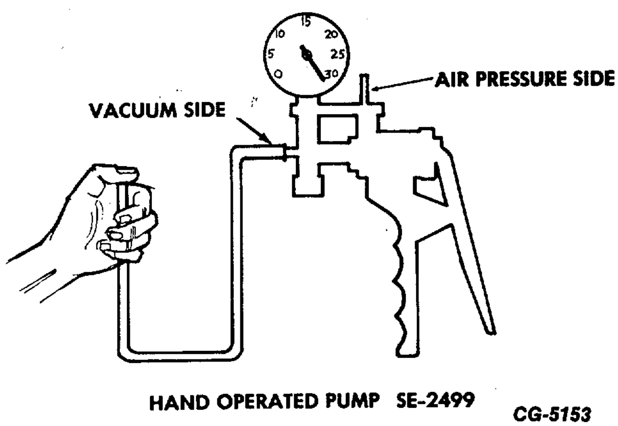


Fig. 14 Check Hand Operated Vacuum Pump SE-2499 for Leakage

1. Test canister fuel bowl vent control valve diaphragm by applying vacuum to the control valve port (smaller top port valve assembly) with hand operated vacuum pump (SE-2499). Observe vacuum pump gauge (Fig. 15). If vacuum drops rapidly the control valve diaphragm is leaking and the canister must be replaced.

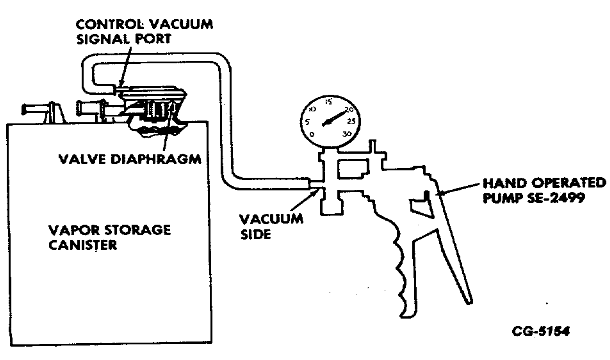


Fig. 15 Canister Fuel Bowl Vent Control Valve Diaphragm Test

2. The valve seat portion of the fuel bowl vent control valve can be tested by applying vacuum to the control valve (same as diaphragm test Fig. 15) and at the same time (with another hand operated pump SE-2499 using air pressure side of pump) apply air pressure to the valve (Fig. 16) until pressure buildup is felt. If pressure buildup is not felt the valve seat is leaking and the canister must be replaced.

3. Test purge control valve diaphragm and valve seat by applying vacuum with hand operated vacuum pump (SE1499) simultaneously to both vacuum signal port and purge port (see Fig. 17). If vacuum of either pump drops rapidly the valve is faulty and the canister must be replaced.

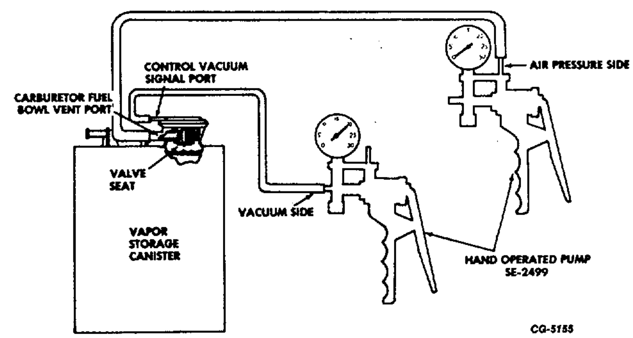


Fig. 16 Canister Fuel Bowl Vent Control Valve Seat Test

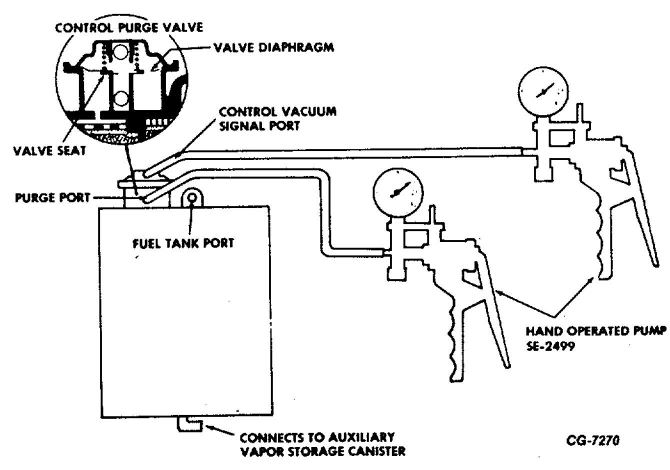


Fig. 17 Canister Purge Control Valve Diaphragm and Valve Seat Test

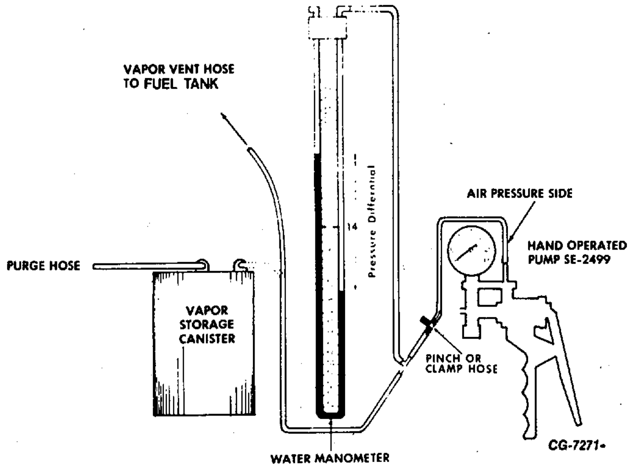


Fig. 18 Method of Pressurizing Vapor Vent System to Check for Leakage

Pressure test fuel tank vapor vent system by disconnecting the hose on canister leading to fuel tank and connect water manometer (SE-2217 or equivalent) and the air pressure side of hand operated vacuum pump (SE-2499) as shown in Figure 18.

Place sufficient water in manometer to allow 356mm (14") differential in height. Pump the hand operated air pump until a pressure of 356mm (14") of water is applied to the system (indicated on the manometer). Pinch or clamp hose between tee and air pump to keep system pressurized. Observe manometer. If pressure drops more than 51mm (2") of water in five (5) minutes, an excessive leak is indicated.

On a warm day it is possible to observe a pressure rise due to evaporation of fuel. This indicates that system is tight.

If excessive leakage is indicated, first check fuel tank cap for a loose fit on tank filler neck or a damaged cap gasket. If either of these conditions are found, replace cap. If cap-to-filler neck fit and cap gasket are satisfactory, cover relief valve opening in cap (small hole in portion of cap which enters filler neck) securely with tape. Reinstall cap and again pressurize system and check for leakage. If excessive leakage persists, check all connections in fuel supply and vapor vent system with soap suds solution to locate leaks. Inspect for cracked or damaged fuel supply or vapor vent tubes or connecting hoses. If no leaks are found and system holds pressure with valve opening uncovered, it can be assumed that relief valve in cap is faulty. Replace cap.

When pressure testing system following installation of a new fuel tank, it will be necessary to disconnect and plug fuel system line at fuel pump to prevent air leakage through fuel pump and carburetor.

Air Cleaner Charcoal Rings

When engine is shut-off, gasoline vapors released through the carburetor throats are temporarily trapped in charcoal rings located in the bottom of the air cleaner. When the engine is started the vapors are drawn from the charcoal rings into the engine and burned. Damaged charcoal rings should be replaced and installed with a silicone type adhesive.

Fuel Tank Cap

Fuel tank caps are nonvented to prevent passing of gasoline vapors directly into the atmosphere.

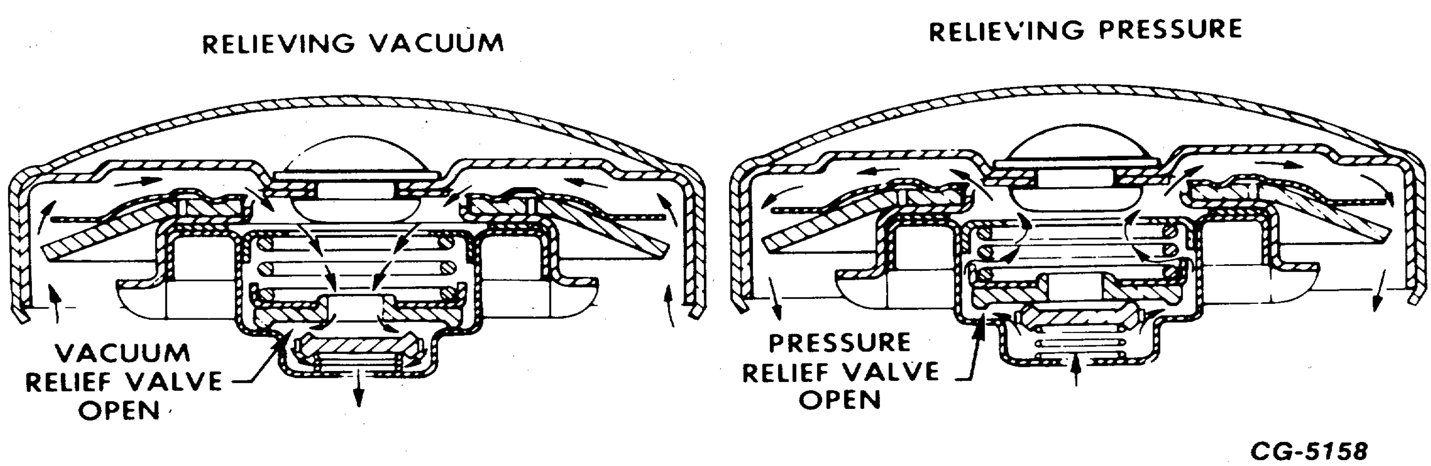


Fig. 19 Fuel Tank Cap Relief Valve Operation

Some caps incorporate a vacuum relief valve set to open at approximately 178 to 356mm of water (7" to 14" H20) and a pressure relief valve set to open at approximately 508 to 1524mm of water (20" to 60" H20).

The vacuum valve provides an air intake opening to the fuel tank. As fuel is consumed or contracts due to cooling, causing low pressure (vacuum) in fuel tank, atmospheric pressure opens the vacuum relief valve, permitting air to enter the fuel tank. The pressure relief valve acts as a pressure release in case the vapor vent system becomes plugged. Operation of fuel tank cap vacuum relief valve and pressure relief valves is illustrated in Fig. 19.

Fig. 20 illustrates a typical nonvented fuel tank cap for vehicles with large side mounted fuel tanks.

Fuel Tank Cap Relief Valve Test

A quick check of the vacuum and pressure relief valves in the fuel tank cap may be made as follows:

Check vacuum relief valve by applying high suction to hole in relief valve housing (portion of cap which enters filler neck). If vacuum relief valve fails to open (no air flow through valve), cap should be replaced.

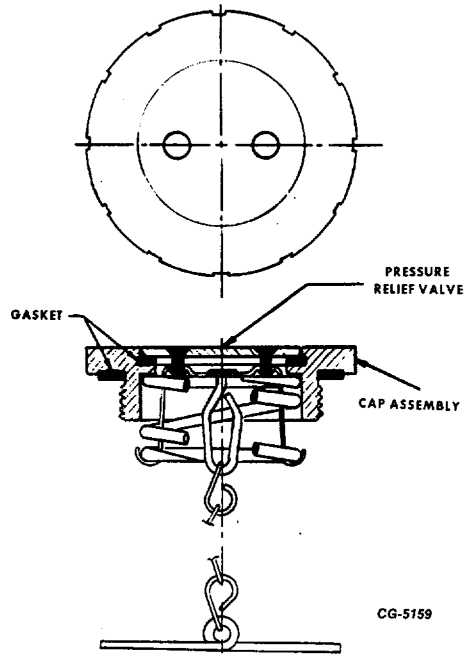


Fig. 20 Fuel Tank Cap (Nonvented Type)

To check pressure relief valve, force air lightly into hole in relief valve housing. An immediate leak (air flow) or failure to release (no air flow) indicates that pressure relief valve is faulty and that the cap should be replaced.

Fuel Tanks

Fuel tanks are designed to provide space to permit expansion of gasoline without overflowing. The tanks incorporate vapor vent outlets which permit passage of gasoline vapors from the tank. Some fuel tanks have multiple vapor vent outlets located such ahat under any sloping attitude of the vehicle at least one of the vent outlets will be above the level of the gasoline in the tank.

Evaporative loss control systems vary between vehicle models, types of fuel tanks and fuel tank installations. Systems used on various vehicle models are illustrated in Figs. 21 thru 38.

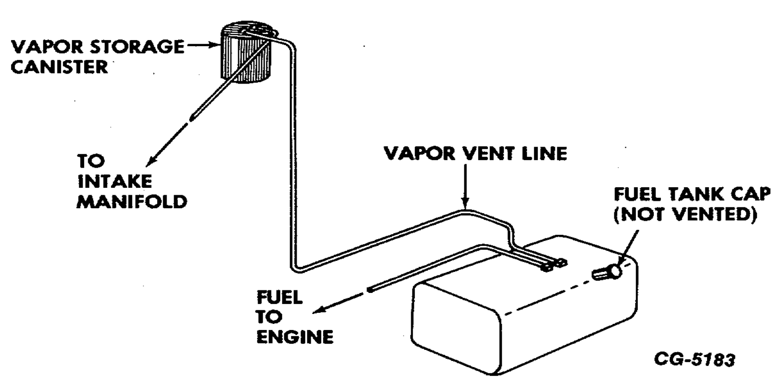


Fig. 21 CO-1610B and COF-1810B Cargostar Vehicles With 30 Gallon Left Fuel Tank

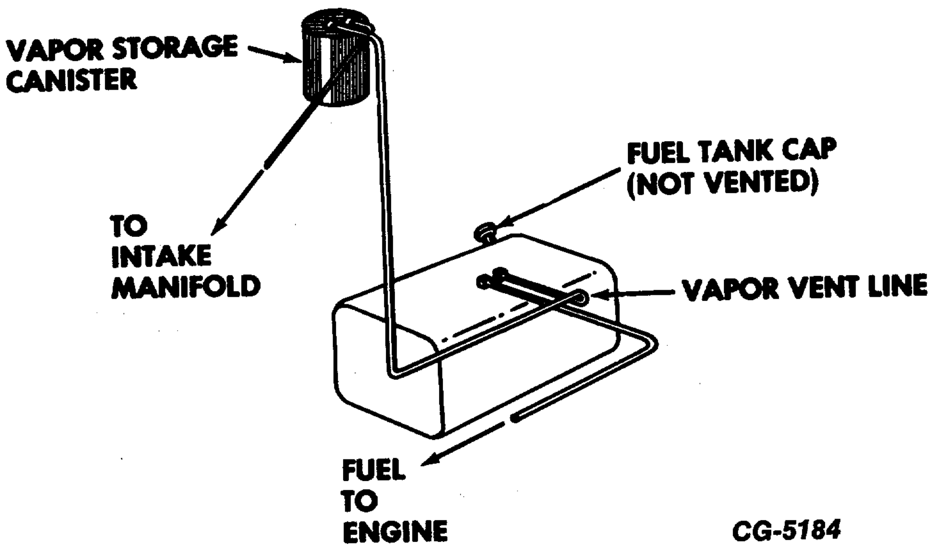


Fig. 22 CO-1610B and COF-1810B Cargostar Vehicles With 30 Gallon Right Fuel Tank

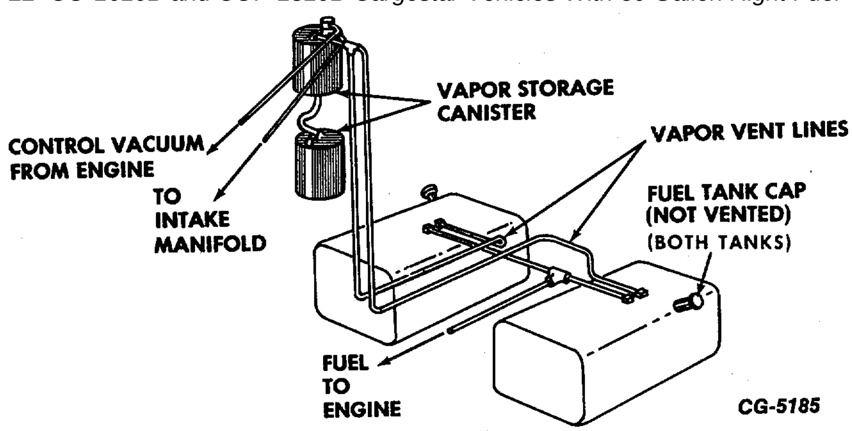


Fig. 23 CO-1610B and COF-1810B Cargostar Vehicles With 30 Gallon Dual Fuel Tanks

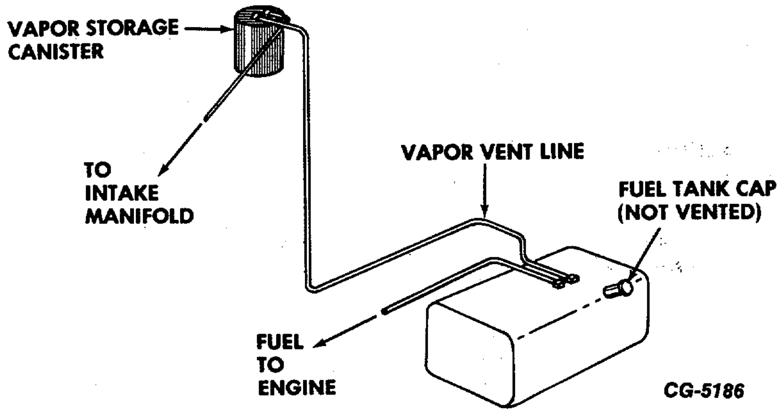


Fig. 24 CO-1610B and COF-1910B Cargostar Vehicles With 33 Gallon Left Fuel Tank

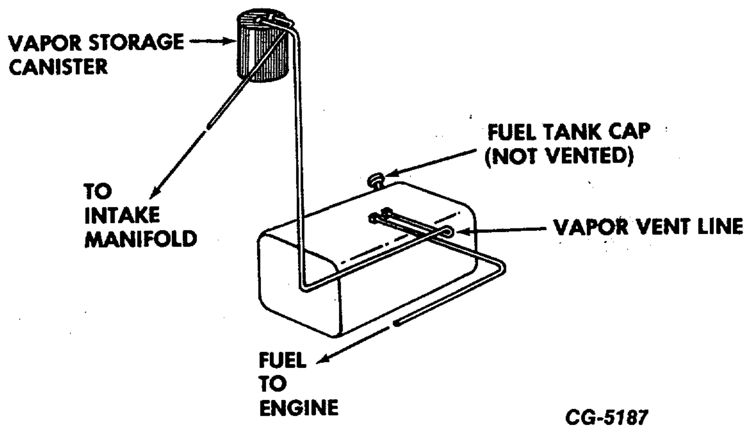


Fig. 25 CO-1610B and COF-1910B Cargostar Vehicles With 33 Gallon Right Fuel Tank

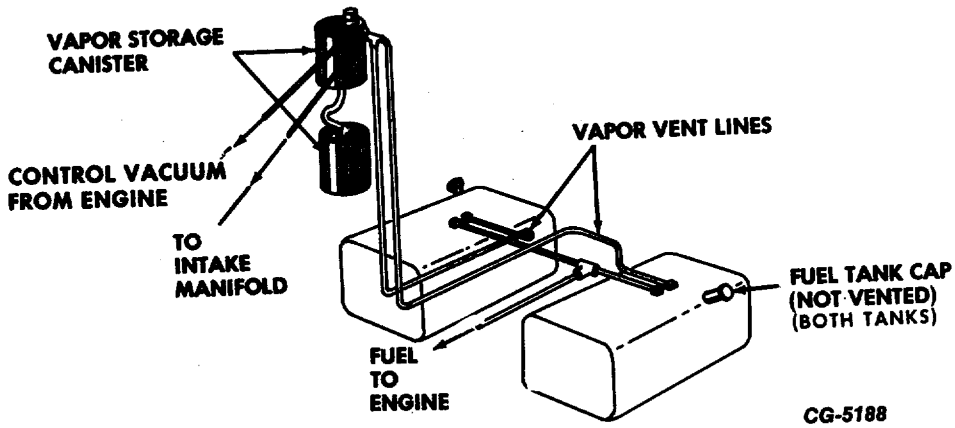


Fig. 26 CO-1610B and COF-1910 Cargostar Vehicles With 33 Gallon Dual Fuel Tanks

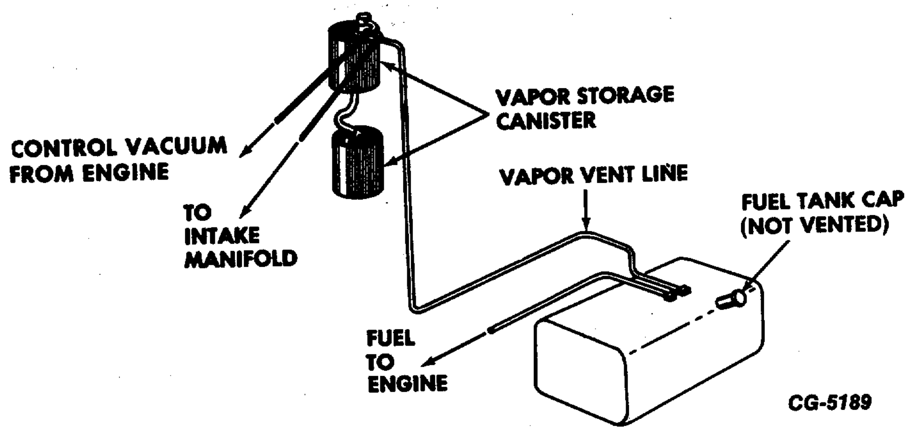


Fig. 27 CO-1610B and COF-1910B Cargostar Vehicles With 50 Gallon Left Fuel Tank

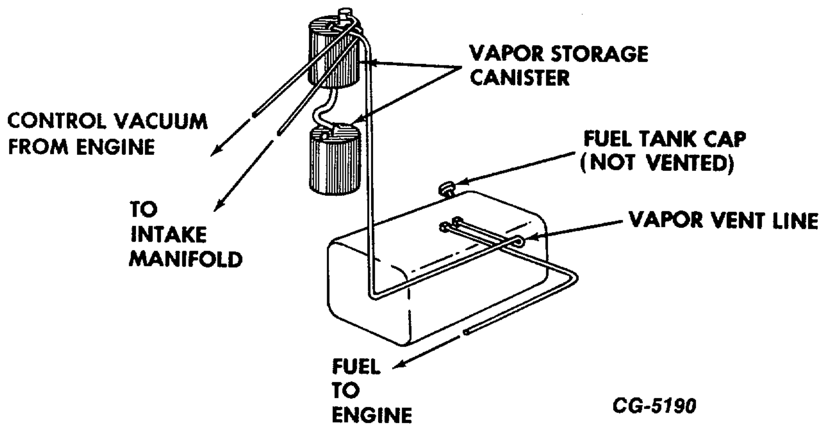


Fig. 28 CO-1610B and COF-1910OB Cargostar Vehicles With 50 Gallon Right Fuel Tank

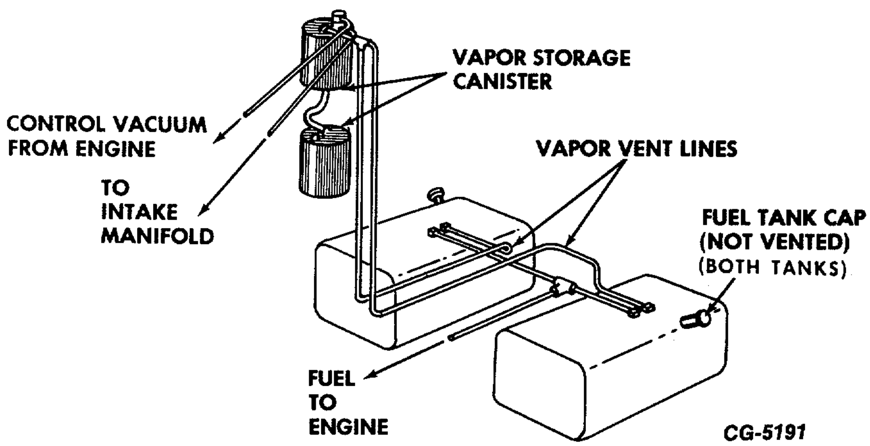


Fig. 29 CO-1610B and COF-1910B Cargostar Vehicles With 50 Gallon Dual Fuel Tanks

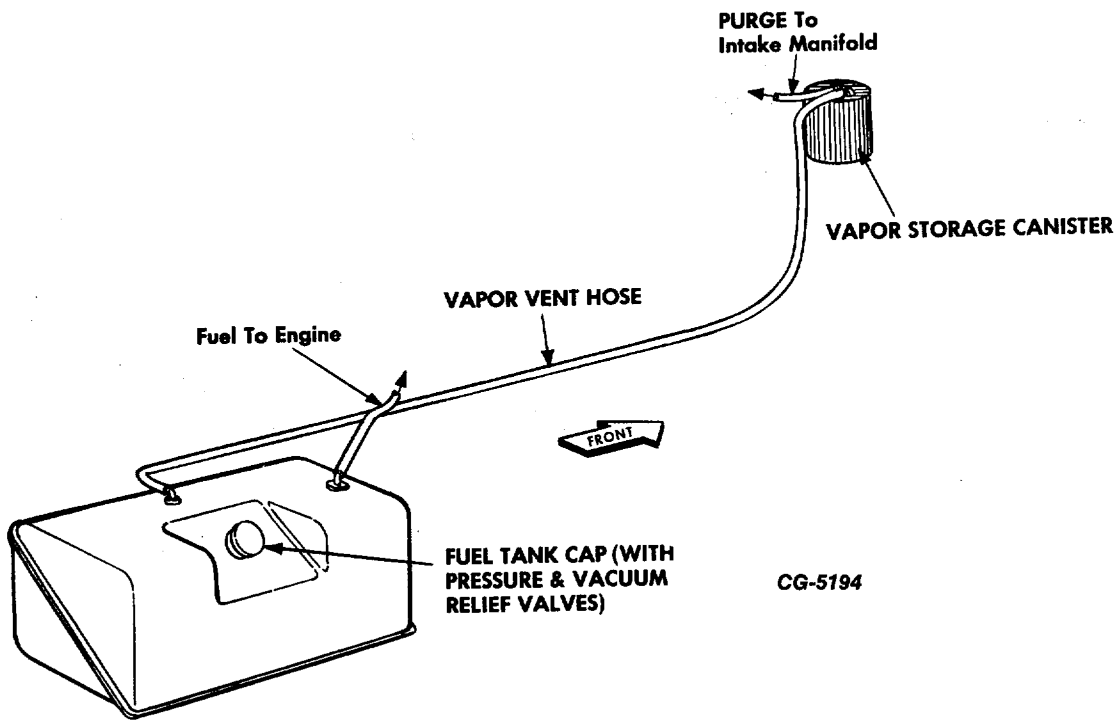


Fig. 30 S-Series 1624, 1724, 1824, 1824 4 x 4, 1924, 1924 6x6, F1924 and F-1925 Vehicles with 30 Gallon Fuel Tank

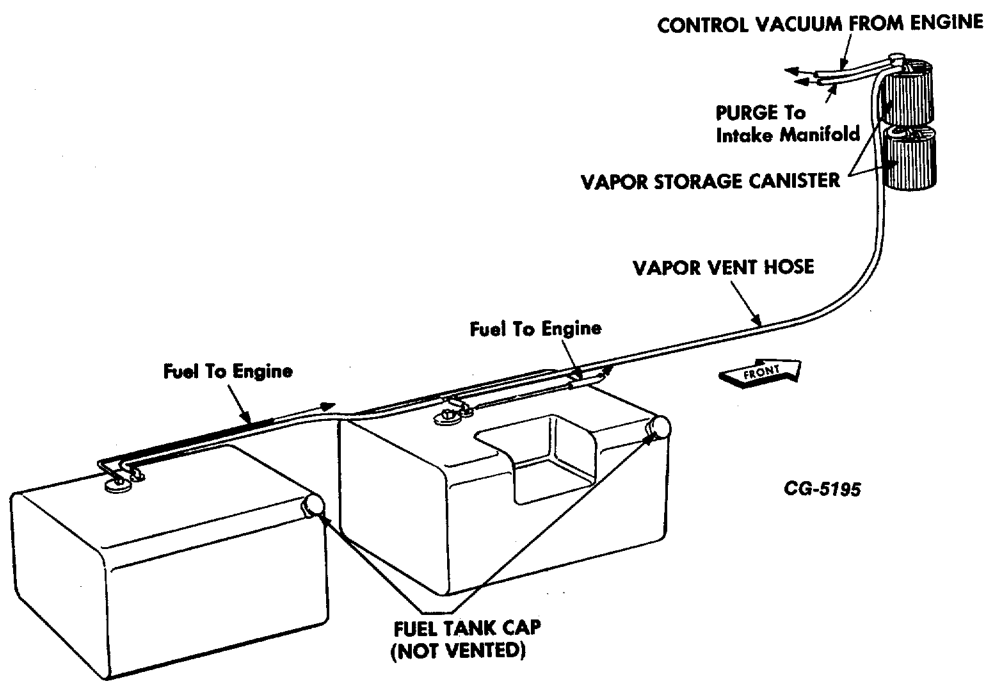


Fig. 31 S-Series 1624, 1724, 1824 1824 4x4, 1924, 1924 6x6, F1924 and F-1925 Vehicles with 45 and 48 Gallon Dual Fuel Tanks

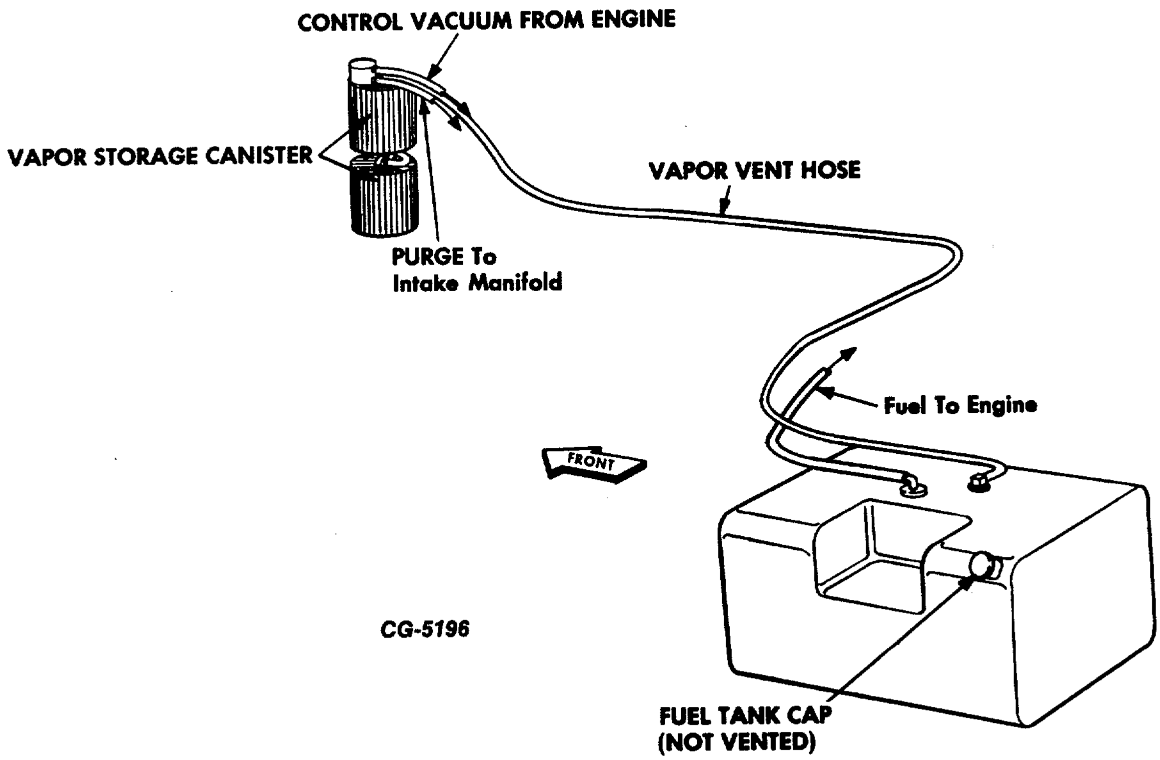


Fig. 32 S-Series 2524 and F2524 Vehicles With 57 Gallon Fuel Tank

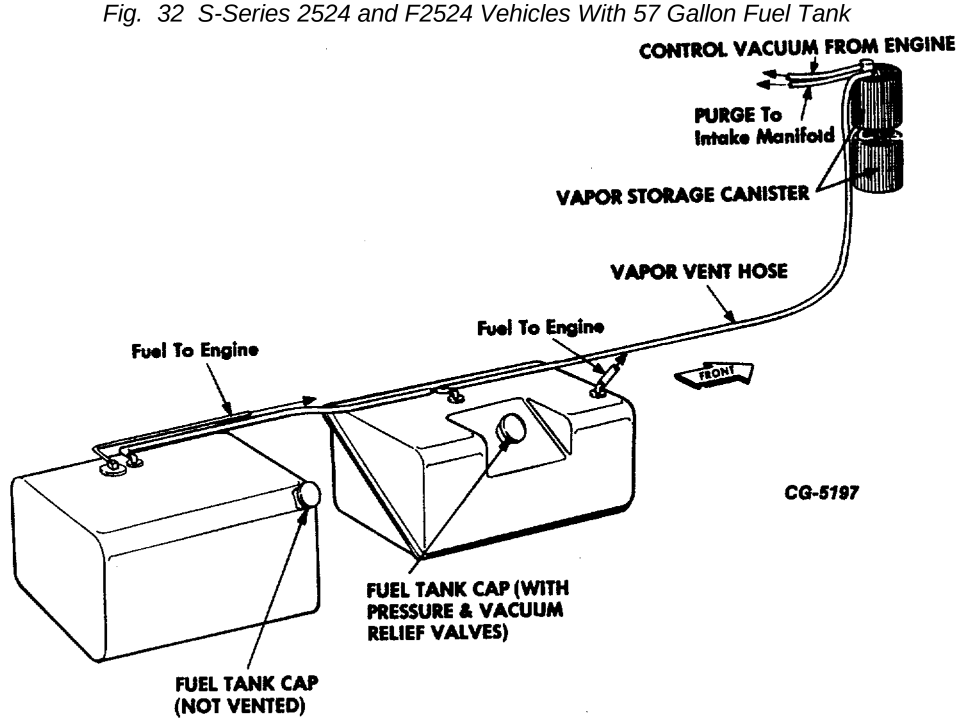


Fig. 33 S-Series 1624, 1724, 1824, 1824 4x4, 1924, 1924 6x6, F1924 and F-1925 Vehicles With 30 and 48 Gallon Fuel Tanks

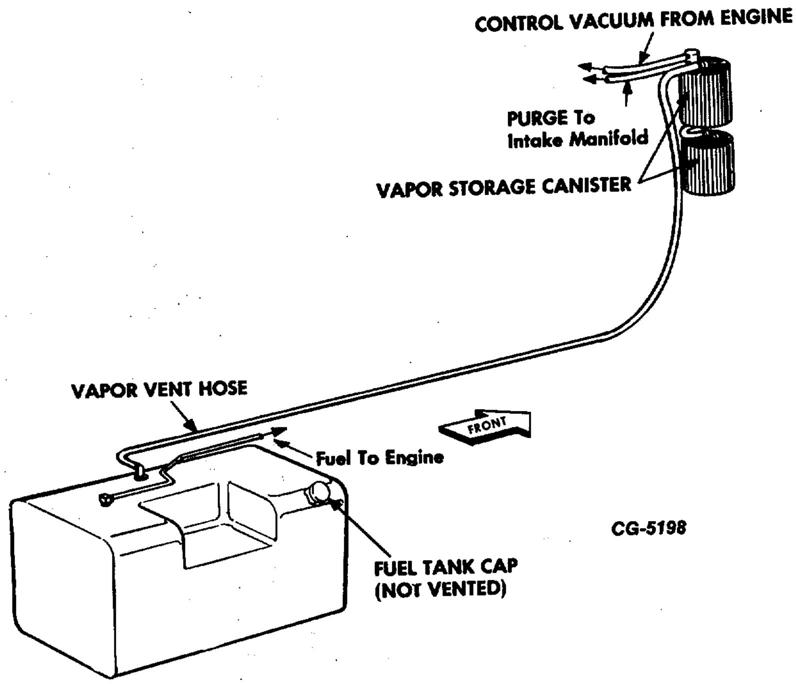


Fig. 34 S-Series 1624, 1724, 1824, 1824 4x4, 1924, 1924 6x6, F9124 and F-1925 Vehicles With 45 Gallon Fuel Tanks

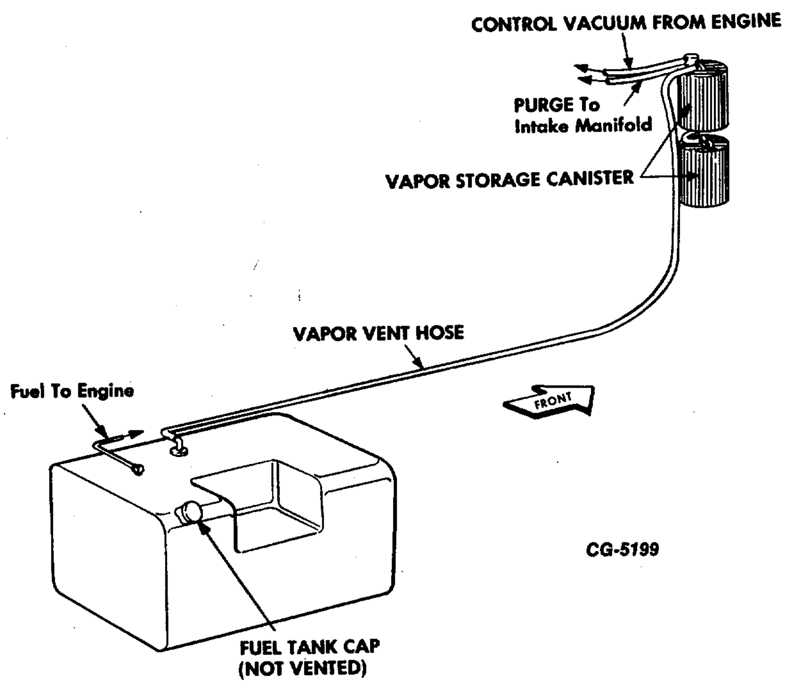


Fig. 35 S-Series 2125 and F2125 Vehicles With 57 Gallon Fuel Tank

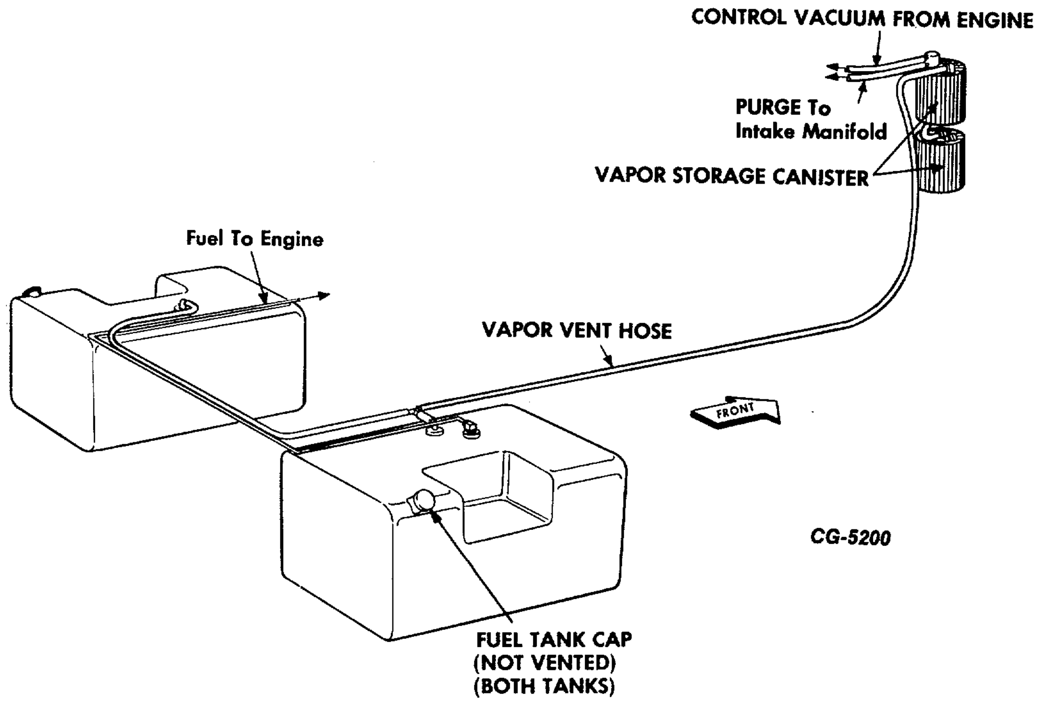


Fig. 36 S-Series 1724, 1824 and 1924 Trailer Toter with 45 Gallon Dual Fuel Tanks
S-Series 2125 and F2125 Vehicles with 57 Gallon Dual Fuel Tanks

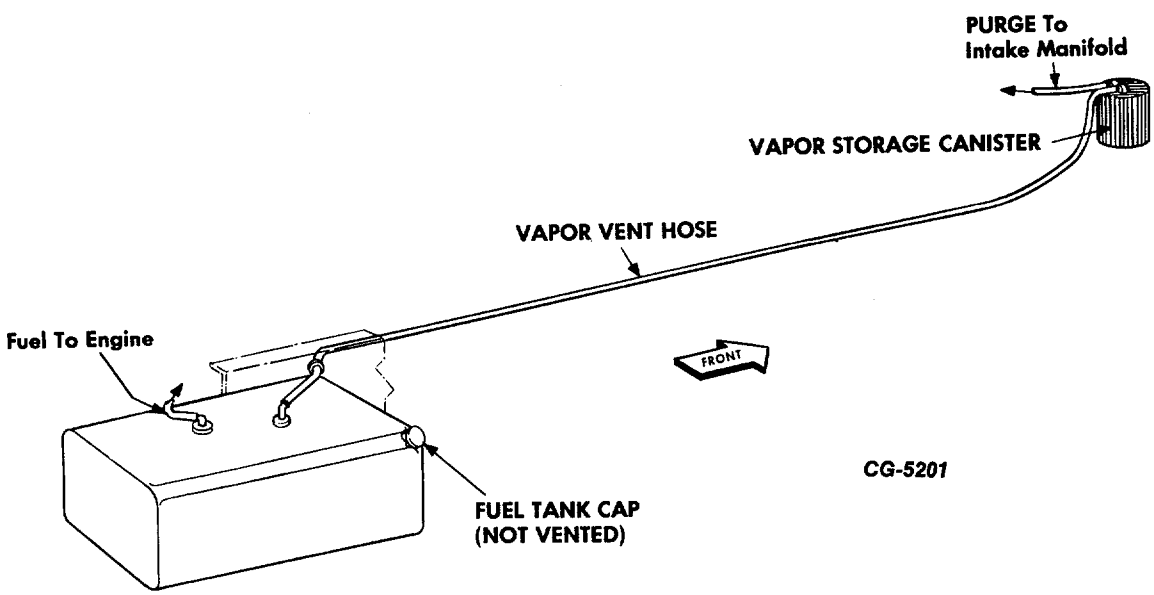


Fig. 37 S-Series 1723 and 1823 Bus with 32 Gallon Fuel Tank

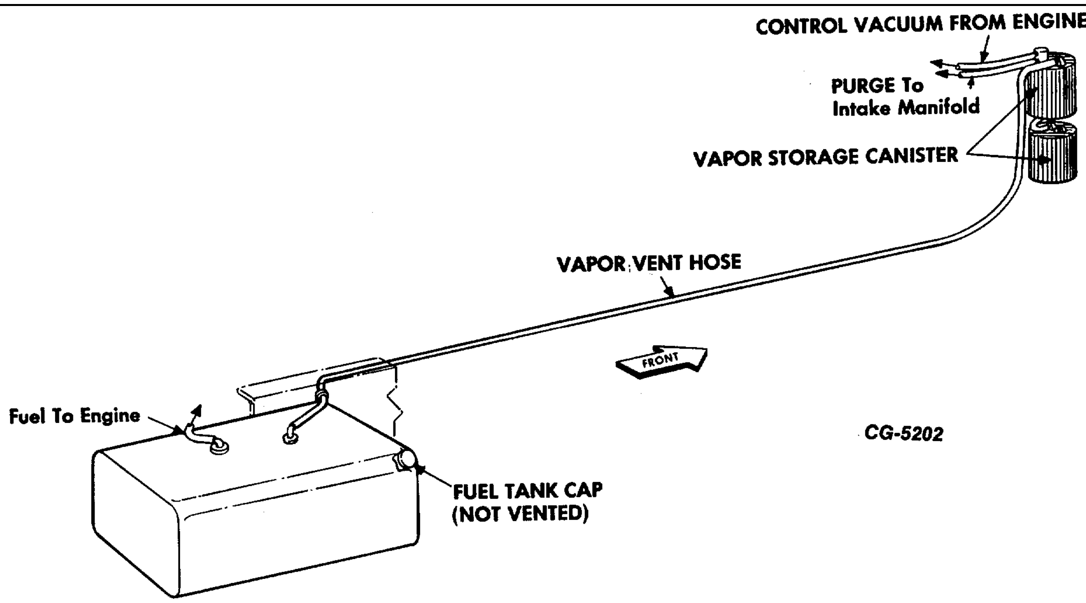


Fig. 38 S-Series 1723 and 1823 Bus With 52 Gallon Fuel Tank

8. Check Engine Bolt Torque and Tighten if Necessary.

Torque carburetor, intake manifold and exhaust manifold mounting bolts (see Tune-Up Specifications).

9. Check Exhaust Gas Control Valve for free operation and service or replace, if necessary (where used).

a. Inspect exhaust heat riser valve for free operation (Fig. 39).

b. Free up with solvent, if necessary, while turning valve by hand (valve should turn to closed position when at ambient temperature)

c. If valve cannot be freed with solvent, replace with new valve.

10. Check Coil output Voltage and replace Coil, if necessary.

a. Connect SE-2576, or equivalent, test equipment.

b. Start and operate engine until normal operating temperatures are reached. Then, increase engine speed to 2500 RPM.

c. Record coil output voltage. If coil output voltage is not within specifications (see Tune-Up Specifications), proceed as follows:

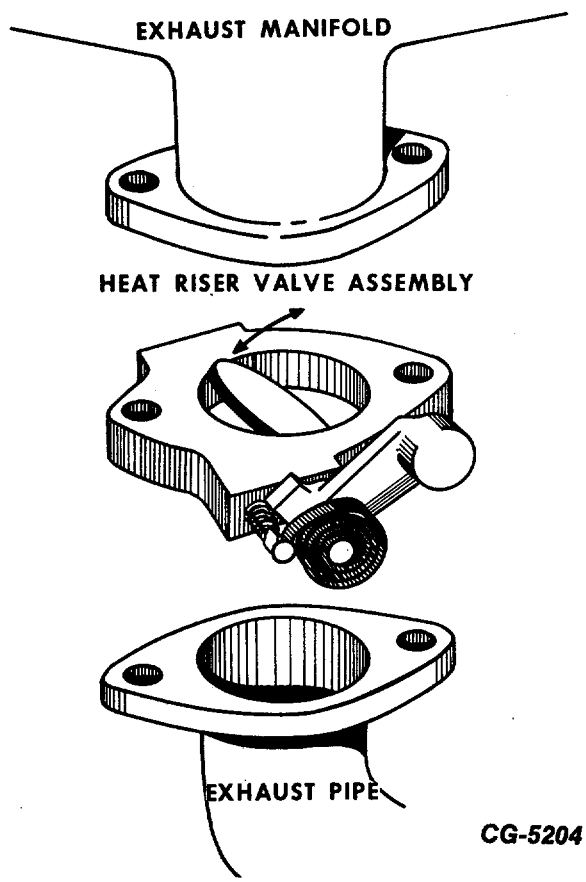


Fig. 39 Heat Riser Valve

d. Measure the D.C. voltage at the positive terminal of the ignition coil with the engine at idle speed and record. age 23

e. Measure battery terminal D.C. voltage with engine at idle speed and record.

f. If coil positive terminal voltage is less than battery terminal voltage by more than .5 volts, replace or repair primary wiring, ignition switch or firewall connector as required. Recheck coil output voltage. If not satisfactory, proceed as follows:

g. Measure ignition coil primary resistance. The resistance from positive terminal to negative terminal with ignition switch off should measure between 1.2 and 1.4 ohms. If resistance is outside these limits, replace coil.

h. Measure secondary resistance of ignition coil by measuring between the positive terminal and the secondary tower connector. The resistance should measure between 9.4 and 11.1 thousand ohms. If the resistance is outside these limits, replace coil.

i. Off-Engine Coil Check: The ignition coil can be removed from the engine and checked with SE2576 or equivalent test equipment.

11. Check Initial Advance and Adjust if necessary.

a. Connect timing light.

b. Disconnect and plug vacuum advance hose.

c. Start engine and operate until normal operating temperatures are reached.

d. Observe engine idle speed. Speed must be within specifications (see Tune-Up Specifications); adjust speed to specifications, if necessary.

e. Observe initial advance with timing light.

f. Loosen distributor clamp and adjust to specifications, if necessary (see Emission Control System Tune-Up Specifications). Tighten distributor clamp and recheck initial advance.

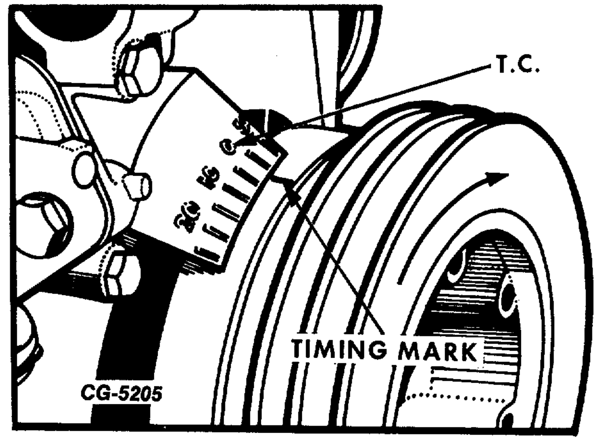


Fig. 40 Typical Location of Timing Marks

g. MV-446 engine, reconnect vacuum advance hose and adjust speed to Tune-Up Specification, if necessary. Other engines, adjust speed to specifications with vacuum advance hose disconnected (Step b).

h. Stop engine. Reconnect vacuum advance hose (if necessary) and remove timing light.

12. Check Operation of Inlet Air System Valve and Service or Replace, if necessary.

Procedure for servicing the sensor controlled vacuum chamber type air cleaner is as follows:

(Canada Scout Vehicles)

a. Test should be conducted when ambient temperature of the vehicle is less than 24 deg. C (75 deg. F) and engine started cold. Air cleaner must have all hoses, piping and cover in place. No leaks permitted.

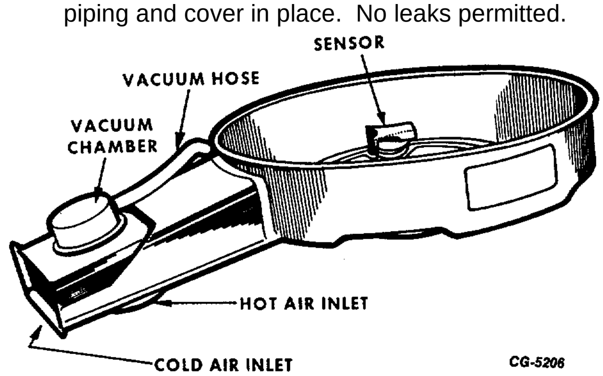


Fig. 41 Sensor Controlled Vacuum Chamber Type Air Cleaner

b. With engine off, inlet tube damper should be in full down position to close heat tube inlet pipe from exhaust manifold stove. Damper position can be determined by looking in end of inlet tube. If damper assembly is not in the correct position, vacuum chamber should be removed and damper movement loosened. Replace vacuum chamber (located on top of inlet tube) and recheck damper position.

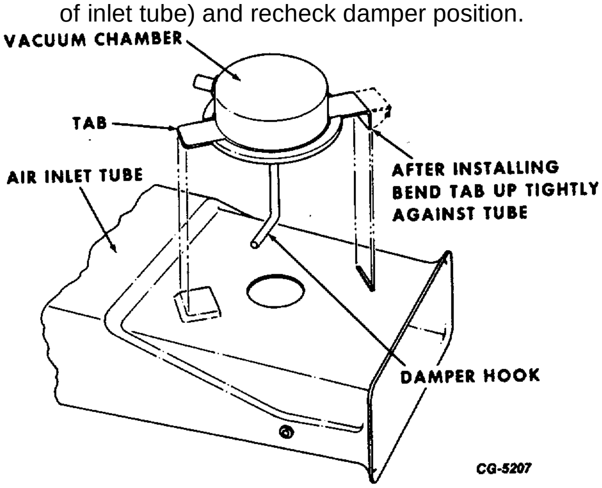


Fig. 42 Vacuum Chamber Details

To replace vacuum chamber (Fig. 42) (cannot be replaced on air cleaners used on 4-196 engines) bend tab nearest inlet tube entrance down from inside tube. Disconnect vacuum hose and lift vacuum chamber, sliding the rear tab out of its slot disengaging damper hook from damper. Attach new chamber by engaging hook in damper, sliding rear tab into its slot and fitting front tab into place. A spring preload should be felt when vacuum chamber is pressed firmly against top of inlet tube. If no preload is felt, check the installation or be sure parts are not faulty. Press front vacuum chamber tab firmly against tube inside surface. Connect vacuum hose.

c. Start engine and note that damper has rotated up to close off cold air inlet. Observe damper position by looking in the inlet tube. If damper did not immediately close cold air inlet, proceed as follows:

(1) Shut off engine and disconnect the two hoses from sensor.

(2) Connect the two hose ends together using suitable tubing.

(3) Restart engine and again check damper location. If damper fully closes cold air inlet, temperature sensor is defective and must be replaced (located inside air cleaner body).

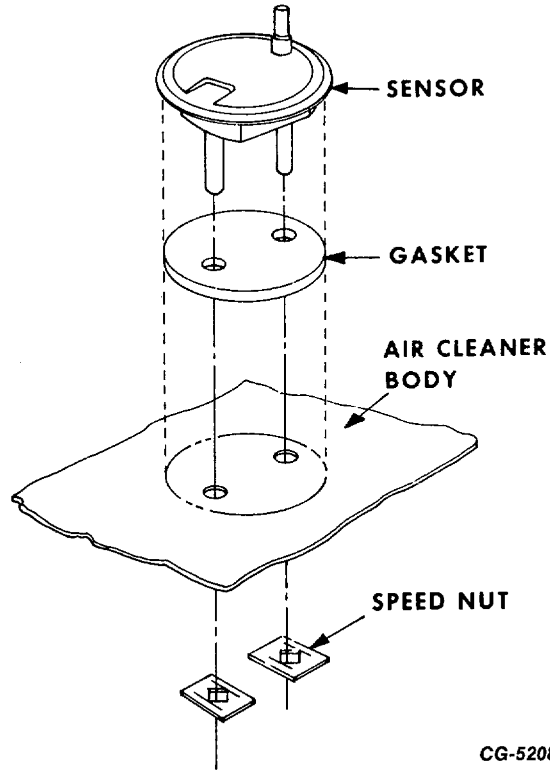


Fig. 43 Sensor Installation

To replace temperature sensor, disconnect two vacuum hoses attached to sensor inlet and outlet tubes on underside of air cleaner body. Remove clamps or speed nuts from tubes and lift sensor from body. Position new sensor and gasket inside air cleaner body. Firmly press two new speed nuts or clamps on tubes to hold sensor in place. Attach vacuum hoses to sensor tubes. If damper does not close cold air inlet, sensor is okay, but damper has bind or vacuum chamber is defective. Remove vacuum chamber and check damper for free movement. If damper moves freely, replace vacuum chamber.

d. After cold start, operate engine for 10 minutes at medium RPM. When engine is at normal operating temperature, slow engine to idle and observe position of inlet tube damper. If damper has not rotated all or part way down to allow some cold air to enter inlet tube, replace temperature sensor.

Procedure for servicing the thermal pellet type air cleaner is as follows: (Cargostar & S-Series Vehicles)

a. With the engine cold and ambient under hood temperature below 32 deg. C (90 deg. F), the damper should be closed to the cold air inlet (open to the hot air inlet). This closed to cold air inlet can be checked by looking in the end of the inlet.

b. With the engine at operating temperature and the ambient under hood temperature above 57 deg. C (135 deg. F), thermal pellet should open the damper allowing cold air to enter the cleaner and at the same time shut off the hot air inlet.

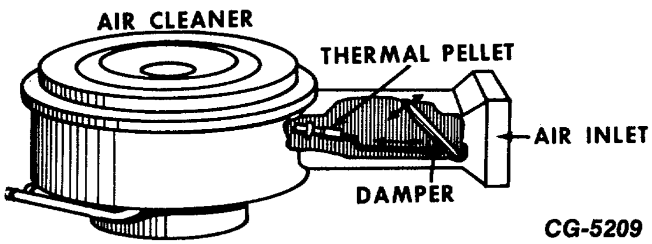


Fig. 44 Pellet Type Controlled Air Cleaner

c. If the damper does not operate as described above, reach in the inlet, move the damper open and check to see if it is sticking. If damper is moving freely and the linkage is connected, then the thermal pellet must be at fault and should be replaced.

When replacing the thermal pellet do not tighten the pellet assembly with a tool. Tighten finger tight only. Use locking compound on the threads to secure in place. If a tool is used, too much pressure may be applied changing the calibration of the thermal pellet and linkage assembly.

13. Check PCV System Hoses and Replace, if necessary, Clean PCV Valve, If necessary.

a. Remove valve from crankcase side, leaving the other end of the valve in hose and connected to intake manifold.

b. With the engine operating, a vacuum should be felt at the end of the valve. If no vacuum is present, the valve, hose and fitting should be removed and cause of restriction determined.

c. Check the inner chamber of the valve to see that it can be moved freely. This may be accomplished by inserting a stiff wire into the valve body and observing whether or not the plunger can be readily moved, or shake the valve and listen for rattle. If the plunger does not move, soak in carburetor cleaner.

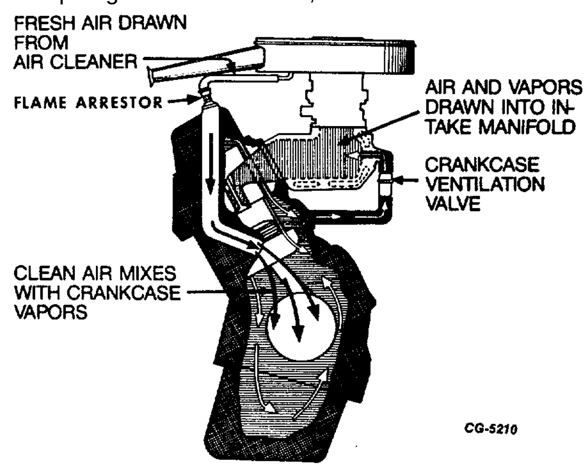


Fig. 45 Typical Air and Vapor Flow Through the System

13A. Positive Crankcase Ventilation Valve (PCV) Operation.

Since the vacuum supply for the PCV system is from the intake manifold, the flow through this system into the manifold must be controlled in such a manner that it varies in proportion to the air-fuel ratio being drawn into the intake manifold.

The PCV valve varies the amount of flow through the system according to the various modes of operation (i.e.

idle, cruise, acceleration, etc.). The valve itself consists of a coil spring, valve and a two-piece outer body which is crimped together. The valve dimensions, spring and internal dimensions are such to produce the desired air flow requirements.

During the periods of deceleration and idle, manifold vacuum is high. The high vacuum overcomes the force of the valve spring and the valve bottoms in the manifold end of the valve housing. This does not completely stop the flow but it does restrict (Fig. 46).

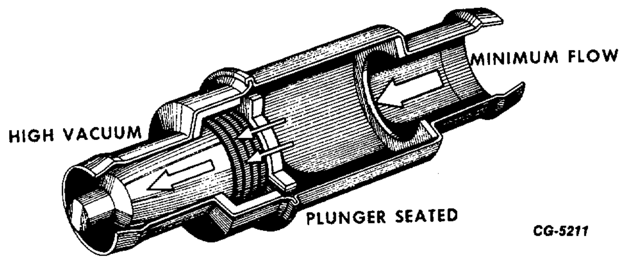


Fig. 46 Plunger Position During Idle or Low Engine Speed

When the engine is accelerated or operated at constant speed, intake manifold vacuum is less than at idle or during deceleration. The spring force is stronger than vacuum pull during this mode so the valve is forced toward the crankcase end of the valve housing. With the valve in this position, more crankcase vapors flow into the intake manifold (Fig. 47).

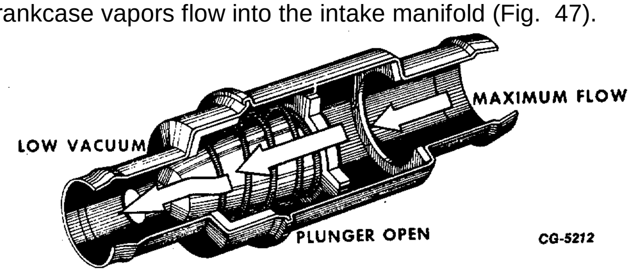


Fig. 47 Plunger Position During High Engine Speed

In the event of a backfire, the valve plunger is forced back and seated against the inlet of the valve body.

This prevents the backfire from traveling through the valve and connecting hose into the crankcase (Fig. 48). If the backfire was allowed to enter the crankcase, it could ignite the volatile crankcase blow-by gases.

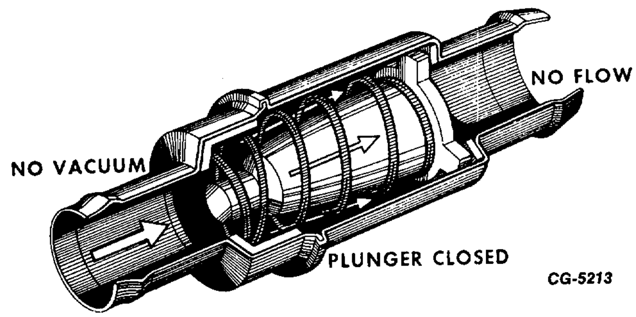


Fig. 48 Plunger Position During Backfire or When Engine is "OFF".

14. Remove and Check EGR Valve and Clean or Replace, if necessary. (V-345 and V-392 Engines Only)

a. Remove EGR valve from engine.

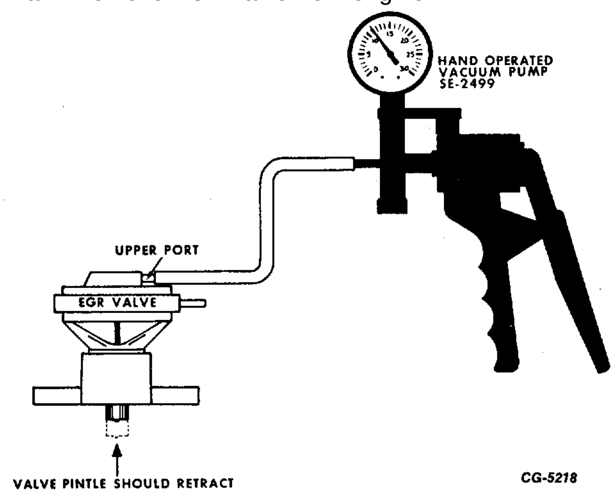


Fig. 49 EGR Valve Test

b. Apply 10-12" vacuum to EGR valve vacuum port (upper port of dual diaphragm valve). As vacuum is applied, valve pintle should move off seat and retract into valve housing (Fig. 49). If valve does not operate when vacuum is applied, valve is faulty and should be replaced.

c. Visually inspect valve for evidence of valve pintle (plunger) not seating or deposit accumulation on pintle and seat. Clean deposits from pintle and seat, if necessary.

To clean deposits from pintle and seat of EGR valve, use a sand blast type spark plug cleaner and the following procedure:

(1) Prepare spark plug cleaner by installing rubber adapter with 22 mm (7/8") hole over cleaning (blast) port. Do not install metal adapter clamp (Fig. 50).

(2) Insert pintle of EGR valve through hole in rubber plug cleaner adapter.

(3) Holding EGR valve tightly down adapter, apply sand blast to clean pintle.

CAUTION

Safety goggles should be worn while performing cleaning operation.

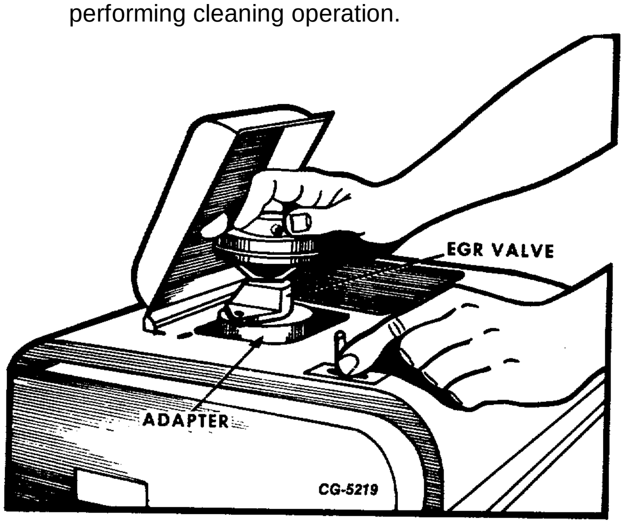


Fig. 50 Cleaning EGRH Valve

(4) After cleaning exposed pintle, hold EGR valve in both hands and press in diaphragm to retract valve pintle into valve housing. Use a 25 mm (1") long bolt (3/4" long for dual diaphragm valves) to hold pintle in retracted position. Apply masking tape to cover outlet port of valve.

(5) With pintle opening of valve aligned with hole in cleaning adapter, hold EGR valve down tightly against adapter and apply sand blast to clean interior of valve housing and valve seat.

d. After cleaning, blow all excess sand from interior of valve housing and remove bolt.

e. Recheck valve for proper operation and seating.

f. Replace with new valve, if necessary.

15. Check EGR System with Functional Test and Clean or Replace, If necessary. (V-345 and V-392 Engines Only)

Perform EGR System Functional Test as follows:

a. Operate engine until it reaches normal operating temperature.

b. Shut off engine. Connect tachometer. Connect vacuum pump with vacuum gauge to EGR system vacuum hose at carburetor.

c. Plug fitting at carburetor.

d. With tachometer installed, operate all engines at 2000 RPM.

e. Apply specified vacuum (see Emission Control System Tune-Up Specifications).

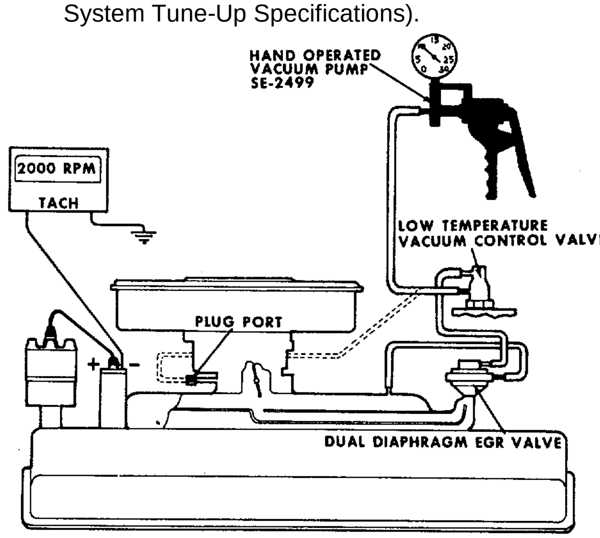


Fig. 51 Complete EGR System Test

f. See Emission Control System Tune-Up Specifications for engine speed drop when vacuum is applied. This procedure checks not only the EGR valve but the intake manifold and related passages as well.

If minimum speed drop specification is not achieved, verify applied vacuum signal acts on valve.

a. Tee vacuum gauge into vacuum hose at EGR valve (upper port on dual diaphragm valves).

b. With engine shut off and normal operating temperature (EGR low temperature vacuum control valve), any vacuum magnitude applied at carburetor end of vacuum hose should be observed at EGR valve end of hose (Fig. 52).

c. If same vacuum is not observed, inspect vacuum hoses for leaks and replace as necessary.

d. Repeat Step b. If same vacuum is not observed, replace EGR low temperature vacuum control valve.

e. Repeat EGR System Functional Test.

If minimum speed drop specification is still not achieved, check for plugged exhaust gas passages and clean as required.

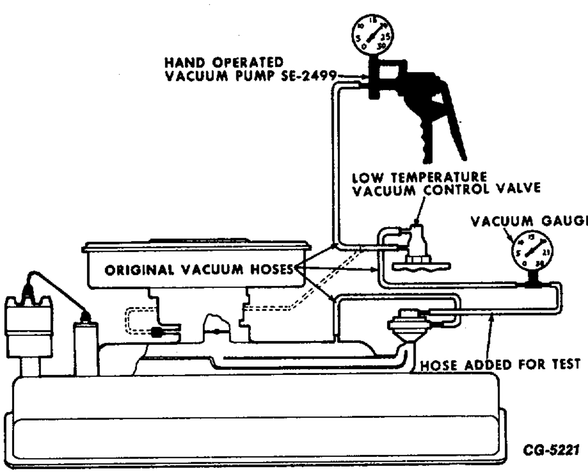


Fig. 52 Low Temperature Vacuum Control Valve and Connecting Hose Test

a. Open carburetor throttle plates and examine exhaust gas ports located in floor of intake manifold directly below carburetor. If ports are plugged with deposits remove carburetor and clean ports as needed.

<u>For Canada V-304/345 Engines Only</u>

a. Operate engine until it reaches normal operating temperature.

b. Shut off engine. Connect tachometer and vacuum gauge to engine.

c. Start engine and block throttle open to give 3000 RPM. Observe and record tachometer reading.

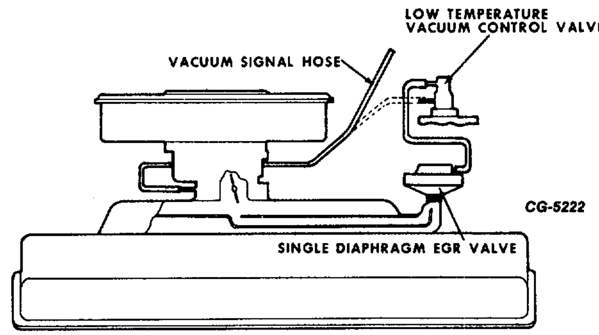


Fig. 53 Single Diaphragm EGR Valve System

d. Disconnect EGR vacuum signal hose (Fig. 53) and again record tachometer reading. If EGR system is functioning properly the minimum speed increase should be 50 rpm for the V-304 and 150 rpm for the V-345. If rpm increase is less than shown above, EGR system is not functioning properly and should be checked per the following steps.

Check low temperature vacuum control valve as follows:

a. With engine operating at fast idle, disconnect vacuum signal hose from low temperature vacuum control valve. A vacuum signal should be felt at the open end of hose. If vacuum is felt, reconnect hose and proceed. If vacuum is not felt, stop engine and check for leaking or restricted vacuum hose or restricted vacuum port in carburetor.

b. With engine operating at fast idle, disconnect vacuum signal hose from EGR valve. A vacuum signal should be felt at the open end of the hose. If vacuum is felt, vacuum supply and low temperature valve are satisfactory (Fig. 53).

If vacuum is not felt:

a. Check for leaking or restricted vacuum hose.

b. Be sure hoses are connected properly to low temperature vacuum control valve.

c. If hoses are satisfactory and vacuum does not pass through low temperature vacuum control valve, valve is faulty and must be replaced.

After correcting any problem and obtaining a vacuum signal at EGR valve, repeat System Operation Test per c and d above.

Check operation of EGR valve as follows:

a. Remove EGR valve from engine.

b. Visually inspect valve for evidence of valve pintle (plunger) not seating. If pintle does not seat due to deposits, clean valve pintle and seat (see EGR Valve Cleaning Procedure). If pintle does not seat properly after cleaning, replace EGR valve.

c. Apply 10-12" Hg vacuum to EGR valve vacuum port (Fig. 51). As vacuum is applied, valve pintle should move off seat and retract into valve housing until end of pintle is approximately flush with surface of valve housing. If valve does not operate when vacuum is applied, valve is faulty and should be replaced. 15A. Replace EGR Valve

15A. Replace EGR Valve

Because EGR valve metering varies between engines, it is important that the correct EGR valve be used in order to obtain optimum engine performance and emission control (see EGR Valve Application Chart).

To assist in identification, EGR valves are coded by a colored disk attached to the center of the vacuum diaphragm housing. The valve may also be identified by the manufacturer's part number stamped on the valve (Fig. 54).

15B. Exhaust Gas Recirculation System Operation.

The exhaust gas recirculation (EGR) system introduces a metered amount of exhaust gas into the intake manifold where it mixes with the air/fuel mixture entering the combustion chambers. Dilution of the air/fuel mixture with exhaust gas lowers combustion temperature and pressure, thereby reducing formation of oxides of nitrogen.

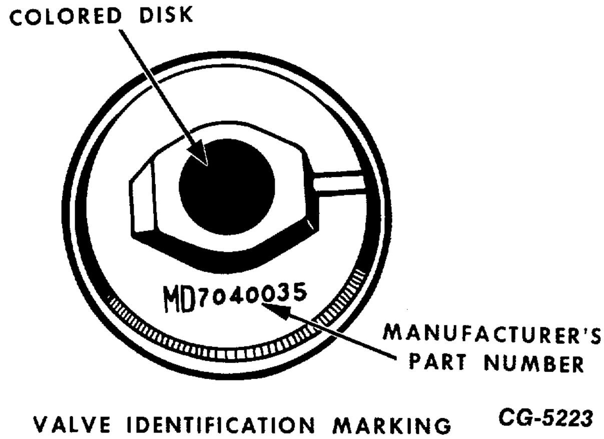


Fig. 54 EGR Valve Identification Marking

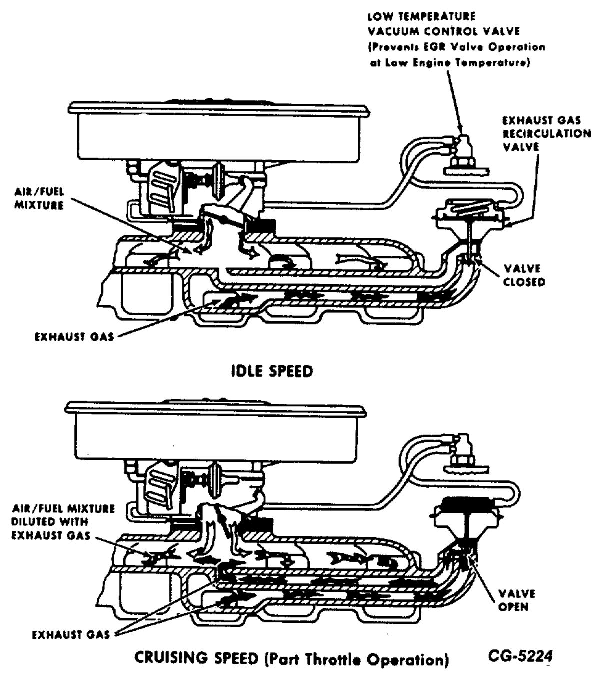


Fig. 55 Exhaust Gas Recirculation System (Single Diaphragm EGR Valve)

The EGR valve regulates the amount of exhaust gas entering the intake manifold. The EGR valve is controlled by ported vacuum, which is determined by position of the carburetor throttle plate(s). Operation of the exhaust gas circulation system is illustrated in Figures 55 and 56.

While the engine is stopped or operating at idle speed (negligible port vacuum), the EGR valve is held closed by spring pressure.

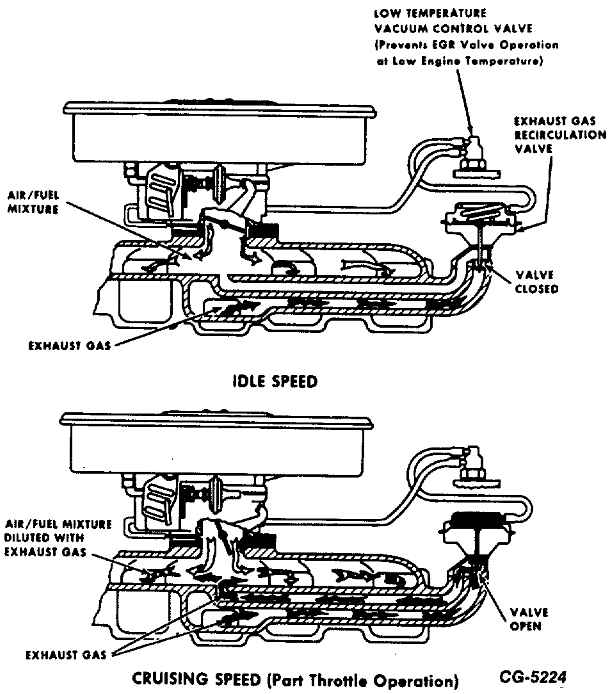


Fig. 56 Exhaust Gas Recirculation System (Dual Diaphragm EGR Valve)

A low temperature vacuum control valve is used in the exhaust gas recirculation system. The purpose of this valve is to prevent exhaust gas recirculation when the engine is cold. The low temperature control valve senses engine coolant temperature and is located in the coolant passage of the intake manifold. Whenever engine coolant temperature is below 46 deg. C (115 deg. F), the low temperature control valve is closed, blocking vacuum from the EGR valve diaphragm, thus preventing EGR valve operation. When engine warm ups and coolant temperature exceeds 46 deg. C (115 deg. F), the low temperature control valve opens, permitting vacuum to actuate the EGR valve and establish exhaust gas recirculation in response to throttle plate position. The low temperature control valve can be identified by a purple exterior color.

EGR VALVE APPLICATION CHART
For 1980 U.S.A. Model Engines
(Except California)

Engine	Carburetor	IH No.	Mfr. No.	Color Code
V-345	2210C	480825C1	17057905	Red/White
V-345	2300EG	472207C1	17051786	Black/White
V-392	4150EG	480824C1	7044409	Green/Black
MV-404	2210C	446981C1	17056690	Green/Yellow
MV-404	2300EG	446981C1	17056690	Green/Yellow
MV-404	4150EG	440312C1	17053177	White
MV-446	4150EG	440312C1	17053177	White
V-537	2300EG	440310C1	17053031	Blue/White

CANADA

V-304	2210C	440308C1	7040435	None
V-345	2210C	440308C1	7040435	None
V-345	2300EG	440306C1	7030983	Black

15C. EGR Maintenance Indicating System (V-345 and V-392 Engines Only)

This system is used to alert the vehicle operator, after each 19200 Km (12,000 miles), that the EGR system must be serviced to insure that it is operating properly.

The system consists basically of a switch, or revolution counting device, and an indicating light (Fig. 57).

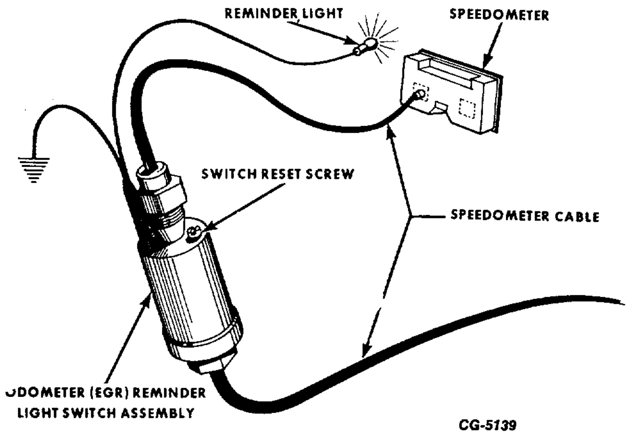


Fig. 57 EGR Maintenance Indicating System

The switch is triggered by a counter mechanism, similar to an odometer, which is connected in series with the speedometer cable. After 19200 Km (12,000 miles), electrical contacts inside the switch snap together and complete the circuit to the indicator light (Fig. 58).

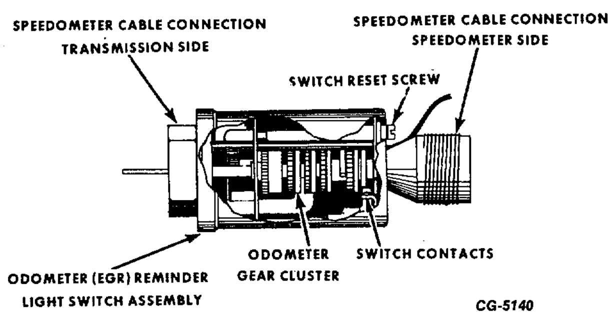


Fig. 58 Reminder Light Switch Assembly

The red indicator light, which has the words "Service EGR" on the face, is mounted on the instrument panel. When lighted, the letters are easily visible even in the daylight.

After the EGR system maintenance is performed, the indicator light can be turned off and the switch reset by turning the reset screw (Fig. 58) about 450 (¼ turn). This zeros the switch's odometer gears and opens the electrical contacts. The switch is then ready to count the next 19200 Km (12,000 mile) interval.

A circuit that tests the indicator light bulb during engine starting is utilized, the same as the brake warning light.

16. Check Curb Idle Speed and Air; Fuel Mixture and Adjust, as necessary.

Adjustment procedure with Exhaust Analyzer

Idle speed and fuel mixture adjustments must be made with parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF".

When making idle adjustments on California engines, disconnect vacuum hose from vapor storage canister and plug end of hose. After idle adjustments have been made, remove plug and reconnect hose to canister.

To compensate for fuel and temperature variations when setting idle mixture, observe these precautions:

a. Do not idle engine continuously for more than three minutes at one time.

b. After each three minutes of idling, increase engine speed to 2000 rpm for one minute.

c. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step b.

Winter grade gasolines, being more volatile than summer grade, can yield vapors which result in excessively rich or erratic air/fuel mixtures, particularly at high engine temperatures. Because of this, care must be taken when making carburetor idle mixture adjustments with the exhaust analyzer. Attempts to adjust the idle mixture screw(s) leaner to overcome a rich mixture caused by evaporation of winter grade fuel at high engine temperatures can result in an extremely lean mixture and associated starting and driveability problems when vehicle is cold. Therefore, with winter grade gasolines, observe the following additional precaution:

Idle mixture adjustments must be made as soon as possible after engine wi1ll run without choke (choke plate fully open) before sufficiently high to cause evaporation of winter grade gasolines. Enrichment of the idle mixture by fuel evaporation can be detected by observing test meter readings. Readings should remain stable. A gradual increase in engine idle speed (RPM) or a tendency for the CO meter to climb toward the rich side without any adjustments being made indicates a richening of the mixture due to fuel evaporation. When this condition occurs, engine should be allowed to cool before making final mixture adjustments.

Setting Procedure:

a. Connect tachometer to engine. (Tachometer should have an expanded scale of 400 to 800 or 0 to 1000 RPM and 1 to 2% accuracy).

CG-5233

Fig. 59 Exhaust Analyzer - SE-2507

b. Disconnect air injection hose(s) at air manifold check valve(s) and plug air manifold check valve(s).

c. Operate engine until it reaches normal operating temperature (unless winter grade gasoline is used).

d. Adjust curb idle speed to specifications (see Emission Control System Tune-Up Specifications).

e. Prepare Exhaust Analyzer SE-2507 or equivalent, and insert exhaust sample probe into vehicle's tail pipe (refer to test equipment manufacturer's instructions for preparation and hook-up procedures.

f. Observe percent of carbon monoxide (%CO) indicated on analyzer dial and adjust idle mixture screw(s) to obtain specified CO setting (see Emission Control System Tune-Up Specifications), if necessary.

g. Readjust idle speed, if necessary, and readjust mixture screw(s) to provide the specified CO setting at the specified speed.

h. If specified CO setting cannot be obtained, establish proper mixture screw(s) setting as follows:

(1) Remove limiter cap(s). To prevent damage to screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

(2) Gently seat idle mixture screws.

(3) Adjust idle speed and mixture screw(s) (equal number of turns) to provide the specified CO setting at the specified speed.

(4) Install new plastic (service limiter cap(s) with tab in the mid-position.

i. Disconnect test equipment from engine and reconnect air injection hose(s) to air manifold check valve(s).

Adjustment Procedure without Exhaust Analyzer.

For U.S.A. (except California) and Canada engines.

Idle speed and fuel mixture adjustments must be made with parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF".

To compensate for fuel and temperature variations when setting idle mixture, observe these precautions:

a. Do not idle engine continuously for more than three minutes at one time.

b. After each three minutes of idling, increase engine speed to 2000 rpm for one minute.

c. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step b.

Adjustment Procedure:

a. Connect tachometer to engine. (Tachometer should have an expanded scale of 400 to 800 or 0 to 1000 rpm and 1 to 2% accuracy.

b. Remove limiter cap(s). To prevent damage to screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

c. Operate engine until it reaches normal operating temperature.

d. Gently seat idle mixture screws (not required on 4-196 engine).

e. Carefully, adjust idle mixture screws (equal number of turns) to produce maximum idle speed.

f. Observe tachometer and adjust curb idle screw to obtain the following required engine speed. Required engine speed is the total of the midrange of Curb Idle Speed (see Emission Control Tune-Up Specifications) and Speed Drop RPM (see Emission Control Tune-Up Specifications) added together.

g. Adjust curb idle mixture screw(s) (equal number of turns) in until mid-point of idle speed range specification is obtained (see Emission Control System Tune-Up Specifications).

h. Install new plastic (service) limiter cap(s) with tab in mid-position.

NON-SCHEDULED MAINTENANCE OPERATIONS

DECELERATION THROTTLE MODULATOR (DTM) SYSTEM

Deceleration Throttle Modulator System Operation

The deceleration throttle modulator system consists basically of a vacuum operated throttle modulator unit on the carburetor, a solenoid vacuum valve and engine speed sensor unit.

Normally an engine will emit relatively high levels of unburned hydro-carbons during "closed throttle" deceleration. This is because the intake of fuel/air mixture is not sufficient to support complete combustion and the engine "misfires" resulting in fuel being passed through the engine unburned. The deceleration throttle modulator system overcomes this condition by maintaining a slightly greater throttle opening (high idle) during initial deceleration which permits intake of just enough additional fuel/air mixture to promote combustion and eliminate misfire.

The engine speed sensor is calibrated to activate or deactivate (extend or retract) the throttle modulator unit at approximately 1850 RPM engine speed. Operation of the throttle modulator is illustrated in Fig. 60.

Above 1850 RPM engine speed, the solenoid vacuum valve is activated (held open) by electrical current from the engine speed sensor unit. This permits manifold vacuum to act upon the diaphragm of the throttle modulator unit extending the modulator unit to the high idle position. Upon deceleration, the returning carburetor throttle level contacts the extended modulator, thus holding the throttle in high idle position.

When engine speed drops below 1850 RPM, the speed sensor unit deactivates the solenoid vacuum valve allowing the valve to close and bleed the vacuum from the throttle modulator diaphragm chamber. This permits the diaphragm spring to retract the modulator unit and allow the throttle lever to return to normal curb idle position.

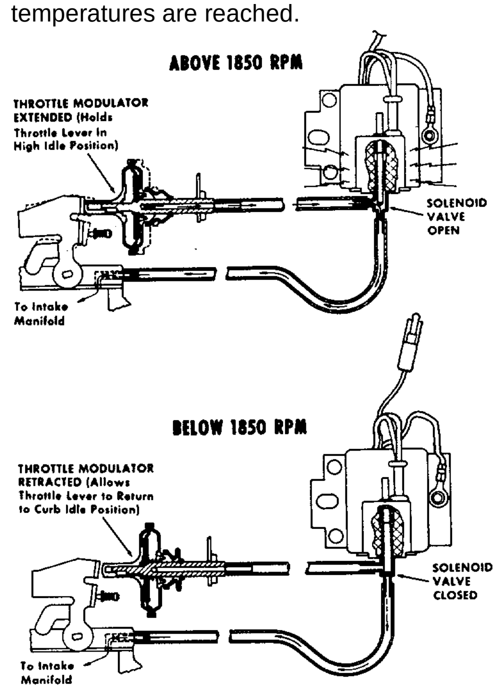
Check Deceleration Throttle Modulator Operation, replace if necessary.

a. Check modulator for free operation by grasping modulator by large diameter of the plastic housing and pulling (without twisting) toward throttle lever. Plastic housing should move freely against internal spring force for about 6 mm (¼"). Modulator should be replaced if it does not move freely or does not return rapidly to fully retracted position (Fig. 60).

b. Check throttle modulator speed setting and adjust, if necessary.

(1) Connect tachometer to engine.

(2) Start and operate engine until normal operating temperatures are reached.



THROTTLE MODULATOR OPERATION CG-5214

Fig. 60 Throttle Modulator Operation

(3) Disconnect vacuum hose from modulator and manually apply vacuum to modulator (Fig. 61). If modulator does not extend, unit is faulty and must be replaced. Allow throttle to close against extended modulator.

(4) Observe engine speed. For proper speed, see Emission Control Tune-Up Specifications.

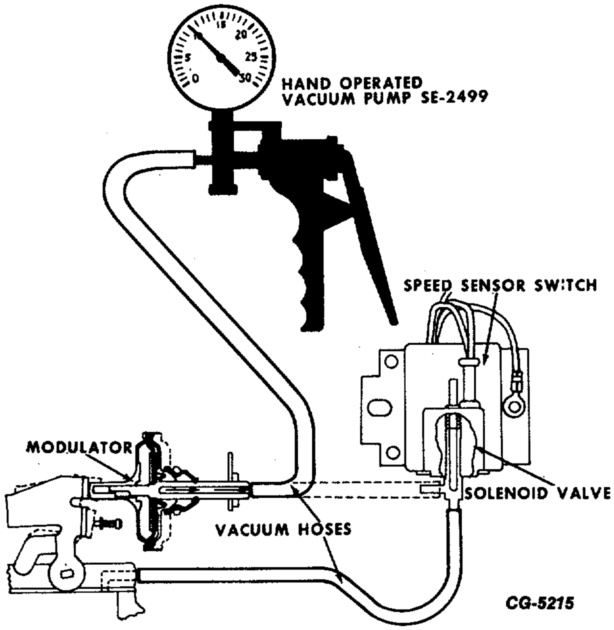


Fig. 61 Modulator Test

(5) If modulator is improperly adjusted, loosen lock nut and adjust position of modulator.

(6) Repeat Steps (3) thru (5) until proper speed is achieved; then tighten lock nut.

(7) Reconnect proper vacuum hose to modulator.

c. Perform DTM operational test as follows:

(1) Verify modulator is retracted at idle.

(2) Slowly accelerate the engine and observe the speed at which the modulator extends. Modulator should extend at 1850 $\pm$ 50 RPM (Fig. 60).

(3) Slowly decelerate the engine and observe the speed at which the modulator retracts. Modulator should retract at 1850 $\pm$ 50 RPM (Fig. 60).

d. Verify solenoid valve functions properly.

(1) Operate engine at any condition.

(2) With wiring harness disconnected from solenoid valve, modulator must be in retracted position.

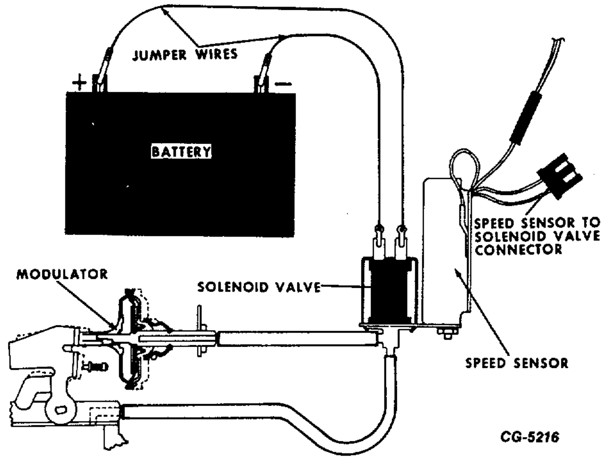


Fig. 62 Jumper Wires from Battery to Solenoid Valve Terminals

(3) With jumper wires from positive terminal of battery and from ground connected to solenoid valve terminals (Fig. 62), modulator must be in extended position.

(4) If modulator does not function properly, solenoid valve is faulty and must be replaced. (The solenoid valve and speed sensor are sold as one assembly.)

e. Verify speed sensor functions properly.

(1) Disconnect wiring harness from solenoid valve and connect a 12-volt test lamp between the two terminals of the harness connector.

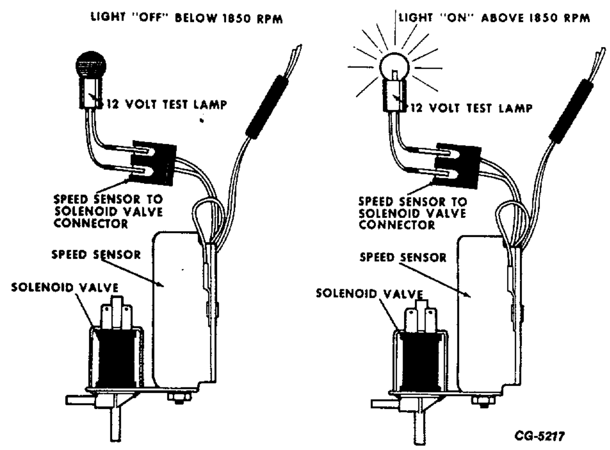


Fig. 63 Speed Sensor Switch Test

(2) Slowly accelerate the engine and observe the speed at which the test lamp lights. Test lamp should light above 1850 ± 50 RPM.

(3) Slowly decelerate the engine and observe speed at which the test lamp goes out. Test lamp should go out below 1850 ± 50 RPM.

(4) If test lamp does not function properly, check speed sensor wiring for proper routing and for clean and tight connections. If wiring is correct, speed sensor is faulty and must be replaced. (The speed sensor and solenoid valve are sold as one assembly.)

AIR INJECTION SYSTEM (U.S.A. Only)

Air Injection System Operation

The air injection system forces air into the cylinder head exhaust ports to promote "after-burning" of any combustibles remaining in the exhaust gases flowing from the combustion chamber. The components of the air injection system are illustrated in Figure 70.

The air pump used in the air injection system is a rotary vane type which is belt driven from the engine. A centrifugal type air filter located behind the pump pulley filters the air entering the pump to prevent entrance of dirt and abrasives (Fig. 66).

The air manifold distributes air under pressure from the pump to the individual exhaust ports in the cylinder heads. Figure 70 shows the location of the air manifolds on the small V8 engines. The air manifold is an integral part of the MV and large V8 engine cylinder heads.

A one-way check valve is used on each air manifold to protect the pump from a back flow of high temperature exhaust gas. The diverter valve prevents backfire in the exhaust system by shutting off air flow during the first few seconds of deceleration. The diverter valve also incorporates a pressure relief valve which exhausts excessive pump outlet air pressure during high speed operation. Operation of the diverter valve is illustrated in Figure 69.

In normal operation (cruising) the air pump delivers air through the air manifolds into the cylinder head exhaust ports. With the addition of air from the air injection system, an over-rich mixture can cause backfire in the exhaust system. To prevent backfire, the diverter valve momentarily stops the flow of air to the cylinder head exhaust ports during deceleration.

The diverter valve is controlled by intake manifold vacuum. At constant manifold vacuum spring pressure holds the valve in normal delivery position. This permits air to flow from the air pump to the air manifolds. During deceleration high manifold vacuum overcomes spring pressure and moves the valve to bypass position. This closes the outlet port and bypasses the air flow through the internal silencer to the atmosphere. The valve returns to normal delivery position when the vacuum being applied to the diaphragm is balanced through the orifice to the chamber on the other side of the diaphragm. Operating cycle time for the valve is approximately six seconds. In cases of high pump output air pressure (due to high engine speed etc.), the pressure relief valve opens and exhausts excessive air flow through the internal silencer to the atmosphere.

Check Air Injection System and replace, if necessary.

Inspect Air Pump Drive Belt(s)

Air injection pump drive belt tension can be checked with belt tension gauge SE-2312 (Fig. 64). Check tension at mid-point between pulleys. Apply gauge to the longest belt span. Instructions for checking are as follows:

(1) Grasp gauge and depress ball handle all the way down. Make certain hook extends beyond legs to pick up the belt.

(2) Apply gauge to belt. Be sure belt is positioned between nose piece and hook and that the nose piece is centered on belt.

(3) Release ball handle quickly. A slow release may present full return of hook, thus giving a false reading.

(4) Observe the area of gauge face indicated at the index mark. If index mark does not indicate a NEW reading on a new belt or a USED reading on a used belt, it

will be necessary to increase or decrease belt tension as required.

(5) Before changing belt tension, repeat Step (3) several times to become familiar with gauge operation. Observe gauge reading each time operation is repeated. Check tension of both belts when so equipped.

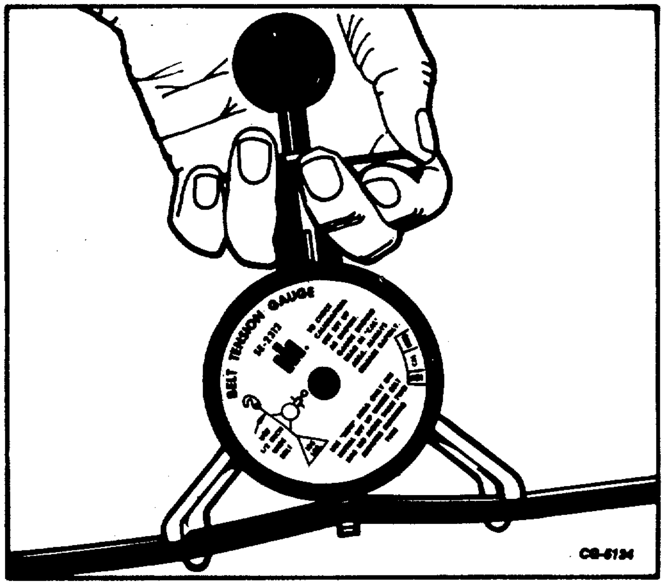


Fig. 64 Checking Belt Tension With SE-2312 Gauge

To establish tension of a loose belt apply SE-2312 gauge to belt and make the adjustment. Tighten belt until proper area for belt is indicated at index mark on gauge. Lock adjustment and recheck belt tension. Readjust as necessary.

When using SE-2312 belt tension gauge, remember to set new belts (belt with less than two minutes running time) to the NEW area on gauge face and used belts (more than two minutes running time) to USED area on gauge.

Belt tension may also be checked by using a straight edge and scale as illustrated (Fig. 65).

Approximately 12.7 mm (½ inch) deflection should be measured. The deflection measurement should be made between pulleys at mid-point of longest belt span.

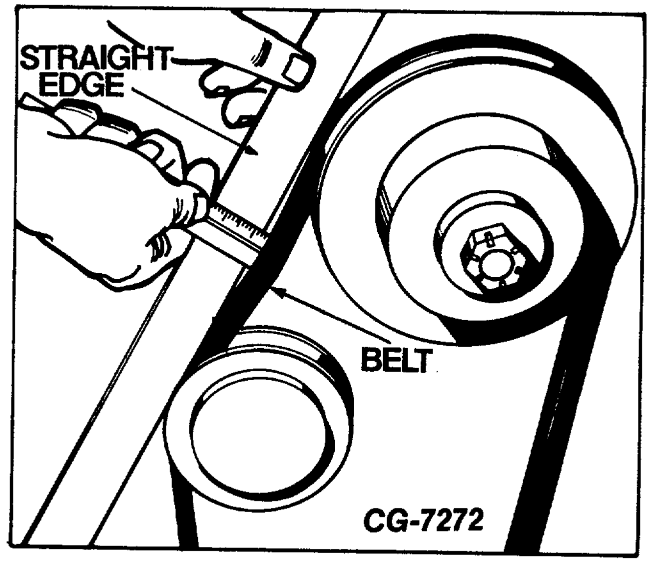


Fig. 65 Measuring Belt Tension

1. Straight Edge 2. Belt

INSPECT AIR PUMP AIR FILTER(S)

Inspect air pump centrifugal air filter; if clogged or damaged, air pump centrifugal filter can be replaced as follows:

(1) Hold pump pulley from turning and remove pulley mounting bolts.

(2) Insert needle nose pliers and pull filter fan from hub (Fig. 66). Care should be taken to prevent fragments of the fan from entering the air intake hole.

(3) Install new filter fan by drawing it on with the pulley and pulley bolts (Fig. 67). Do not attempt to install the filter by hammering or pressing it on.

(4) Draw filter fan down evenly by alternately tightening the pulley mounting bolts. Make certain that the outer edge of the filter slips into the pump housing. A slight amount of interference with housing bore is normal.

(5) Hold pulley from turning and torque pulley bolts to 34 N. m (25 ft. lbs.). The new filter may squeal up on initial operation until its outside diameter sealing lip has worn in.

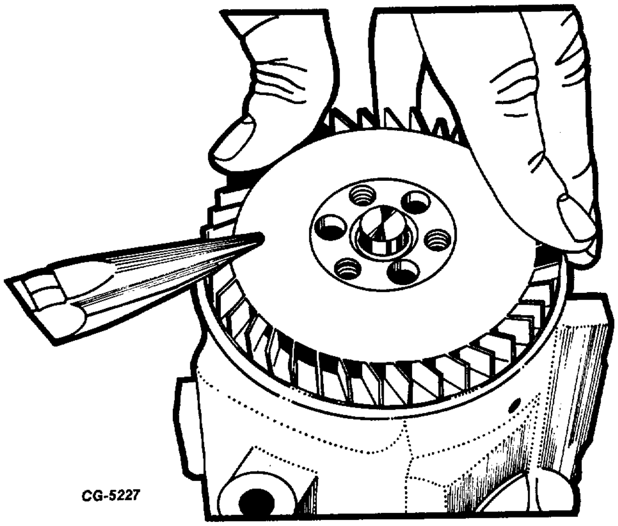


Fig. 66 Removing Centrifugal Air Filter Fan

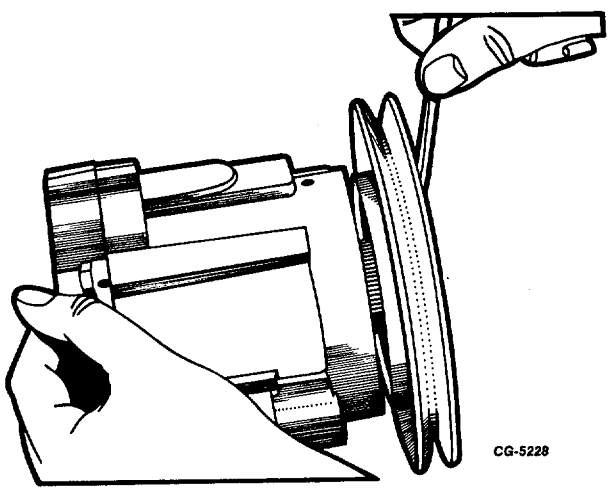


Fig. 67 Installing Centrifugal Air Filter Fan

AIR INJECTION SYSTEM FUNCTIONAL TEST (Not for California)

Perform air injection system functional test as follows:

(1) Disconnect one air injection hose from check valve and plug end of hose. (Fig. 68)

(2) Disconnect other air injection hose from check valve and connect air pump tester SE-2498, or equivalent, to end of hose. (Fig. 68)

(3) Connect tachometer to engine.

(4) Operate engine at speed specified (see Emission Control System Tune-Up Specifications).

(5) Observe air pressure indicated. If air pressure does not exceed minimum specification (see Emission Control Tune-Up Specifications) perform the following steps, a, b and c.

a. Check air hoses for leaks. If leaks are found, replace hose(s) and repeat steps 4 and 5.

b. Check for flow of air through diverter valve external exhaust ports. If air flows through diverter valve external exhaust ports (Fig. 69), valve is faulty and must be replaced. After replacing diverter valve, repeat step b.

c. If the air pump output pressure does not meet minimum specifications, pump output is low and the pump must be replaced. When installing a new pump or adjusting the air pump belt tension, do not pry on the pump housing.

(6) Operate engine at speed specified (see Emission Control System Tune-Up Specifications).

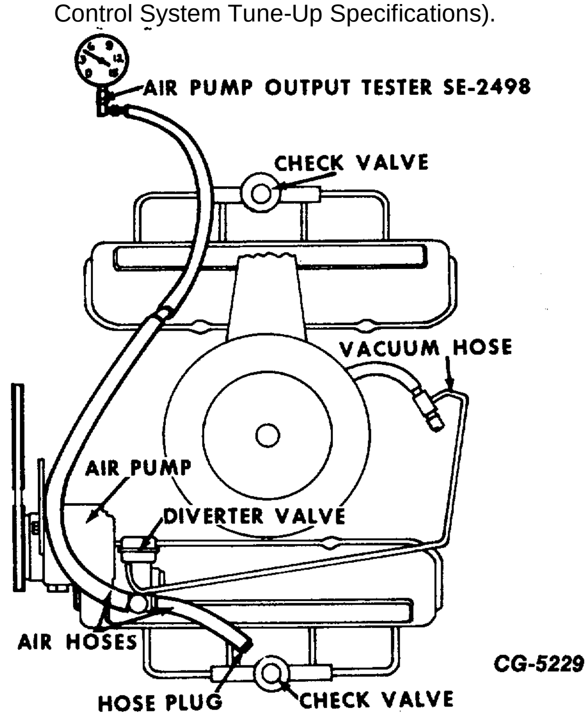


Fig. 68 Checking Air Injection System Output Used on Small V8 Engine (Except California)

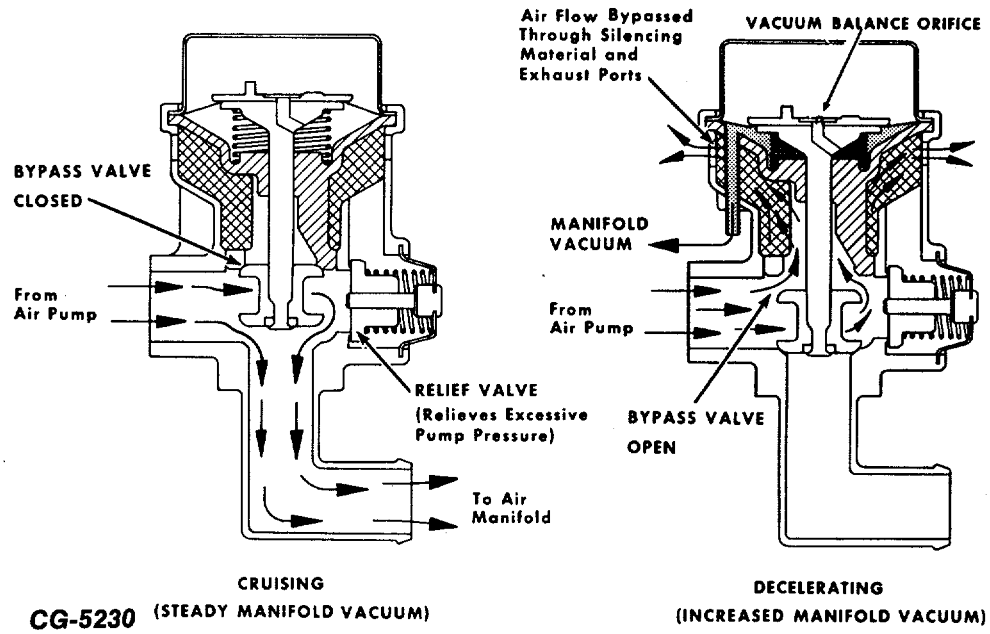


Fig. 69 Typical Diverter Valve Operation

(7) Remove vacuum hose from diverter valve (Fig. 68) and check for a vacuum pull at the end of hose. If no vacuum is felt, replace hose.

(8) Reconnect vacuum hose from diverter valve and check for momentary flow of air through the diverter valve exhaust ports (Fig. 69). After a few seconds, flow of air through the diverter valve exhaust ports should be restored. If diverter valve does not function properly, valve is faulty and must be replaced.

AIR INJECTION SYSTEM FUNCTIONAL TEST (For California)

The air injection system used on engines sold in California consists of two separate systems, one system operating the left bank and the other system operating the right bank. Each system, consisting of an air pump, diverter valve and connecting hoses, must be tested individually.

Perform air injection system functional test as follows:

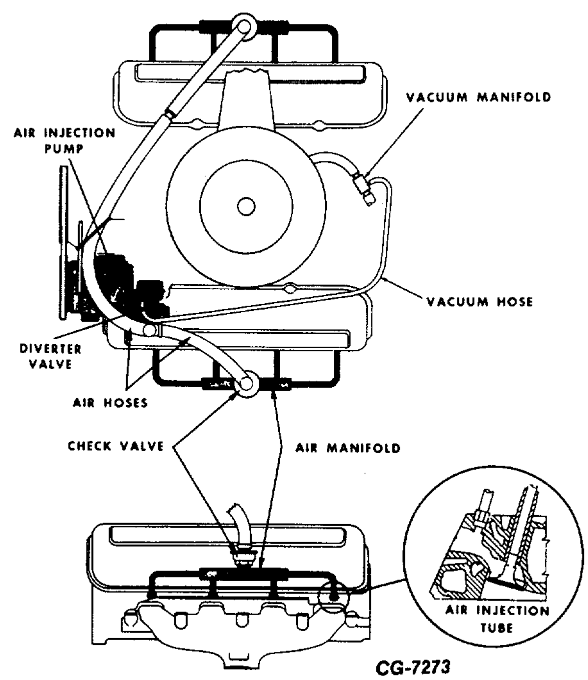


Fig. 70 Air Injection System Used on Small V8 Engine (Except California)

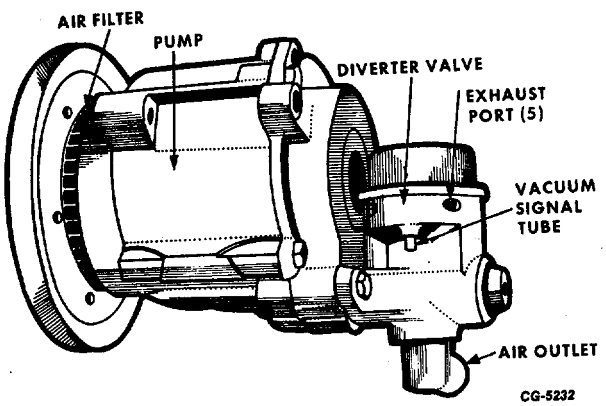


Fig. 71 Air Injection Pump With Diverter Valve (Except California)

(1) Disconnect left bank air injection hose from air manifold check valve and connect air pump output tester SE-2498 to end of hose.

(2) Disconnect left bank pressure limiting hose from air cleaner and plug end of hose.

(3) Connect tachometer to engine.

(4) Operate engine at speed specified (see Emission Control Tune-Up Specifications)

(5) Observe pressure indicated. If air pressure does not exceed minimum specification (see Emission Control Tune-Up Specifications) perform the following steps a, b, c and d.

a. Check air hoses for leaks. Check diverter valve for, external leaks. If leaks are found, replace hose(s) and/or diameter valve and repeat steps 4 and 5.

b. Disconnect air hose (connecting air pump outlet to diverter valve inlet) from diverter valve and connect air pump output tester SE-2498 to end of hose.

c. Operate engine at specified speed (see Emission Control System Tune-Up Specifications) and observe minimum pressure.

(1) If air pressure is less than specified minimum (see Emission Control System Tune-Up Specifications), air pump is faulty and must be replaced. When installing a new air pump or adjusting the air pump belt tension, do not pry on the pump housing.

(2) If air pump pressure is higher than specified minimum (see Emission Control System Tune-Up Specifications), diverter valve is faulty and must be replaced.

d. Connect air pump output tester SE-2498 to air injection hose removed from check valve. Connect air injection hose from air pump to diverter valve inlet and repeat steps 4 and 5.

(6) With the engine operating at speed specified, observe the pressure gauge. Multiply observed pressure by .7 to obtain multiplied pressure. (Example: Observed pressure is 6 PSI and multiply by .7. 6 x .7 = 4.2 PSI multiplied pressure)

(7) Remove plug in the pressure limiting hose and observe the pressure gauge.

a. If observed pressure in step 7 is higher than multiplied pressure in step 6, diverter valve is acceptable for further use.

b. If observed pressure in step 7 is lower than multiplied pressure in step 6, diverter valve is faulty and must be replaced.

(8) With the engine operating at speed specified (see Emission Control System Tune-Up Specifications), remove vacuum hose from diverter valve and check for vacuum pull at the end of the hose. If no vacuum is felt, check for restriction in vacuum hose, vacuum manifold and carburetor vacuum port. Repair as needed.

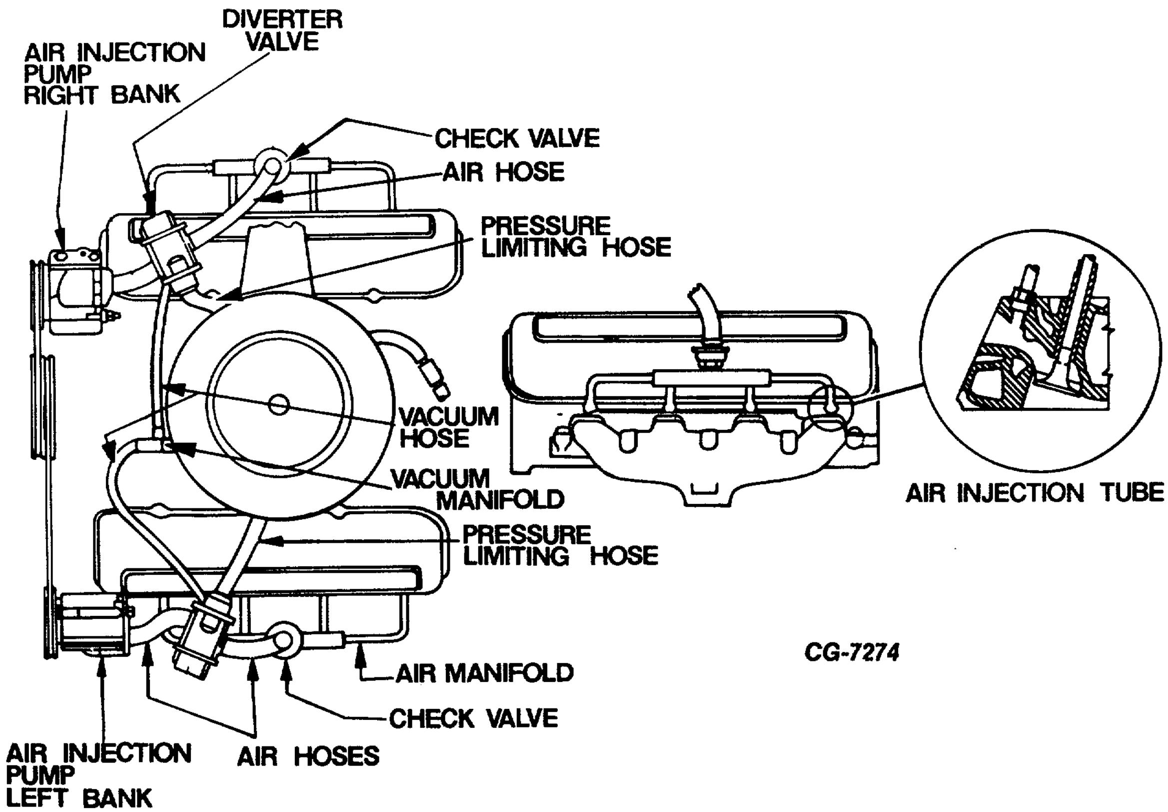


Fig. 72 Air Injection System Used on Small V8 Engine (For California)

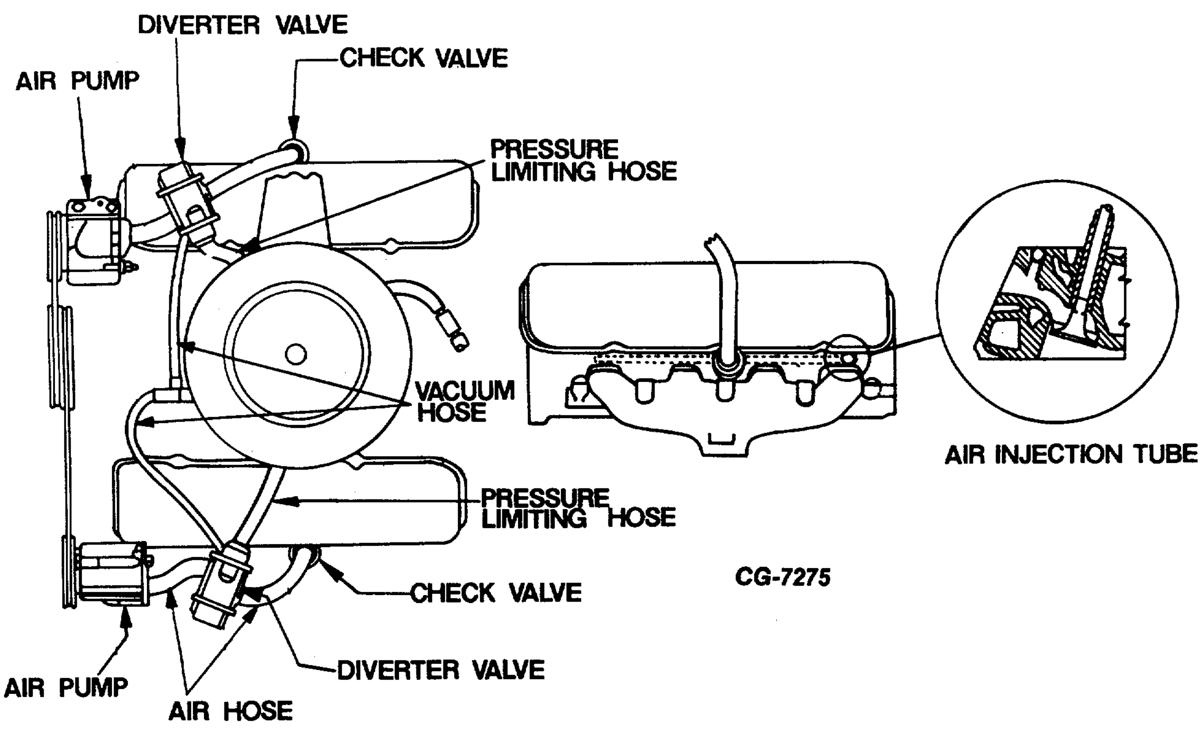


Fig. 73 Air Injection System Used on MV404; 446 Engines (For California)

(9) With engine operating at speed specified (see Emission Control System Tune-Up Specifications), reconnect vacuum hose to diverter valve and check for momentary reduction of air pressure. After a few seconds, air pressure should be restored. This indicates normal operation of the diverter valve. If diverter valve does not function properly, valve is faulty and must be replaced.

(10) Connect air injection hose to air manifold check valve and connect pressure limiting hose to air cleaner.

(11) Complete steps 1 through 10 for the right bank air injection pump and diverter valve.

Check Automatic Choke (where used) for proper setting and free operation

a. See Carburetor Service Manual for proper choke setting procedure.

b. Check choke valve for free operation by opening and closing choke valve manually.

VACUUM HOSE ROUTING

Vacuum Hose Identification Legend

Key Letter	Location	Color Code
A	Carburetor Port-to-Solenoid Valve	Yellow Stripe
B	Solenoid Valve-to-Throttle Modulator	Blue Stripe
C	Carburetor Port or Intake Manifold Fitting to Distributor Vacuum Advance Unit	Red Stripe
D	Carburetor Port-to-High Temperature Vacuum Valve	White Stripe
E	High Temperature Vacuum Valve-to-Distributor Vacuum Advance Unit	Red Stripe
F	High Temperature Vacuum Valve-to-Vacuum Manifold	Purple Stripe
G	Carburetor Port-to-Vacuum Manifold	(Plain)
H	Carburetor Port-to-Low Temperature Vacuum Valve (EGR System)	Green Stripe
I	Low Temperature Vacuum Valve (EGR System) to EGR Valve	Green Stripe
J	Canister-to-Tee	(Plain)
K	Air Cleaner Temperature Sensor-to-Vacuum Manifold	(Plain)
L	Intake Manifold Vacuum Port-to-Tee	(Plain)
M	Carburetor Fuel Bowl to Canister	(Plain)
N	Carburetor Ported Signal Port to Fuel Tank Canister Vacuum Control Port	(Plain)
O	Diverter Valve-to-Tee or Intake Manifold Fitting	Purple Stripe
P	Carburetor Fuel Bowl Canister to PCV Manifold Fitting	(Plain)
Q	Fuel Tank Canister Purge Port to PCV Manifold Fitting	(Plain)

USA - Except California
For engines sold in USA except California use vacuum hose location charts on Figure 74 through and including Figure 81.

USA California only.
For engines sold in California use vacuum hose location charts on Figure 82 through and including Figure 87.

Canada
For engines sold in Canada use vacuum hose location charts on Figure 88 through and including Figure 95.

NOTE: The Canada version of the V-392 engine with the 4150G carburetor is not shown because it does not have any external emission controls.

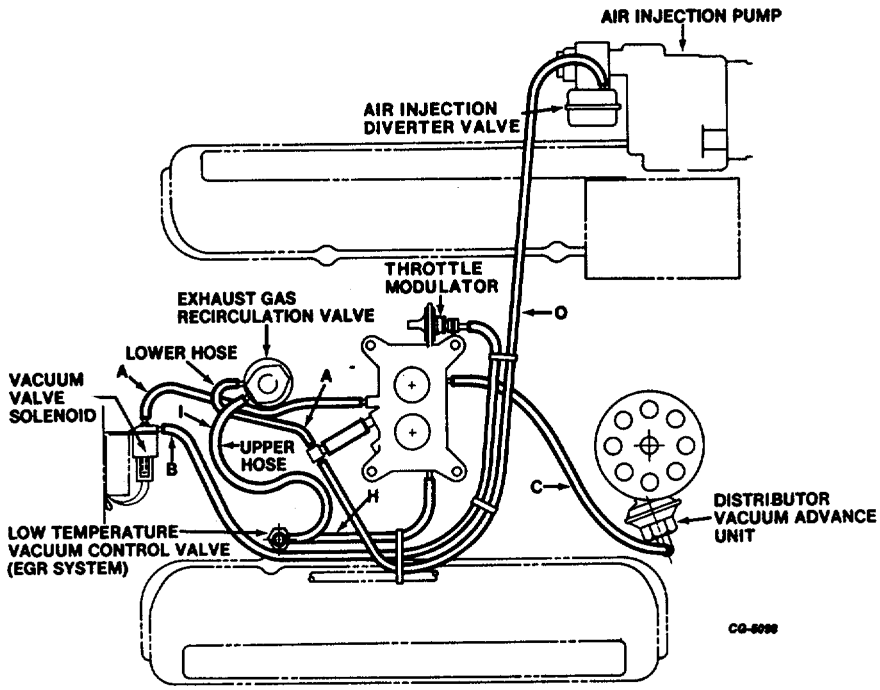


Fig. 74 Vacuum Hose Locations on V-345 Engine With 2210C Carburetor in Cargostar and S-Series Vehicles (Sold in USA Except California)

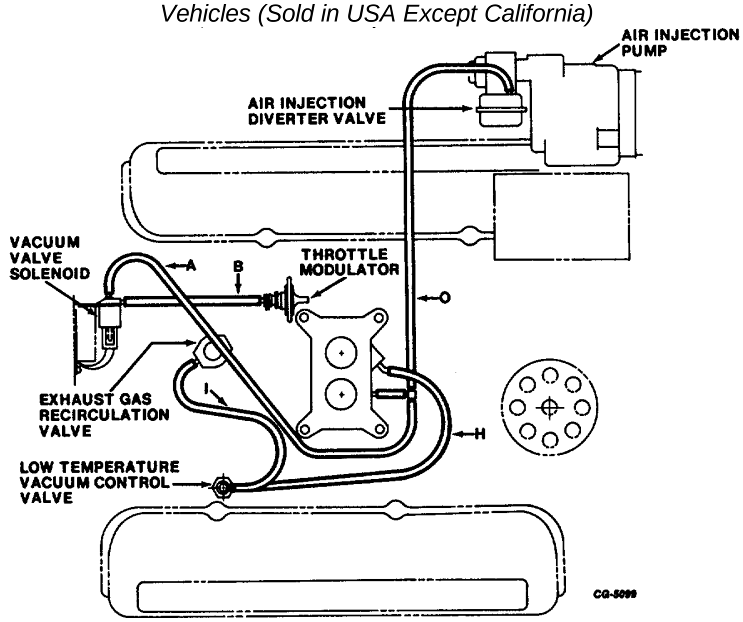


Fig. 75 Vacuum Hose Locations on V-345 Engine With 2300 EG Carburetor in Cargostar and S-Series Vehicles (Sold in USA Except California)

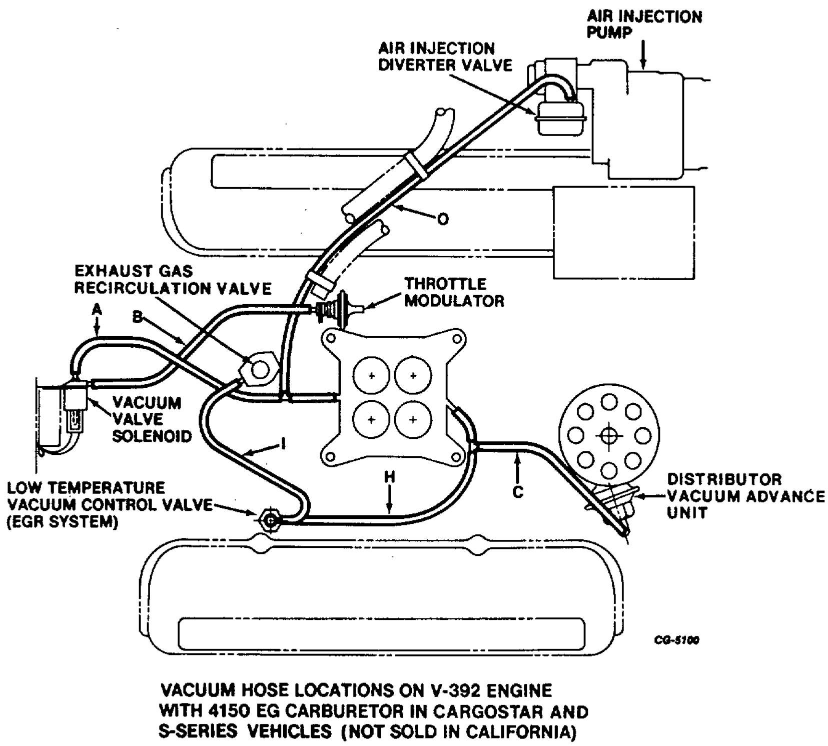


Fig. 76 Vacuum Hose Locations on V-392 Engine With 4150 EG Carburetor in Cargostar and S-Series Vehicles. (Sold in USA Except California)

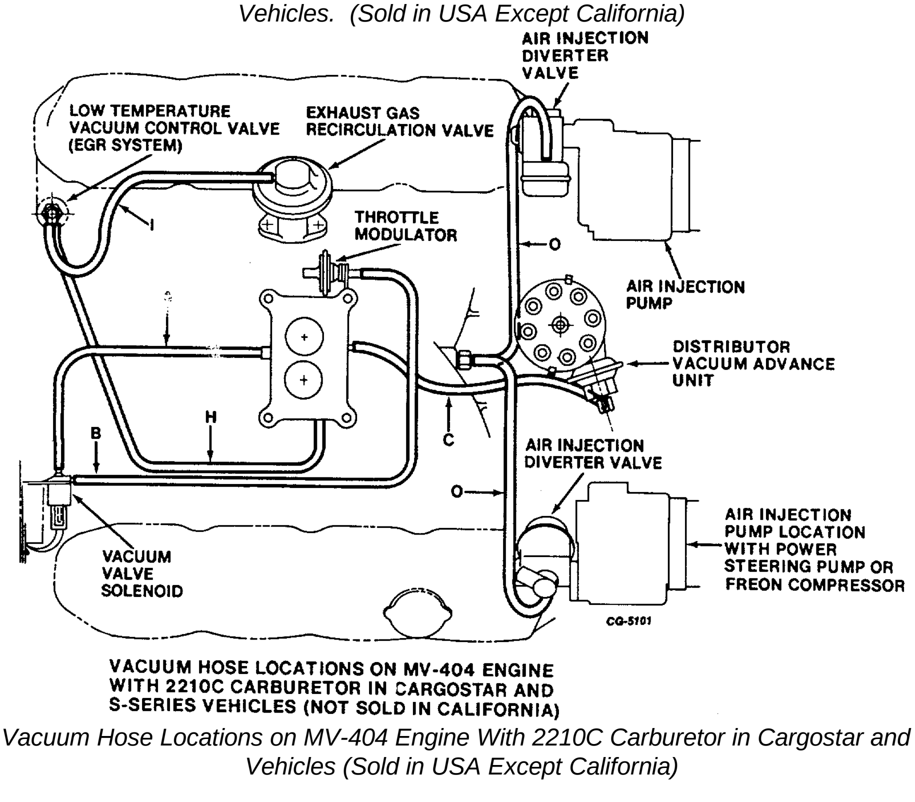


Fig. 77 Vacuum Hose Locations on MV-404 Engine With 2210C Carburetor in Cargostar and S-Series Vehicles (Sold in USA Except California)

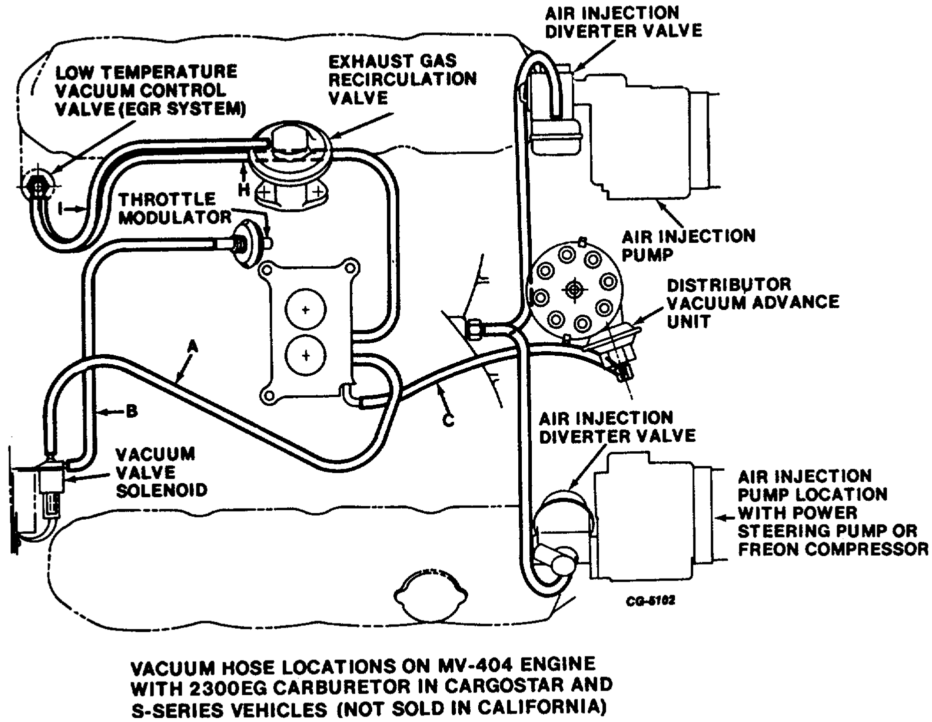


Fig. 78 Vacuum Hose Locations on MV-404 Engine With 2300 EG Carburetor in Cargostar and S-Series Vehicles. (Sold in USA Except California)

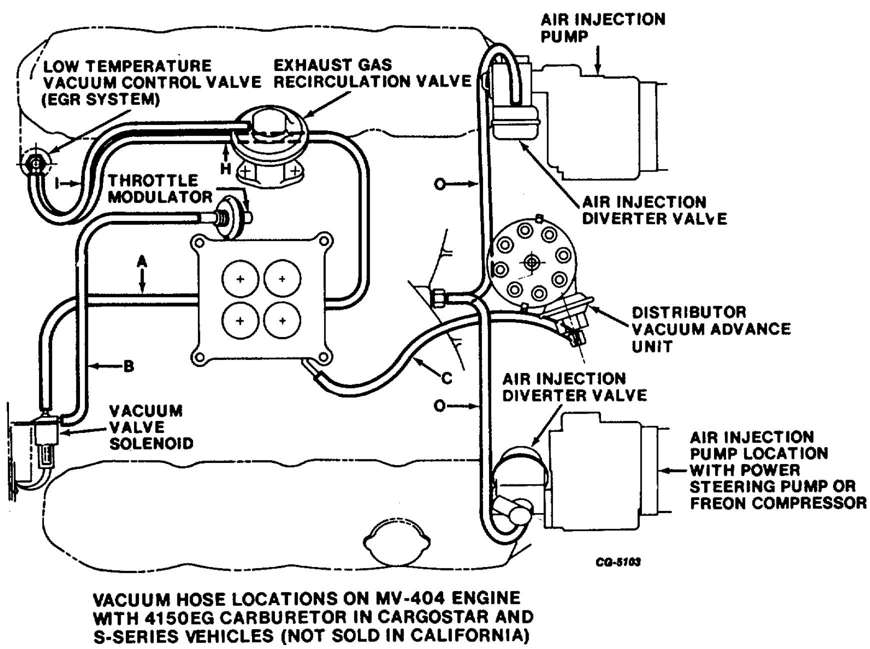
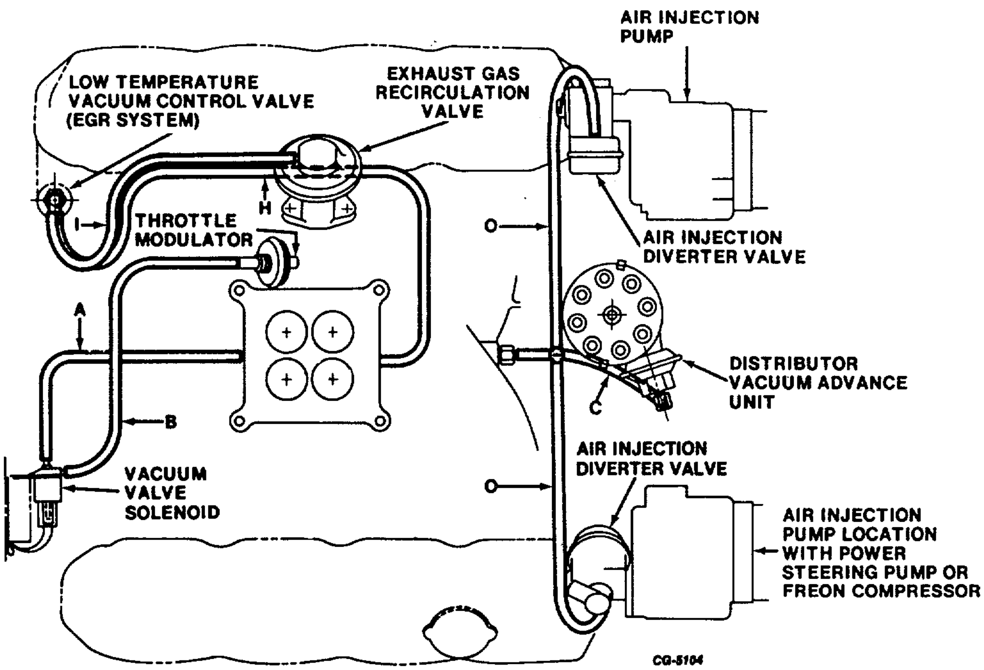
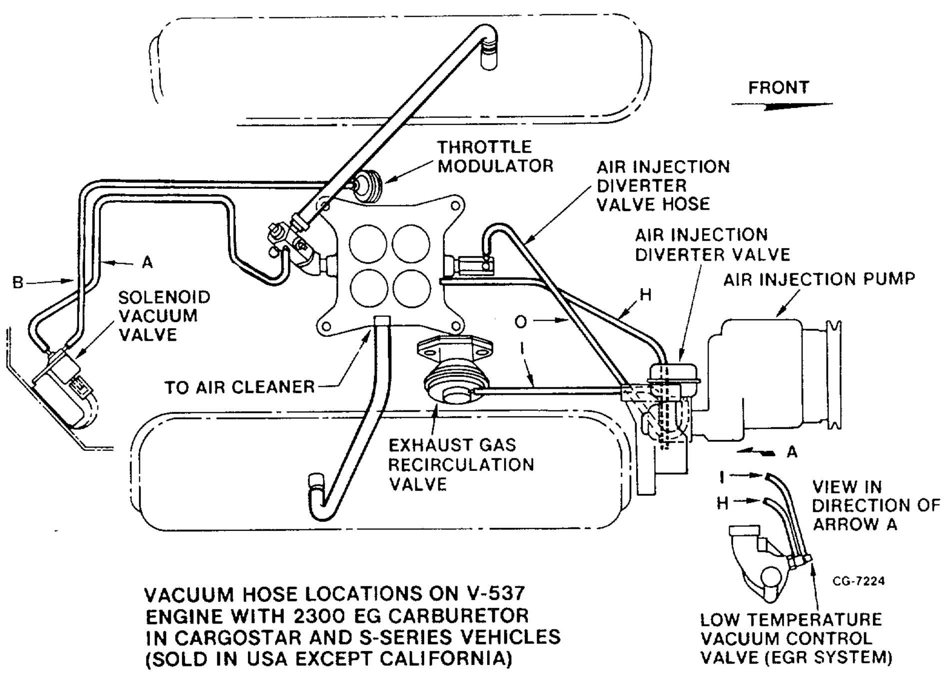


Fig. 79 Vacuum Hose Location on MV-404 Engine With 4150 EG Carburetor in Cargostar and S-Series Vehicles. (Sold in USA Except California)



VACUUM HOSE LOCATIONS ON MV-446 ENGINE WITH 4150EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (NOT SOLD IN CALIFORNIA)

Fig. 80 Vacuum Hose Locations on MV-446 Engine With 4150 EG Carburetor in Cargostar and S-Series Vehicles (Sold in USA Except California)



VACUUM HOSE LOCATIONS ON V-537 ENGINE WITH 2300 EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (SOLD IN USA EXCEPT CALIFORNIA)

Fig. 81 Vacuum Hose Locations on V-537 Engine With 2300 EG Carburetor in Cargostar and S-Series Vehicles (Sold in USA Except California)

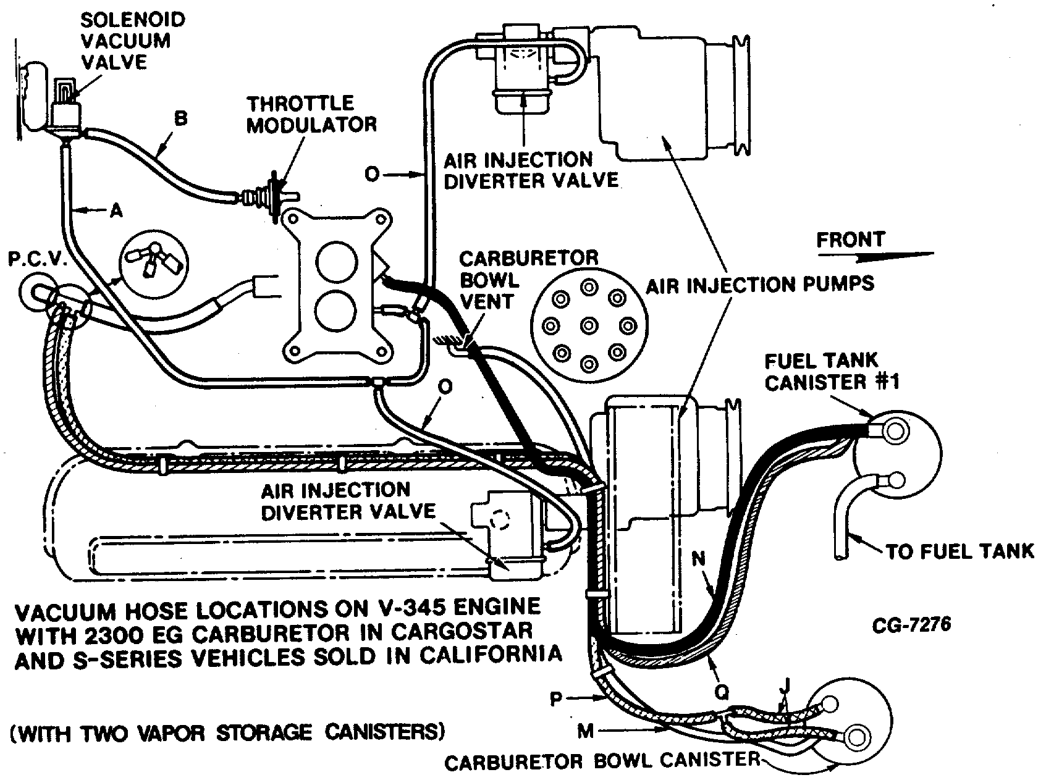


Fig. 82 Vacuum Hose Locations on V-345 Engine With 2300 EG Carburetor in Cargostar and S-Series Vehicles With Two Vapor Storage Canisters (Sold in California)

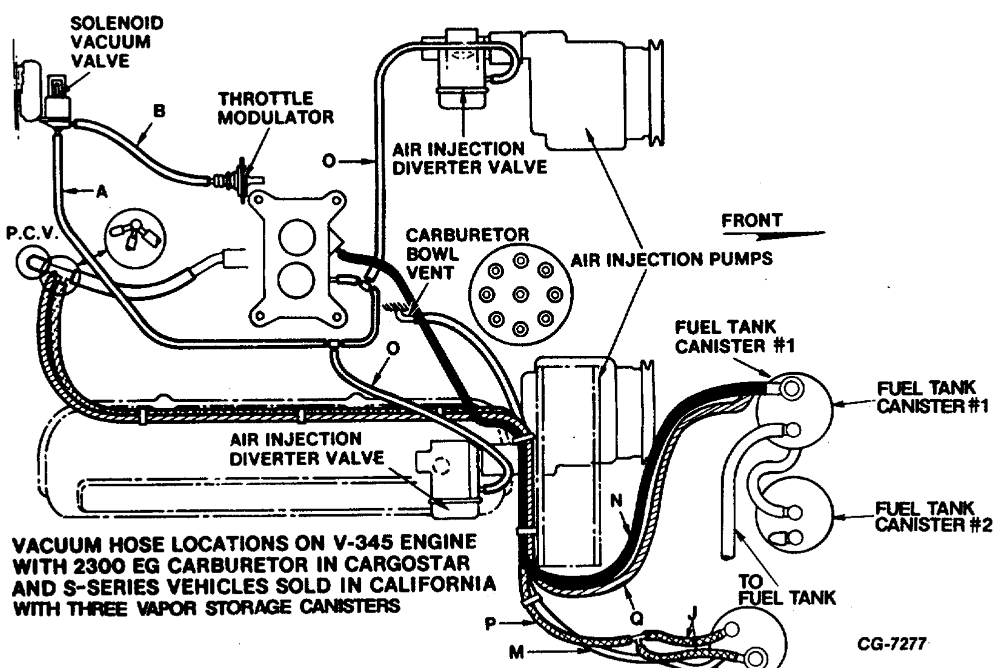


Fig. 83 Vacuum Hose Locations on V-345 Engine With 2300 EG Carburetor in Cargostar and S-Series Vehicles With Three Vapor Storage Canisters (Sold in California)

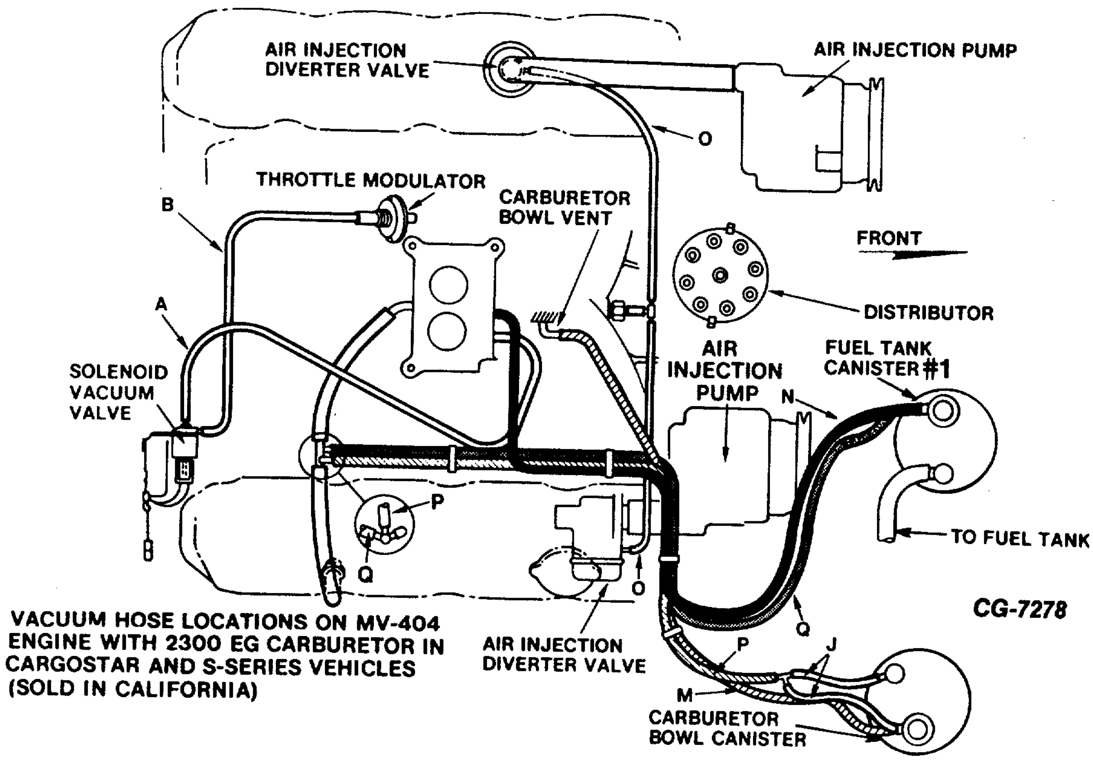


Fig. 84 Vacuum Hose Locations on MV-404 Engine With 2300 EG Carburetor in Cargostar and S-Series Vehicles With Two Vapor Storage Canisters (Sold in California)

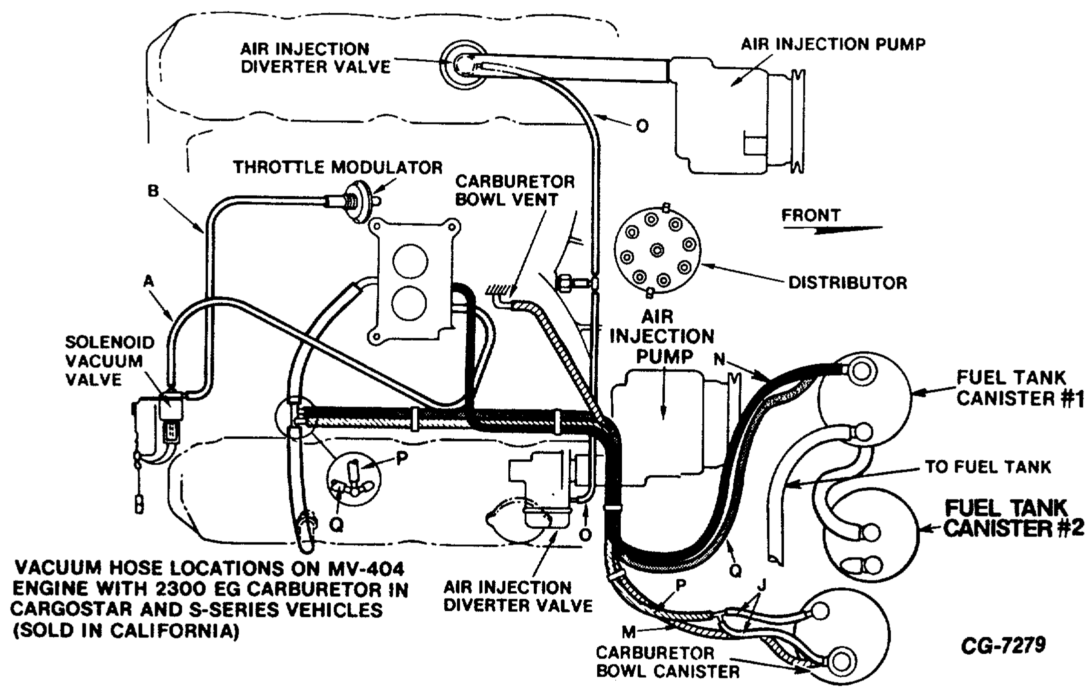


Fig. 85 Vacuum Hose Locations on MV-404 Engine With 2300 EG Carburetor in Cargostar and S-Series Vehicles With Three Vapor Storage Canisters (Sold in California)

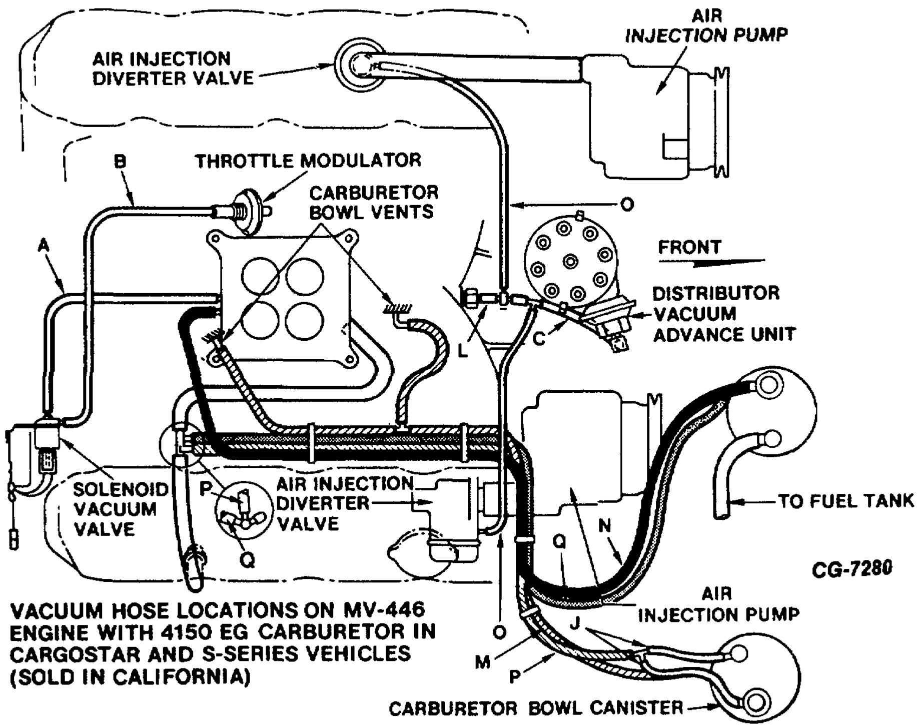


Fig. 86 Vacuum Hose Location on MV-446 Engine With 4150 EG Carburetor in Cargostar and S-Series Vehicles With Two Vapor Storage Canisters (Sold in California)

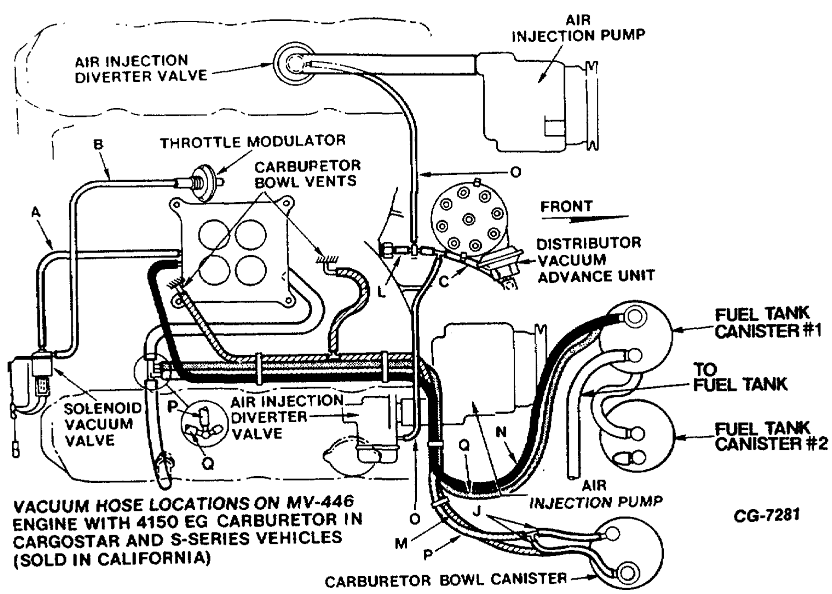


Fig. 86 Vacuum Hose Location on MV-446 Engine With 4150 EG Carburetor in Cargostar and S-Series Vehicles With Three Vapor Storage Canisters (Sold in California)

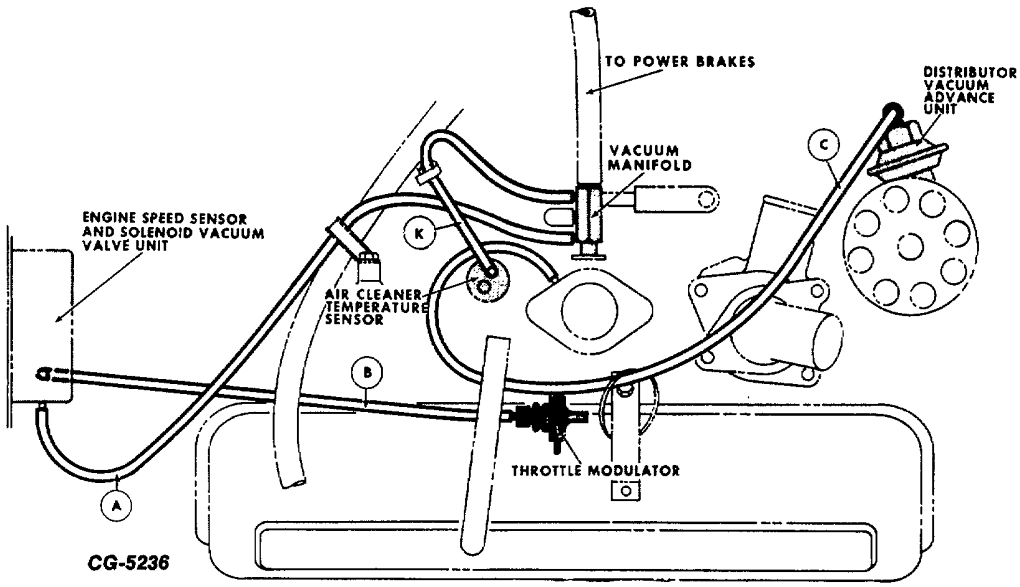


Fig. 88 Vacuum Hose Locations on 4196 Engine With 1940C Carburetor in Scout Vehicles (Sold in Canada)

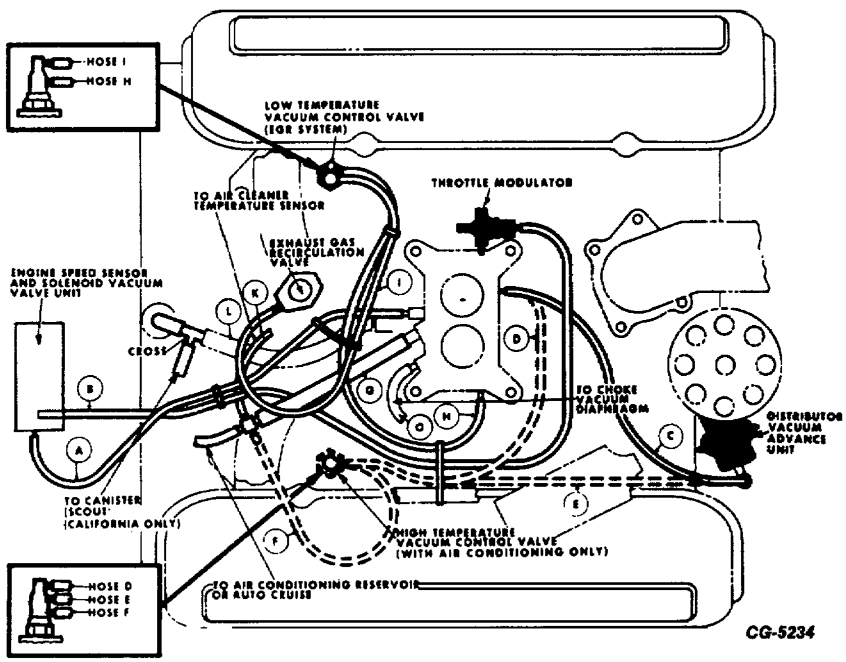


Fig. 89 Vacuum Hose Locations on V-304;345 Engines With 2210C Carburetor in Scout Vehicles (Sold in Canada)

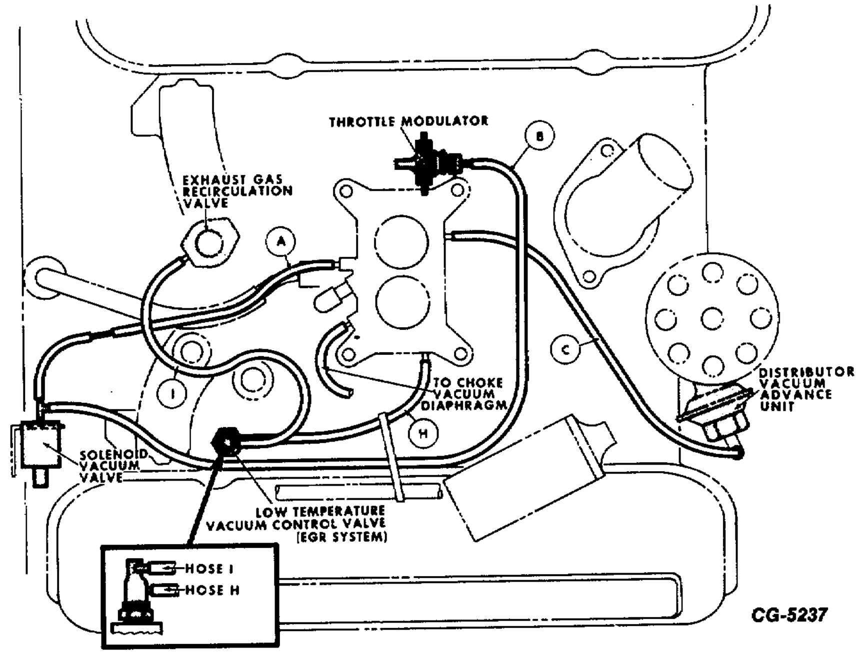


Fig. 90 Vacuum Hose Locations on V-345 Engine With 2210C Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

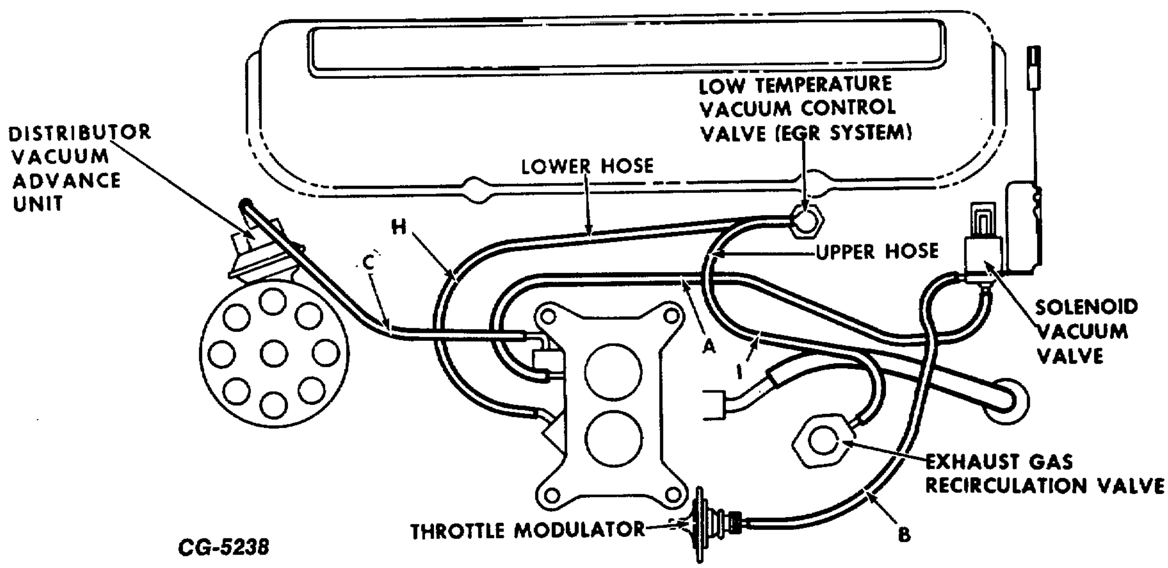


Fig. 91 Vacuum Hose Locations on V-345 Engine With 2300 EG Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

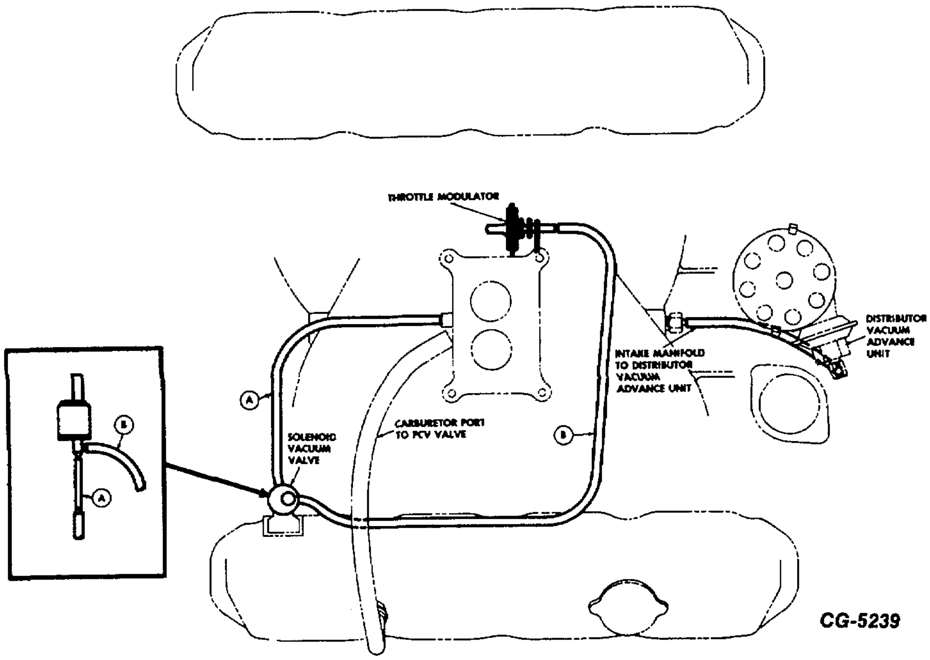


Fig. 92 Vacuum Hose Locations on MV-404 Engine With 2210C Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

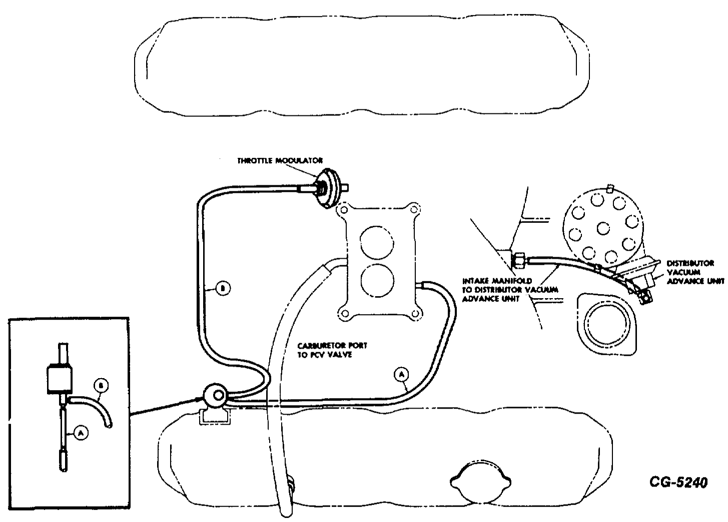


Fig. 93 Vacuum Hose Locations on MV-404 Engine With 2300 EG Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

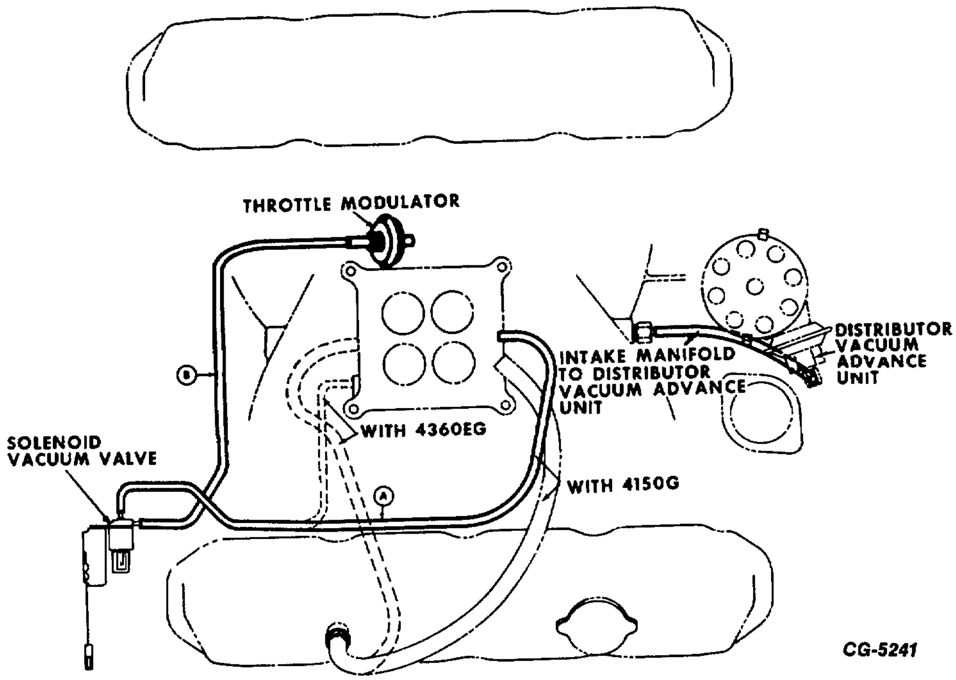


Fig. 94 Vacuum Hose Locations on MV-404;446 Engines With 4150G Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

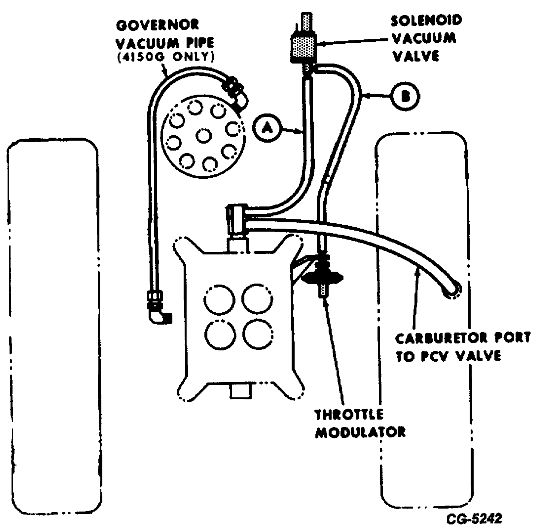


Fig. 95 Vacuum Hose Locations on V-537 Engine With 4150G Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

ENGINE FUEL REQUIREMENTS

Your gasoline engine is designed to operate efficiently in normal operations on "Regular" grade fuels of at least 91 RON (Research Octane Number) or 86.5 anti-knock index designation. (The latter figure is now generally posted on fuel dispensing pumps.) "Low Lead" fuel containing at least .13 gpl (0.5 gpg) lead, or the equivalent additive, per gallon may be used.

Continuous use of gasoline which is completely free of lead, or other lubricating additives such as phosphorus, is not recommended. Prolonged use of such fuel can cause excessive exhaust valve seat wear resulting in loss of emission control, poor performance and possible engine failure.

Because of this, it is recommended that you alternate to regular grade fuel every fourth tank. The alternating fuel method is not necessary with use of low lead content fuel as it can be successfully used without any harm to your engine.

Use of a fuel which is too low in antiknock quality will result in "spark knock." Since anti-knock quality of all "regular" grade gasolines is not the same and factors such as altitude, terrain and air temperature affect operating efficiency, knocking may result even though you are using the grade of fuel recommended for your engine.

Continued engine operation under "Spark Knock" conditions can cause severe engine damage. At these times a higher antiknock quality gasoline is required to prevent engine damage. If knocking persists with higher grade fuel, it is recommended an IH or suitably qualified service outlet be contacted as engine repairs may be needed.

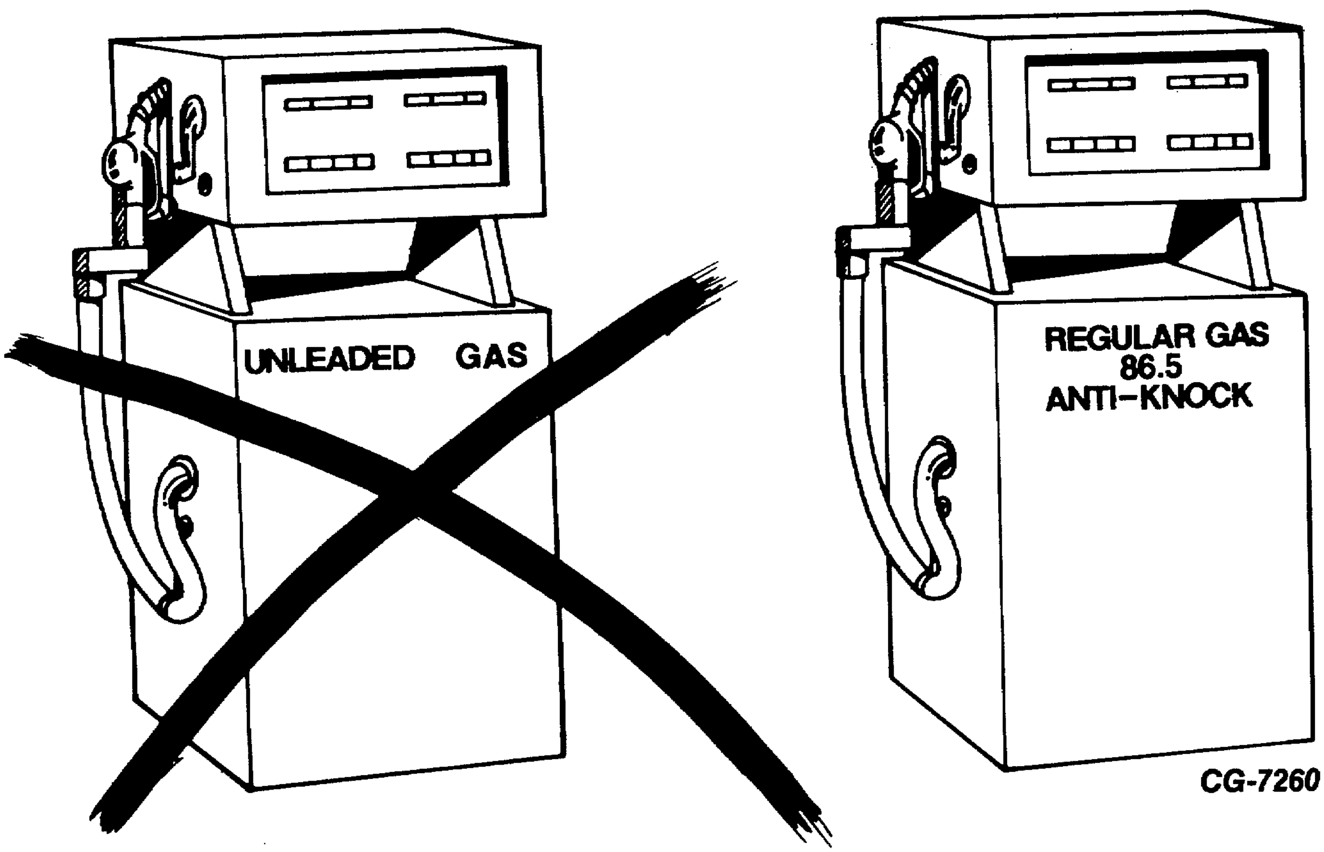


Fig. 96 Engine Fuel Requirements.

Emission Certification Label

The engine exhaust emission control information label attached to the engine valve cover is very valuable to the tune-up technician. It gives him ready information: engine model, cubic inch displacement, timing, idle speeds and idle mixture settings.

Tuning IH Engines Equipped with Emission Controls

Tune-up on engines with emission controls is performed in the conventional manner. It is extremely important that the IH tune-up specifications found in this manual be used. It is necessary to become completely familiar with all types of emission controls, how they operate and how they are serviced.

Using the recommended specifications and procedures will provide good performance in idling characteristics as well as allow the engine to operate within government regulations.

Owners have the responsibility to see that their engine is properly maintained on a regular schedule, or at any hint of an engine malfunction. The service technician has the responsibility to obtain the knowledge and skills to continuously perform each maintenance job completely and without fault.

Emission Control Tune-Up Specifications

The following tune-up specifications cover Canada and U.S.A. engines.

These specifications should be used in conjunction with the scheduled maintenance intervals and the explanation of each maintenance step given on the previous pages.

EMISSION CONTROL SYSTEM TUNE-UP SPECIFICATIONS-1980 (U.S.A. EXCEPT CALIFORNIA)

ENGINE	V-345		V-392	MV-404			MV-446	V-537
CARBURETOR MODEL	2210C	2300EG	4150EG	2210C	2300EG	4150EG	4150EG	2300EG
Ignition System								
Dwell, Degrees: Breakerless Only	24-34							
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")							
Coil Output Voltage @ 2500 RPM	20 KV Min.							
Ignition Timing Without Vacuum Advance Degrees (Engine at Specified Idle RPM)	5° BTDC	TDC		9° BTDC			5° BTDC	7° BTDC
Ignition Cable Resistance (Maximum)								
Up to 36" Long	30K Ohms							
Over 36" Long	45K Ohms							
Cold Starting Enrichment System								
Fast Idle Speed, RPM	2200	2000		1800	2400			2000
Curb Idle Speed and Air/Fuel Mixture								
Curb Idle Speed, RPM (In Neutral)	625-675			525-575*				500-550*
Mixture, %CO	0.5-1.5	1.0-3.0	0.5-1.5	0.5-2.5				1.0-2.0
Speed Drop RPM	60	110	40	50				40
Spark Plugs								
Standard	RJ-10Y (CR435)**			RBN-13Y (R44LTS)**				ON-11Y
Plug Gap	.88 mm (.035")							.76 mm (.030")
Optional for Light Service	N/A							ON-12Y
Plug Gap	N/A							.76 mm (.030")
Optional for Severe Service	RJ-6 (CR-43)**			RBN-4 (R44LT)**				N/A
Plug Gap	.76 mm (.030")							N/A
Torque	38.0-40.7 N·m (28-30 ft.lbs.)			16.3-24.4 N·m (12-18 ft.lbs.)				34.0-40.7 N·m (25-30 ft.lbs.)
Required Voltage @ 100 RPM	8-15 KV							
Exhaust Gas Recirculation System								
Functional Test @ 2000 RPM Vacuum to be Applied	33.7 kPa Hg (10.0" Hg) Min.							
Minimum Speed Drop, RPM	400		485	350				375
Air Injection System								
Engine Speed for Test, RPM	1500	1000						
Minimum Pressure	27.58 kPa (4 psi)							
Decel Throttle Modulator System								
Speed at which Mod. Funct., RPM	1800-1900							
DTM Speed (no load) with Mod. Extended, RPM	1300-1400	1400-1500	1350-1450	1300-1400			1250-1350	1300-1400
Bolt Torque								
Intake Manifold-to-Cylinder Head	34-40 N·m (25-30 ft.lbs.)			36.6-50.2 N·m (27-37 ft.lbs.)				40.7-51.5 N·m (30-38 ft.lbs.)
Exhaust Manifold-to-Cylinder Head				36.6-44.7 N·m (27-33 ft.lbs.)				
Carburetor-to-Intake Manifold	8.1-10.8 N·m (6-8 ft.lbs.)							

N/A = Not Applicable
* = Range 100 RPM higher will Allison Autometic Transmission
** = Approved corresponding spark plug

EMISSION CONTROL SYSTEM TUNE-UP SPECIFICATIONS-1980 (U.S.A. FOR CALIFORNIA)

ENGINE	V-345	MV-404	MV-446
CARBURETOR MODEL	2300EG	2300EG	4150EG
Ignition System Dwell, Degrees: Breakerless Only	24-34		
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")		
Coil Output Voltage @ 2500 RPM	20 KV Min.		
Ignition Timing Without Vacuum Advance Degrees (Engine at Specified Idle RPM)	TDC	5° BTDC	1° BTDC
Ignition Cable Resistance (Maximum) Up to 36" Long Over 36" Long	 30K Ohms 45K Ohms		
Cold Starting Enrichment System Fast Idle Speed, RPM	2800		2400
Curb Idle Speed and Air/Fuel Mixture Curb Idle Speed, RPM (In Neutral)	625-675	525-575*	
Mixture, % CO	1.0-3.0	0.5-2.5	1.0-2.5
Spark Plugs Standard	RJ-10Y (CR-435)**	RBN-13Y (R44LTS)**	
Plug Gap	.88 mm (.035")		
Optional for Light Service	N/A		
Plug Gap	N/A		
Optional for Severe Service	RJ-6 (CR-43)	RBN-4 (R44LT)**	
Plug Gap	.76 mm (.030")		
Torque	38.0-40.7 N·m (28-30 ft.lbs.)	16.3-24.4 N·m (12-18 ft.lbs.)	
Required Voltage @ 100 RPM	8-15 KV		
Exhaust Gas Recirculation System Functional Test @ 2000 RPM Vacuum to be Applied	N/A		
Minimum Speed Drop, RPM	N/A		
Air Injection System Engine Speed for Test, RPM	1200	1070	
Minimum Pressure	27.58 kPa (4 psi)		
Decel Throttle Modulator System Speed at which Mod. Funct., RPM	1800-1900		
DTM Speed (no load) with Mod. Extended, RPM	1400-1500	1300-1400	1350-1450
Bolt Torque Intake Manifold-to-Cylinder Head	34-40 N·m (25-30 ft.lbs.)	36.6-50.2 N·m (27-37 ft.lbs.)	
Exhaust Manifold-to-Cylinder Head		36.6-44.7 N·m (27-33 ft.lbs.)	
Carburetor-to-Intake Manifold	8.1-10.8 N·m (6-8 ft.lbs.)		

N/A = Not applicable
* = Range 100 RPM higher with Allison Automatic Transmission
** = Approved corresponding spark plug

EMISSION CONTROL SYSTEM TUNE-UP SPECIFCATION - 1980
(CANADA)

ENGINE	4-196	V-304	V-345		V-392	MV-404			MV-446	V-537	
CARBURETOR MODEL	1940C	2210C	2210C	2300EG	4150	2210C	2300EG	4150	4150	2300EG	4150
Ignition System Dwell, Degrees: Breaker Point	N/A	28-32				N/A					
Breakerless	24-34										
Gap, Inches: Points - Reset	N/A	.406 - .508 mm (.016"-.020"				N/A N/A					
Air Gap, Trigger Wheel-to-Sensor	.2mm (.008")										
Coil Output Voltage @ 2500 RPM	20 KV Min.										
Ignition Timing Without Vacuum Advance, Degrees (Engine at Specified Idle RPM)	TDC					9°BTDC			5°BTDC	7°BTDC	
Ignition Cable Resistance (Max.): Up to 36" Long Over 36" Long	 30K Ohms 45K Ohms										
Cold Starting Enrichment System Fast Idle Speed, RPM	2000	2200			2000	1800		2400		2000	
Curb Idle Speed & Air/Fuel Mix. Curb Idle Speed, RPM (In Neutral)	525-575	650-700				525-575*				500-550*	
Mixture, %CO	0.5-2.0	2.0max.	1.5 max.		2.0max.	0.5-2.5			0.5-2.5	1.5-3.0	
Speed Drop RPM	30	80	60	110	40	50				40	
Spark Plugs Standard	RJ-10Y (CR435)**					RBN-13Y (R44 LTS)**				ON-118	
Plug Gap	.88 mm (.035")									.76 mm (.030")	
Optional for Light Service	N/A									ON-12Y	
Plug Gap	N/A									.76 mm (.030")	
Optional for Severe Service	N/A		RJ-6 (CR-43)**			RBN-4 (R44LT)**				N/A	
Plug Gap	N/A		.76mm (.030")			.76mm (.030")				N/A	
Torque	38.0-40.7N.m(28-30ft.lb.)					16.3-24.4N.m(12-18ft.lbs.)				34.0-40.7N.m(25-30ft.lbs.)	
Required Voltage @1000 RPM	8 - 15 KV										
Exhaust Gas Recirculation System Functional Test @300 RPM Minimum Speed Increase by Removing Signal Vacuum	N/A	50 rpm	150 rpm		N/A						
Decel Throttle Modulator System Speed at which Modulator Functions, RPM	1800-1900			N/A	N/A	1800-1900					
DTM Speed (No Load) W/Mod. Extended, RPM	1300-1400			N/A	N/A	1300-1400			1250-1350	1300-1400	
Bolt Torque Intake Manifold-to-Cylinder Head						36.6-50.2N.m(27-37ft.lbs.)					
Exhaust Manifold-to-Cylinder Head	34.0-40.7N.m(25-30ft.lbs.)									40.7-51.5N.m(30-38ft.lbs.)	
Carburetor-to-Intake Manifold	8.1 - 10.8 N.m (6-8 ft. lbs.)										

N/A = Not applicable
* = Range 100 rpm higher with Allison Automatic Transmission
** = Approved corresponding spark plug

PART II

TROUBLE-SHOOTING

GUIDE

FOR

INTERNATIONAL

GASOLINE ENGINES

PRINTED IN UNITED STATES OF AMERICA

The following trouble shooting guide can be used for all 1980 International gasoline engines.

If each step is followed, a particular problem can be found and corrected without any difficulty.

To use the guide first diagnose the problem; engine will not start, engine idle speed varies, spark knock or pinging, etc. Check the engine diagnostic chart page for the chart number show ing the problem. The engine diagnostic chart page shows a chart number for each diagram in the guide.

When the problem is isolated to a particular component and more information is needed for repair or replacement, find the appropriate IH Truck Service Manual for the faulty component by referring to the chart below.

IH ENGINE DIVISION SERVICE MANUAL OR
IH TRUCK SERVICE MANUAL CTS NUMBERS AND SUBJECTS
FOR USE WITH ENGINE DIAGNOSTIC CHARTS

COOLING

CTS No.	Description
2019	General Information
ELECTRICAL	
2024	Battery
2013	Ignition Coils
2016	Spark Plugs
CGES-150	Distributor, Model IDN 4100 Prestolite
CGES-145	Electronic Ignition System With Integral Module
2258	Starter Motor (Standard)
CGES-230	Starter Motor (Heavy Duty)
ENGINE	
2145	Failure Analysis - All Engines
2523	Diagnosing Excessive Oil Consumption
CGES-160	V-304/345/392 (8-Cylinder)
2682	4-196 (4-Cylinder)
CGES-210	MV-404/446 (8-Cylinder)
2683	V-537
FUEL SYSTEM	
CGES-120	Carburetor, Model 2300G
CGES-125	Carburetor, Model 4150G
CGES-110	Carburetor, Model 1940C
CGES-115	Carburetor, Model 2210C
2050	Fuel Pump
2056	Air Cleaner
PROPELLER SHAFT	
2045	General Information
2046	Universal Joints and Center Bearings
COMPLETE IH TRUCK SERVICE MANUALS (1980)	
2313	Scout
2315	Loadstar, Cargostar (Medium Duty)
2314	Paystar, Co-Transtar (Heavy Duty)
2311	S-Series
2001	Complete Service Manual for all IH Vehicles

ENGINE DIAGNOSTIC CHARTS

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CHART NO. 01
ENGINE WILL NOT CRANK - STARTER SPINS

Verify the Condition

Remove starter and inspect for broken or worn starter drive

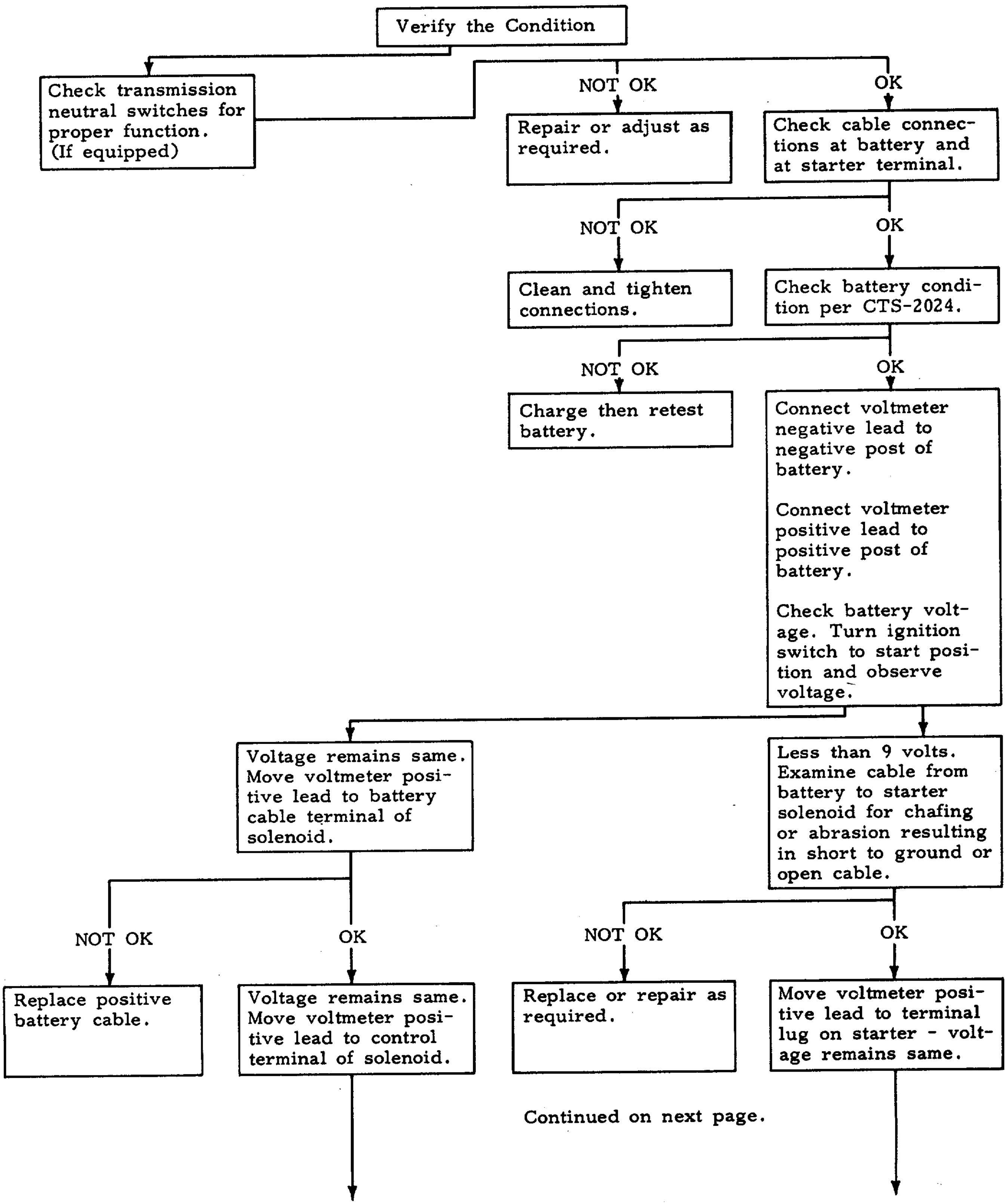
NOT OK: Replace starter drive. Inspect flywheel assembly and repair and/or replace as required.

OK: Perform starter bench tests. Per CTS-2258 or CGES-230.

NOT OK: Repair and/or replace starter assembly as required.

OK: Repair and/or replace flywheel and ring gear assembly.

CHART NO. 02
ENGINE WILL NOT CRANK



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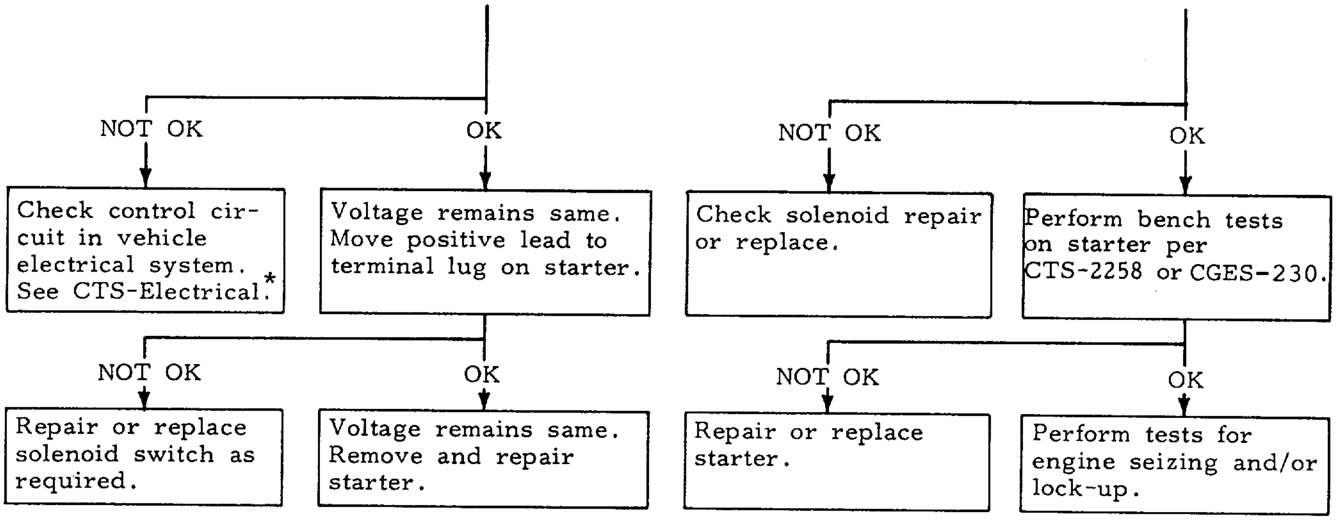
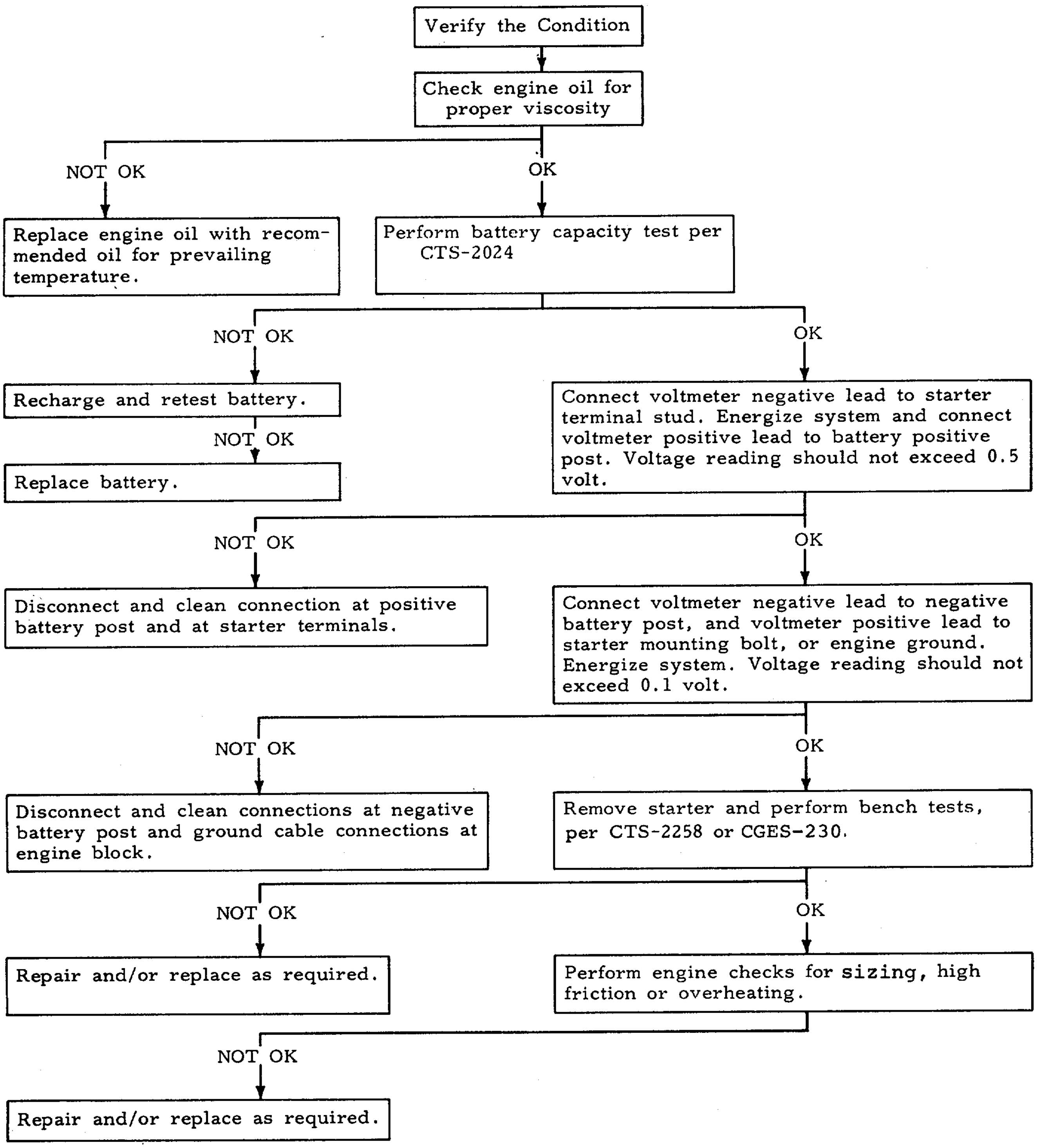


*See CTS or CGES.

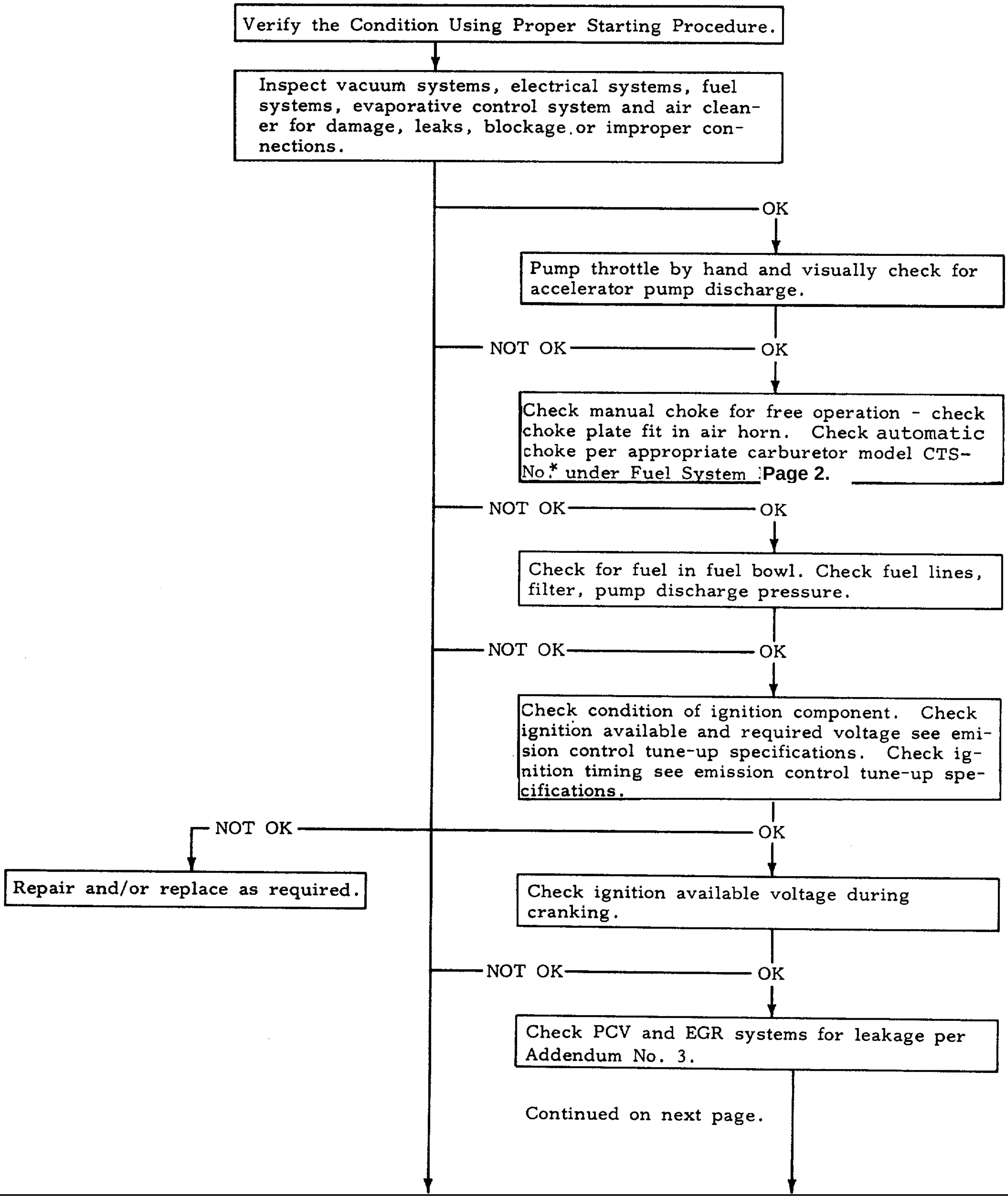
CHART NO. 03

ENGINE CRANKS SLOWLY



* See CTS or CGES.

CHART NO. 04
ENGINE CRANKS NORMALLY - STARTS HARD WHEN COLD



* See CTS or CGES.

NOT OK — OK

Perform cylinder compression and/or leakage test per Addendum No. 2.

NOT OK

Refer to appropriate engine model CTS-No.* under Engine, Page 2 for repair.

*See CTS or CGES.

CHART NO. 05
ENGINE CRANKS NORMALLY - STARTS HARD WHEN HOT

Verify the Condition Using Proper Starting Procedures.

Inspect vacuum systems, electrical systems, fuel systems, evaporative control system and air cleaner for damage, leaks, blockage and proper connections.

NOT OK → Repair and/or replace as required.

OK → Check hot engine for flooding or percolation condition.

NOT OK → Replace fuel inlet needle and seat. Check condition of carburetor insulator/gasket. Repair as required. See appropriate carburetor model CTS-No.* under Fuel Systems, Page 2.

OK → Check for wide open choke plate.

NOT OK → (to Repair and/or replace as required. See appropriate carburetor model CTS-No.* under Fuel System, Page 2.)

OK → Check for vapor lock condition per Addendum No. 1 at the end of this section.

NOT OK → Repair and/or replace as required. See appropriate carburetor model CTS-No.* under Fuel System, Page 2.

OK → Check for overheating.

NOT OK → Refer to Diagnostic Chart No. 20.

OK → Check condition of ignition systems components. Check ignition system available and required voltage see emission control tune-up specifications. Check ignition timing see same specifications.

NOT OK → Repair and/or replace as required.

OK → Check PCV system and EGR system for leakage per Addendum No. 3.

Continued on next page.

*See CTS or CGES.

NOT OK — OK

Check exhaust heat control valve, and for restricted exhaust system.

NOT OK — OK

Perform cylinder compression and/or leakage test per Addendum No. 2.

NOT OK

Refer to appropriate engine model CTS-No.* under Engine, Page 2 for repair.

*See CTS or CGES.

CHART NO. 06
ENGINE IDLES ROUGH - MISSES (WARM OR COLD ENGINE)

Verify the Condition

Inspect vacuum systems, electrical systems, fuel systems, evaporative control system and air cleaner for damage, leaks or improper connections.

NOT OK — OK

Check the integrity of all vacuum systems and check for leaks per Addendum No. 3.

NOT OK — OK

Repair or replace as required.

Perform idle set adjustments per emission control tune-up specifications for appropriate engine.

NOT OK — OK

Check for flooding condition: Look for black smoke in vehicle exhaust.

NOT OK — OK

Replace carburetor inlet needle valve assembly see appropriate carburetor model CTS-No.* under Fuel Systems, Page 2.

Check for proper choke settings see appropriate carburetor model CTS-No.* under Fuel Systems, Page 2.

NOT OK — OK

Perform ignition system tests see appropriate distributor model CTS-No.* under Electrical, Page 2.

Check ignition timing see emission control tune-up specification.

Check condition of ignition components.

NOT OK — OK

Repair and/or replace as required.

Check EGR and PCV systems for leakage per Addendum No. 3.

Continued on next page.

*See CTS or CGES

NOT OK — OK

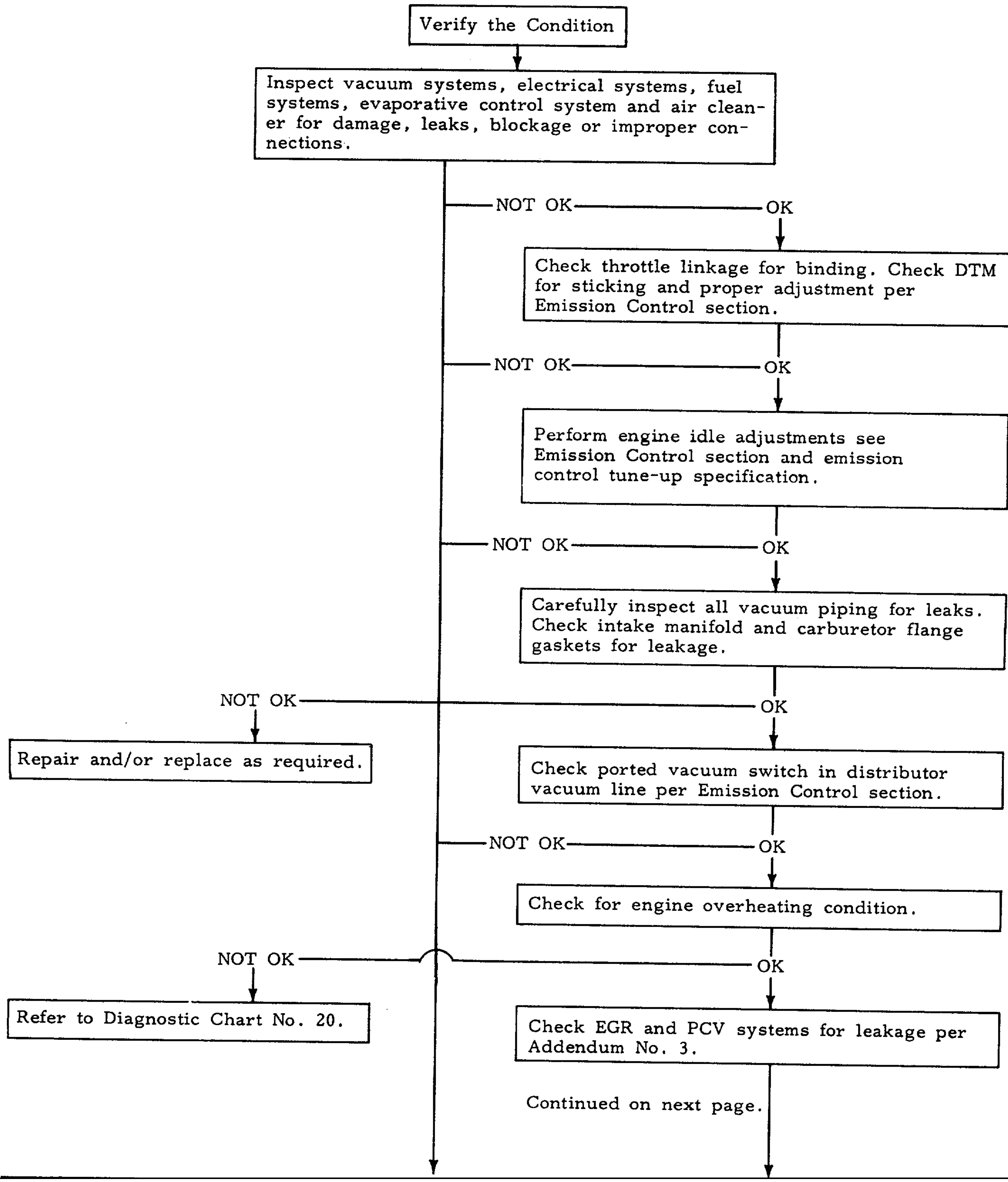
Perform compression and/or cylinder leakage test per Addendum No. 2.

NOT OK

Refer to appropriate engine model CTS-No.* under Engine, Page 2.

*See CTS or CGES

CHART NO. 07
ENGINE IDLE SPEED VARIES



NOT OK — OK

Perform ignition system tests see emission control tune-up specification.

Check ignition timing see same specification.

NOT OK — OK

Check distributor mechanical and vacuum advance curves see appropriate distributor model CTS-No.* under Electrical.

NOT OK — OK

Perform compression and/or cylinder leakage tests per Addendum 2.

NOT OK

Refer to appropriate engine model CTS-No.* under Engine, Page 2

*See CTS or CGES.

CHART NO. 08
ENGINE MISSES AT HIGH SPEED

Verify the Condition

Inspect vacuum hoses, electrical wiring, fuel system, air cleaner, duct, valve, element, evaporative system for leaks, damage or improper connections.

OK

Carefully inspect condition of all ignition system components.

NOT OK — OK

Perform ignition system tests using emission control tune-up specification.

NOT OK — OK

Repair and/or replace as required.

Remove and inspect spark plugs.

NOT OK — OK

Check fuel filter for plugging. Check fuel pump discharge pressure per Addendum No. 1.

NOT OK — OK

Inspect carburetor for presence of dirt in metering systems.

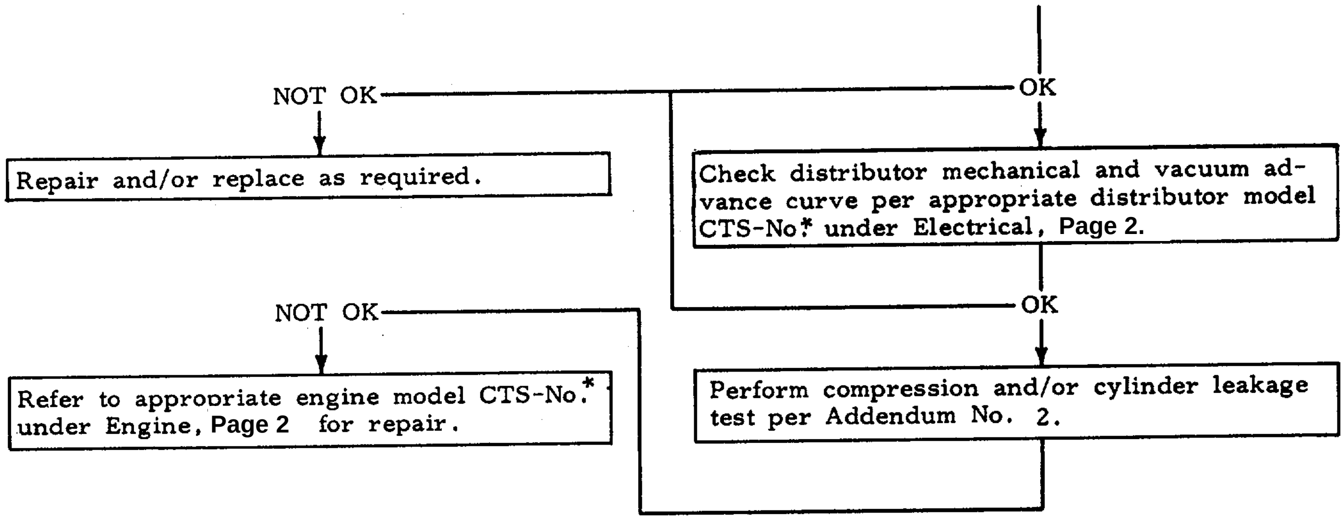
NOT OK — OK

Clean or overhaul carburetor per appropriate carburetor model CTS-No.* under Fuel System, Page 2.

Check system for vapor lock condition per Addendum No. 1.

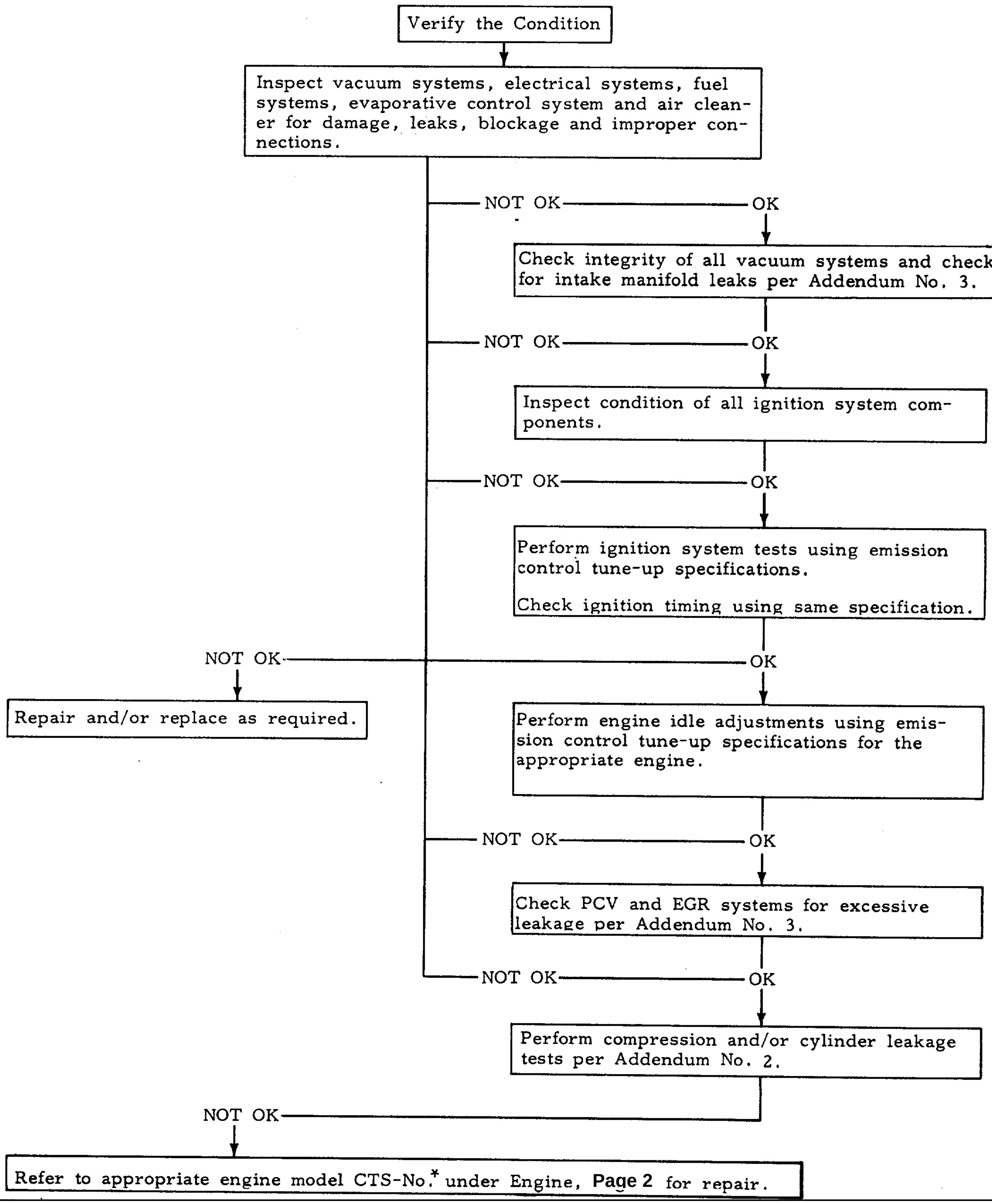
Continued on next page.

*See CTS or CGES.



*See CTS or CGES

CHART NO. 09
ENGINE MISSES AT LOW SPEED



*See CTS or CGES.

CHART NO. 10
ENGINE STALLS AT IDLE - ENGINE COLD

Verify the Condition

Inspect vacuum systems, electrical systems, fuel systems, evaporative control system and air cleaner for damage, leaks or improper connections.

NOT OK — Repair and/or replace as required.

OK — Check choke for proper operation - binding, sticking and/or improper adjustment.

NOT OK — Perform choke adjustments per appropriate carburetor model CTS-No.* under Fuel System, Page 2.

OK — Check for carburetor icing.

NOT OK — Thaw carburetor and add anti-icing additive to fuel.

OK — Perform engine idle adjustments per emission control tune-up specifications.

NOT OK — Repair and/or replace as required.

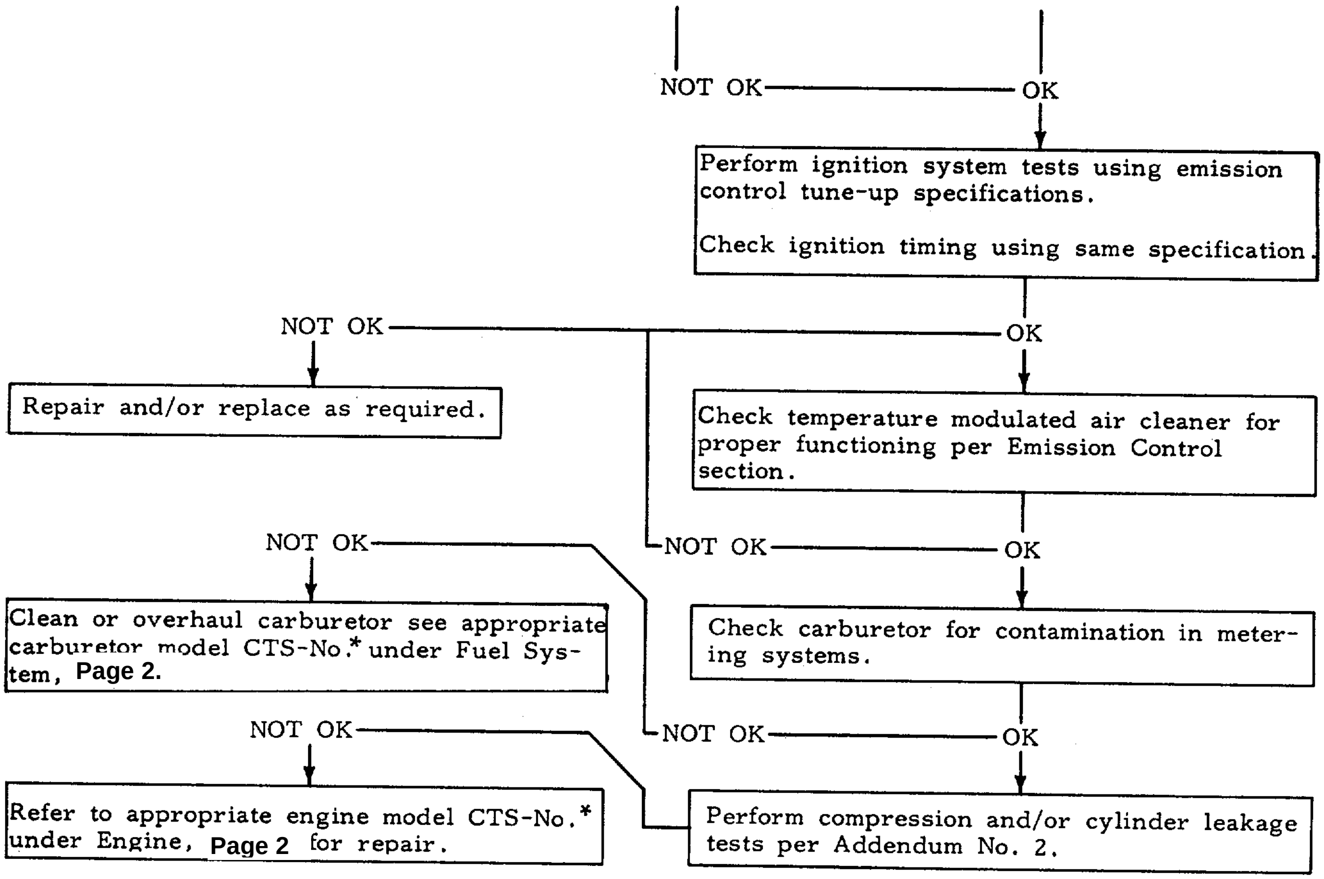
OK — Check operation of EGR cold switch per CTS-* Emission Control section.

NOT OK / OK — Check EGR and PCV systems for excessive leakage per Addendum No. 3.

NOT OK / OK — Check condition of all ignition components.

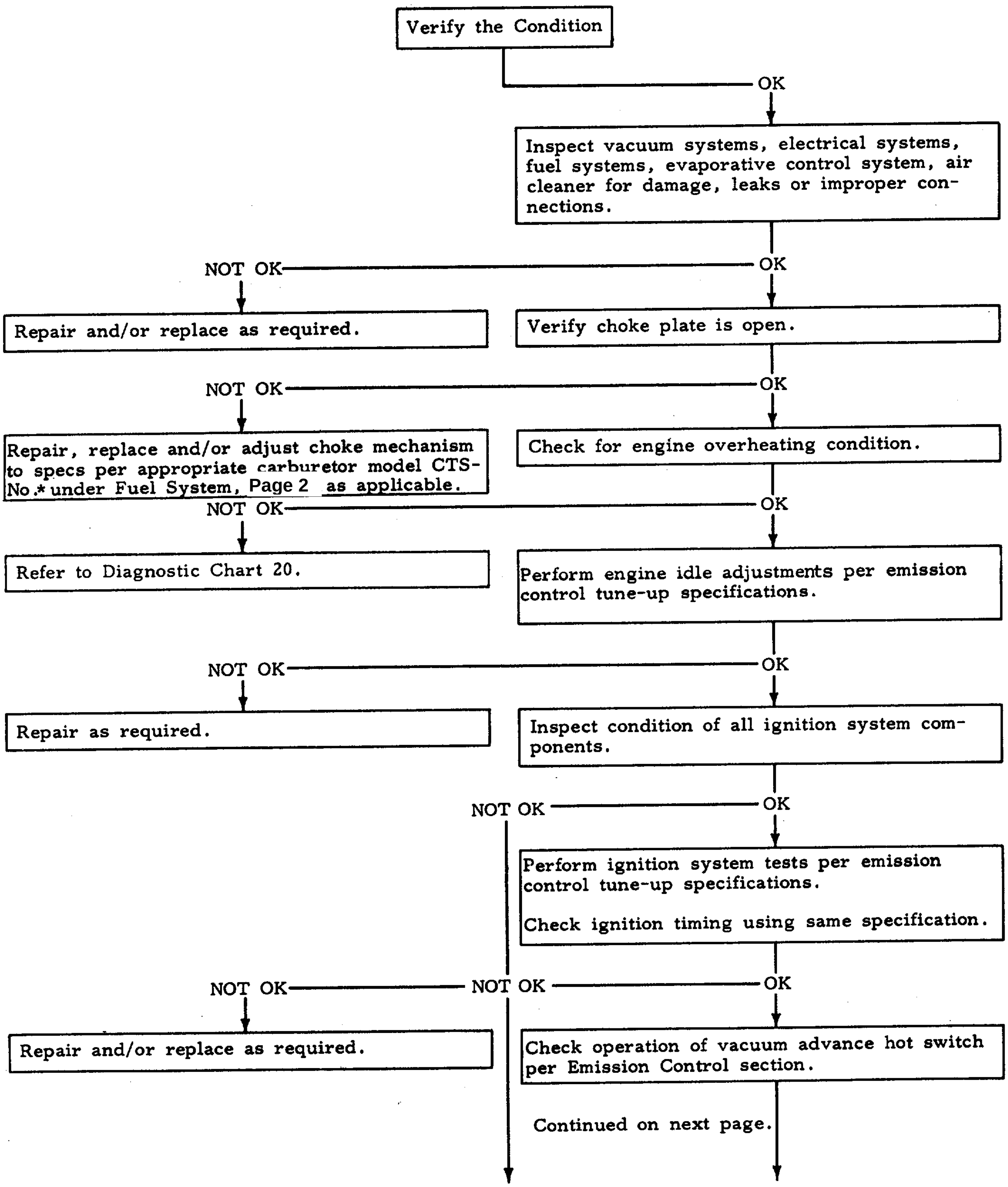
Continued on next page.

*See CTS or CGES



*See CTS or CGES.

CHART NO. 11
ENGINE STALLS AT IDLE - ENGINE HOT



*See CTS or CGES.

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NOT OK — OK

Check for vapor lock conditions per Addendum No. 1.

NOT OK — OK

Repair and/or replace as required.

Check carburetor for contamination in metering systems.

NOT OK — OK

Clean or overhaul carburetor per CTS*fuel system section.

Perform compression and/or cylinder leakage tests per Addendum No. 2.

NOT OK

Refer to appropriate engine model CTS-No.* under Engine, Page 2 for repair.

*See CTS or CGES.

CHART NO. 12
ENGINE HESITATES-STALLS DURING ACCELERATION

Verify the Condition

OK ↓

Inspect vacuum systems, electrical systems, fuel systems, evaporative control system, air cleaner for damage, leaks or improper connections.

- NOT OK → Repair and/or replace as required.
- OK → Remove air cleaner, pump throttle by hand. Observe accelerator pump discharge.
  - NOT OK → Repair or replace accelerator pump per appropriate carburetor model CTS-No.* under Fuel System, Page 2.
  - OK → Inspect condition of all ignition system components.
    - NOT OK → Repair and/or replace as required.
    - OK → Perform ignition system tests per emission control tune-up specifications. Check ignition timing using same specification.
      - NOT OK → Repair and/or replace as required.
      - OK → Check fuel pump discharge pressure. Check for plugged fuel filter.
        - NOT OK → Replace fuel pump or fuel filter as required.
        - OK → Check for vapor lock condition per Addendum No. 1.
          - NOT OK → Repair and/or replace as required per Addendum No. 1.
          - OK → Check carburetor for contamination in metering system

Continued on next page.

* See CTS or CGES.

NOT OK — OK

Clean or overhaul carburetor per appropriate carburetor model CTS-No.*under Fuel System, Page 2.

Check distributor mechanical and vacuum advance curves per appropriate distributor model CTS-No.*under Electrical, Page 2.

NOT OK — OK

Repair and/or replace as required.

Perform compression and/or cylinder leakage tests per Addendum No. 2.

NOT OK

Refer to appropriate engine model CTS-No.* under Engine. Page 2 for repair.

* See CTS or CGES.

CHART NO. 13
ENGINE HAS POOR ACCLERATION
(LESS THAN NORMAL POWER)

Verify the Condition

Inspect vacuum systems, electrical system, fuel system, evaporative control system and air cleaner for damage, leaks or improper connections.

OK

Inspect condition of all ignition system components.

OK

Perform ignition system tests per emission control tune-up specifications.

Check ignition timing using same specification.

NOT OK — OK

Check for clogged fuel filter.

Check fuel pump discharge pressure.

NOT OK — OK

Check for clogged air filter element.

NOT OK — OK

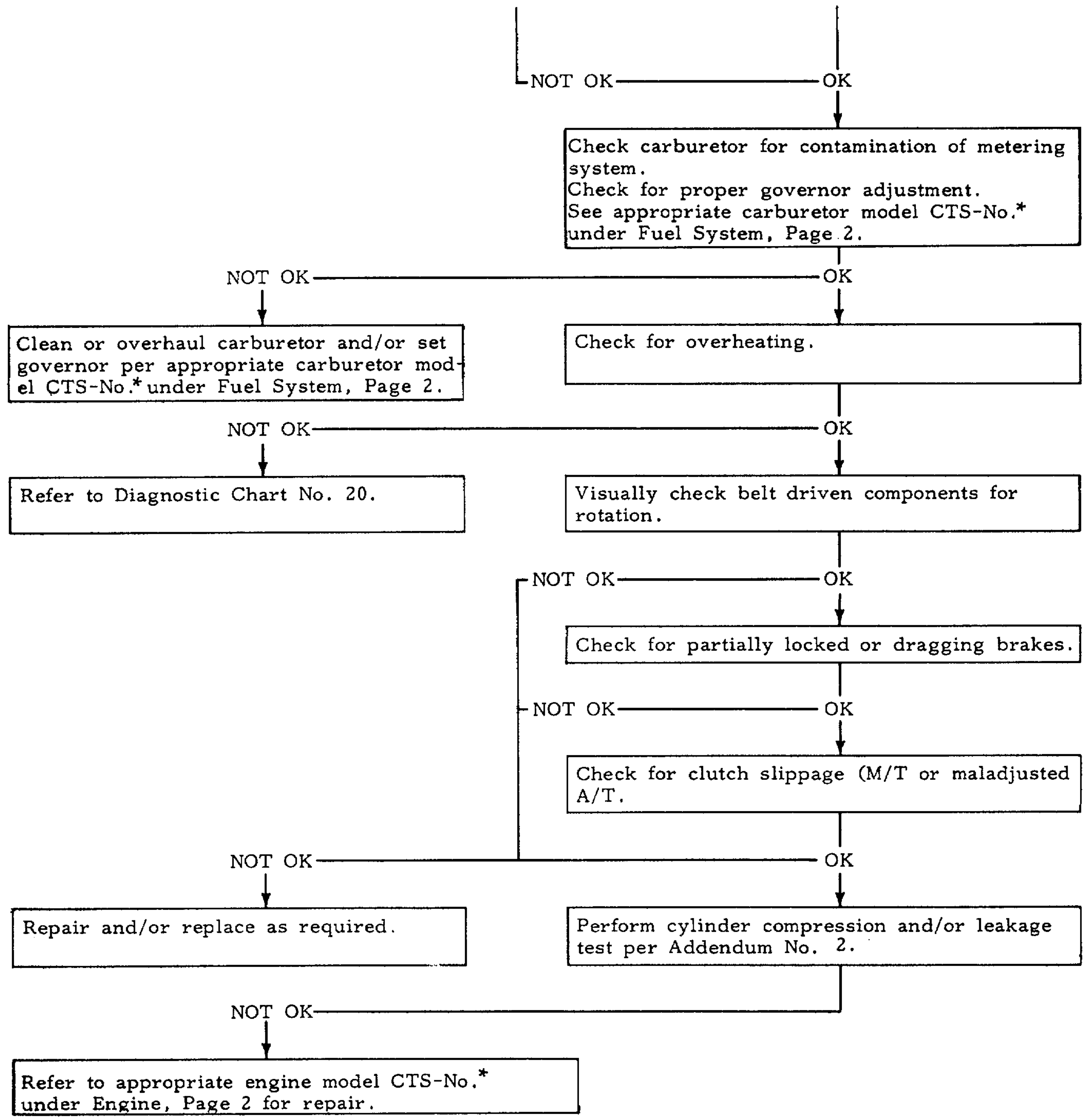
Repair and/or replace as required.

Check throttle linkage for complete travel from closed to wide open throttle.

NOT OK — OK

Check for stuck heat control valve and restricted exhaust system.

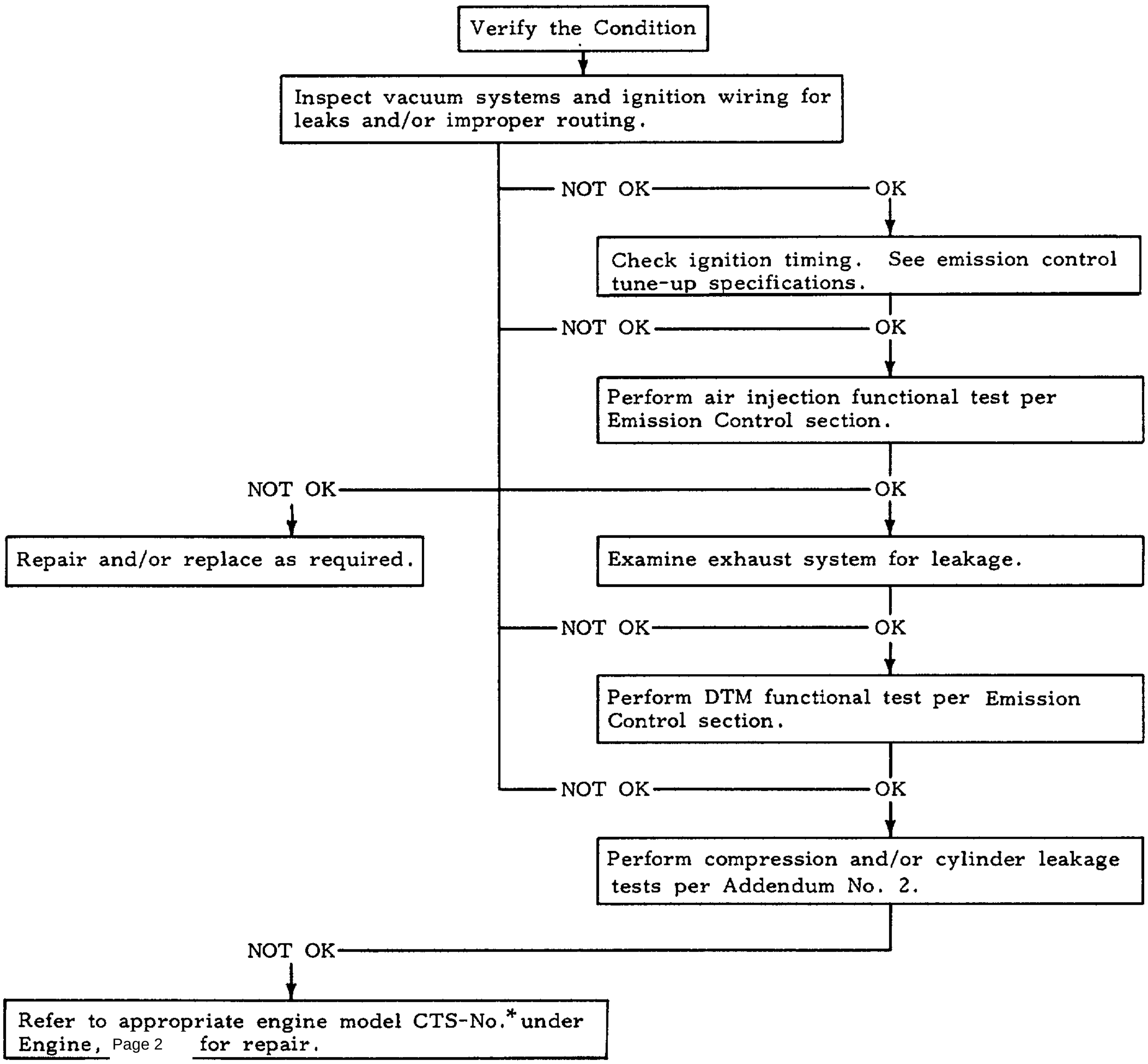
Continued on next page.



* See CTS or CGES

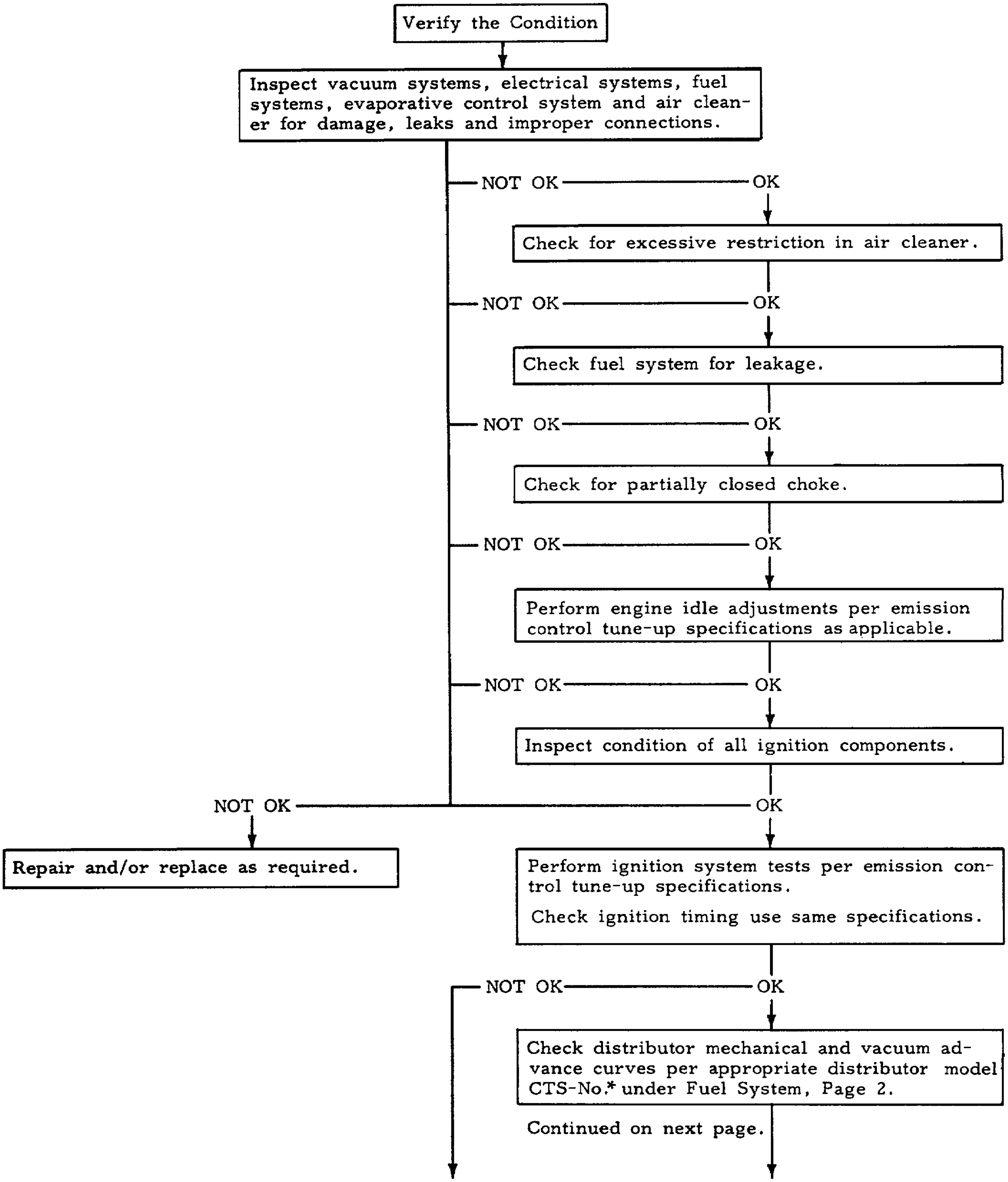
CHART NO. 14

EXHAUST SYSTEM BACKFIRE



*See CTS or CGES.

CHART NO. 15
EXCESSIVE FUEL CONSUMPTION



* See CTS or CGES.

OK

Perform EGR functional tests per Emission Control section.

NOT OK

OK

NOT OK

Repair and/or replace as required.

OK

Perform compression and/or cylinder leakage tests per Addendum No. 2.

NOT OK

Refer to appropriate engine model CTS-No.* under Engine, Page 2 for repair.

*See CTS or CGES

CHART NO. 16
EXCESSIVE OIL CONSUMPTION

Verify the Condition

The most common cause of oil loss is leakage. To verify an excessive oil consumption complaint, it is necessary that a thorough inspection be made to insure that leakage does not exist. The following steps should be followed to verify an excessive oil consumption complaint.

A. Steam clean the engine (if necessary) to remove accumulated dirt and/or oil.

B. Drain engine oil and change the oil filter.

C. Fill the crankcase with the specified amount of the recommended grade of oil. (Check to be sure the correct dipstick has been installed.)

D. Check positive crankcase ventilation system for excessive oil pullover into air cleaner.

E. Drive the vehicle under normal conditions until the engine is at normal operating temperature. With the vehicle parked on a level surface, place a clean paper under the engine (to aid in detecting leakage).

F. Shut off engine and check for leakage at:

1. **Valve rocker arm cover gaskets.**
2. **Oil pan gasket.**
3. **Cylinder block front cover gasket.**
4. **Cylinder block-to-fuel pump gasket and fuel pump air vent.**
5. **Intake manifold seals or valley cover gasket.**
6. **Crankshaft seals.**
7. **Distributor housing gasket.**
8. **Oil filter.**
9. **Oil pressure sending unit.**
10. **Oil Cooler.**

G. When all causes of leakage (if any) have been repaired, check the oil level and adjust oil level to full mark on dipstick.

H. Record the odometer reading. Have the customer operate the engine for the approximate number of miles indicated by the complaint and then return it to you for examination.

I. When customer returns the vehicle, verify the odometer reading. Check the oil level and reinspect the engine for signs of oil leakage.

J. Add a measured amount of oil as necessary to bring the oil level to the full mark.

K. If oil consumption is not within specified limits (400-500 miles per quart), proceed with oil consumption diagnosis as outlined below.

NOTE: A new engine may require up to 6000 miles of operation in order to properly seat (break in) the piston rings. For this reason, the engine should not be condemned as long as oil economy is improving with mileage accumulation. If oil economy ceases to improve with mileage accumulation, corrective action should be taken.

Perform cylinder compression and/or leakage test Addendum No. 2.

NOT OK

Refer to appropriate engine model CTS-No.* under Engine Page 2 for repair.

OK

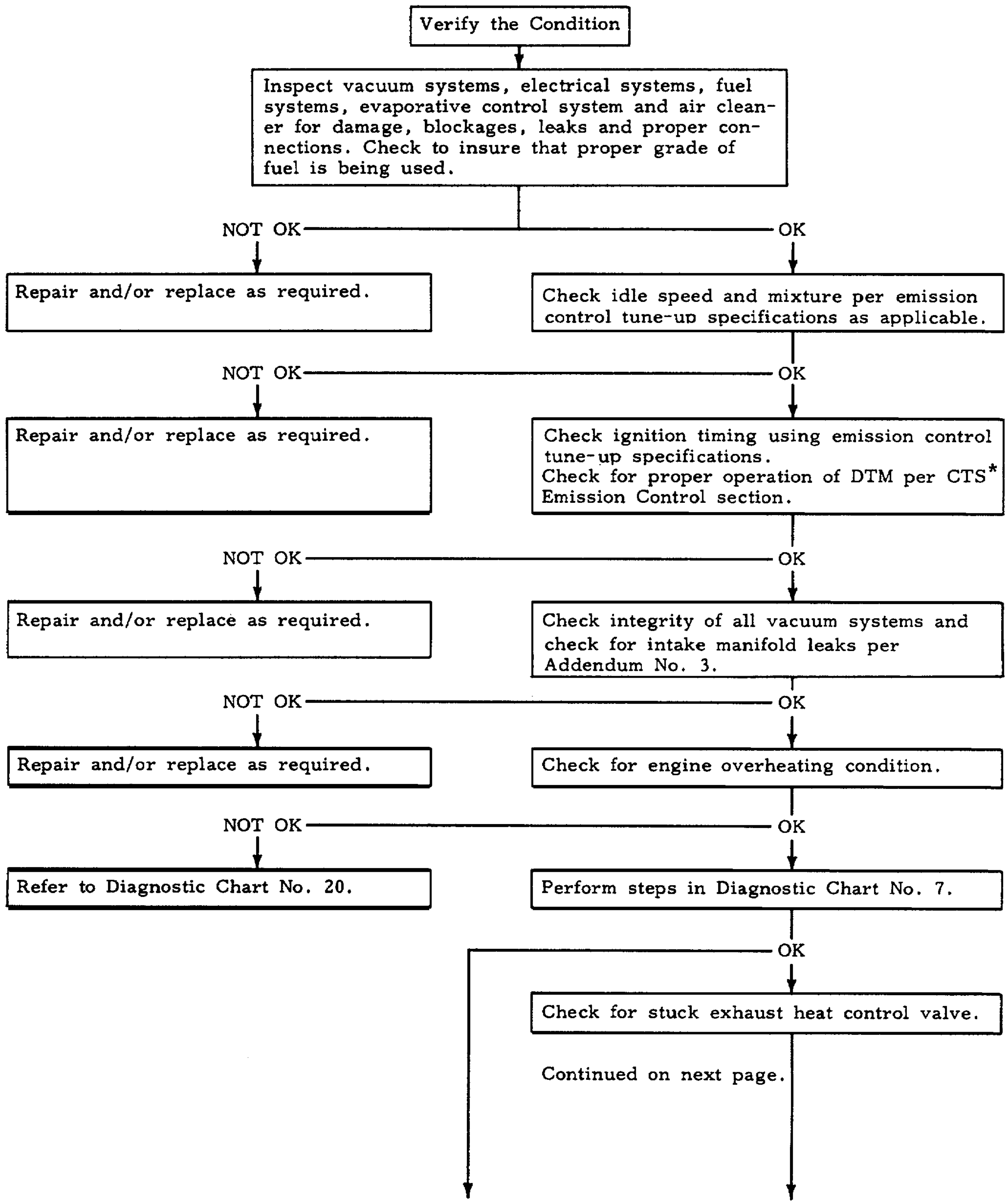
Check for excessive valve stem to guide clearance, worn, loose, or damaged valve stem seals, cracked intake manifold, leaking intake manifold gasket, and/or leakage from the rocker arm support bolt holes into the cylinder head intake runners. Check positive crankcase ventilation system for improper or restricted operation. Make all necessary repairs and/or replacements.

NOT OK

Overhaul engine as required per appropriate engine model CTS-No.* under Engine, Page 2.

*See CTS or CGES.

CHART NO. 17
ENGINE DIESELS-CONTINUES TO RUN AFTER SHUT OFF



*See CTS or CGES.

NOT OK

Repair and/or replace as required.

OK

Check camshaft timing. Refer to appropriate engine model CTS-No.* under Engine, Page 2.

NOT OK

Repair and/or replace as required.

*See CTS or CGES.

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CHART NO. 18
ENGINE NOISE

Noisy engine operation covers a wide range of conditions; therefore, to make the most efficient use of diagnostic aids to correct the condition, an accurate verification of the symptoms must be made. When the symptom is identified as to the type and general location of the noise, proceed to the applicable step outlined below. It can be seen that many of the steps are based on similar symptoms and, indeed, may be a matter of individual interpretation. Therefore, if the most likely step fails to correct the condition, proceed to the next most likely step, and so on until the condition is corrected.

A. Spark Knock or Pinging

This condition is characterized as being increasingly more noticeable as engine load increases. That is, at a given vehicle speed and throttle opening the problem would generally be more noticeable on a steep grade than on a level surface. The condition is due to low octane fuel, excessive spark advance or engine overheating.

If any discrepancies are noted in the following checks, repair and/or replace as required. Advise owner of proper octane fuel and verify correct spark plug heat range. If engine overheating is indicated, perform steps in CHART 20, check ignition timing and check distributor mechanical and vacuum advance curve per CTS * ELECTRICAL section.

B. Light Clicking (Varies with Engine Speed)

This condition is usually caused by improperly adjusted, failed or malfunctioning valve train components. Insert feeler gauge between rocker arm and valve stem tip and/or exert pressure on rocker arm. If noise is eliminated, adjust valve clearance to specifications. If condition persists, inspect for worn or malfunctioning valve train components. If no failure is detected, check for excessive valve stem-to-valve guide wear by exerting side pressure on valve stem. If noise is corrected excessive wear is indicated. If valve is eliminated as a possible cause, check for accessory component noise by loosening and/ or removing drive belts, one at a time, until noise stops. Investigate fuel pump and/or pump drive as possible cause.

C. Sharp Rapping (Varies with Engine Speed)

This condition is usually caused by malfunctioning hydraulic lifter and may be located with the aid of a stethoscope. If the problem is not corrected, perform Step B.

D. Hissing

Inspect vacuum systems for leakage due to loose or broken connections and/or failed parts. Inspect manifolds for leaks. Perform cylinder compression and/or leakage tests to identify and isolate cylinder head gasket leaks. Inspect for carburetor gasket leaks.

E. Sharp Snapping Noise During Acceleration

Look for arcing from high tension ignition cables.

F. Squeaks and/or Squeals

Loosen drive belts, one at a time, to determine if accessory component or water pump is at fault.

G. Heavy Squeal During Acceleration

Check for accessory drive belt slippage and adjust tension or replace as required.

H. Ringing, Grinding or Combination of Both

Check for loose, bent or improper pulleys. Check for front end bracket interference between rotating parts and surrounding components caused by misalignment of engine, engine components or surrounding components. Check for worn or damaged water pump or accessory components by loosening drive belts, one at a time, until noise stops.

I. Buzzing or Whistling During Engine Operation

Perform radiator cap functional check and verify proper cap sealing. If engine overheating is indicated, perform engine overheating routine. Check for interference with the fan or front end drive components by foreign material, loose or broken surrounding parts. Check for loose carburetor mounting. Check for vacuum leaks. Check power steering.

*See CTS or CGES.

CHART No. 18A

SPARK KNOCK OR PINGING

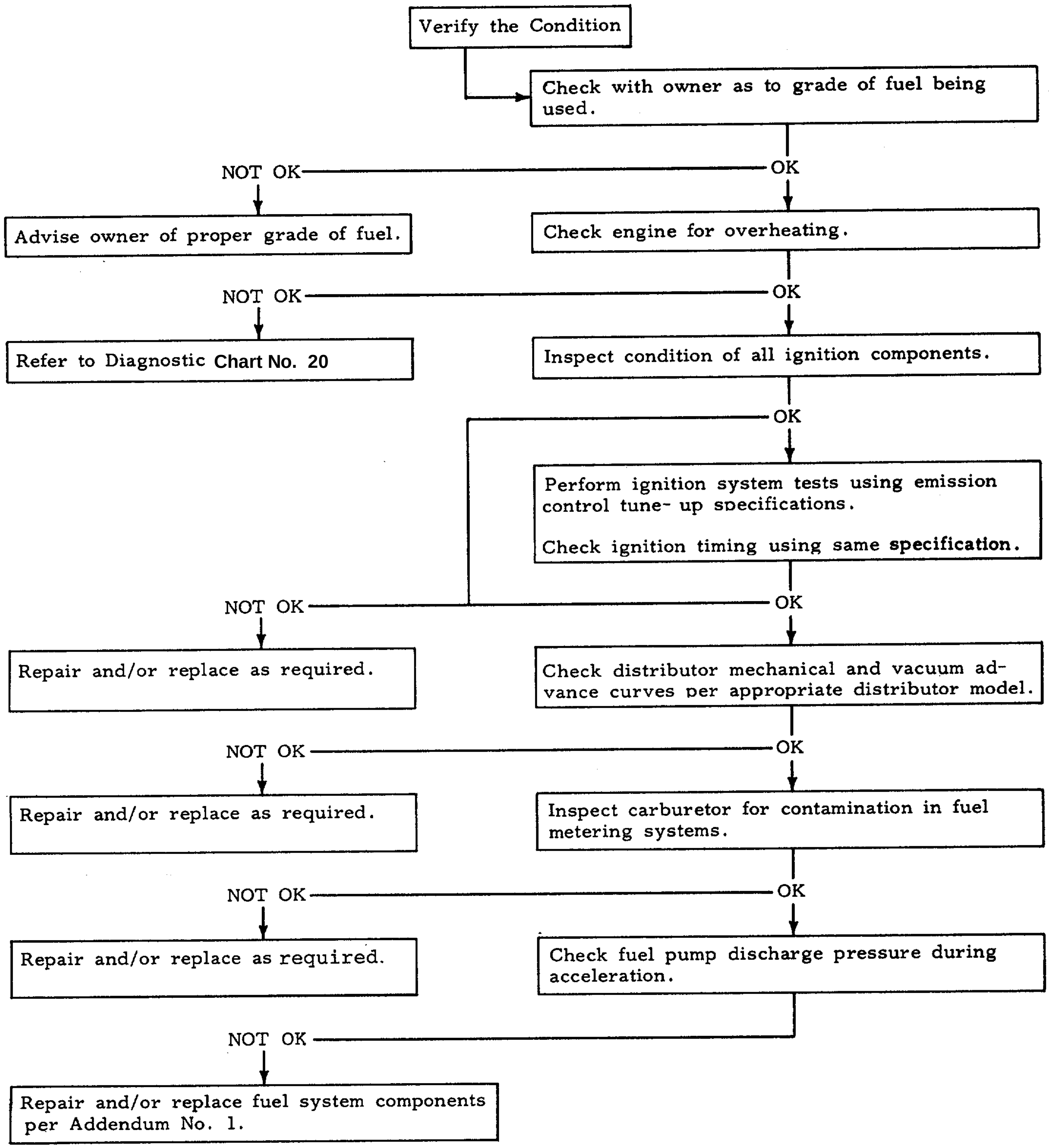


CHART NO. 19

ENGINE VIBRATION

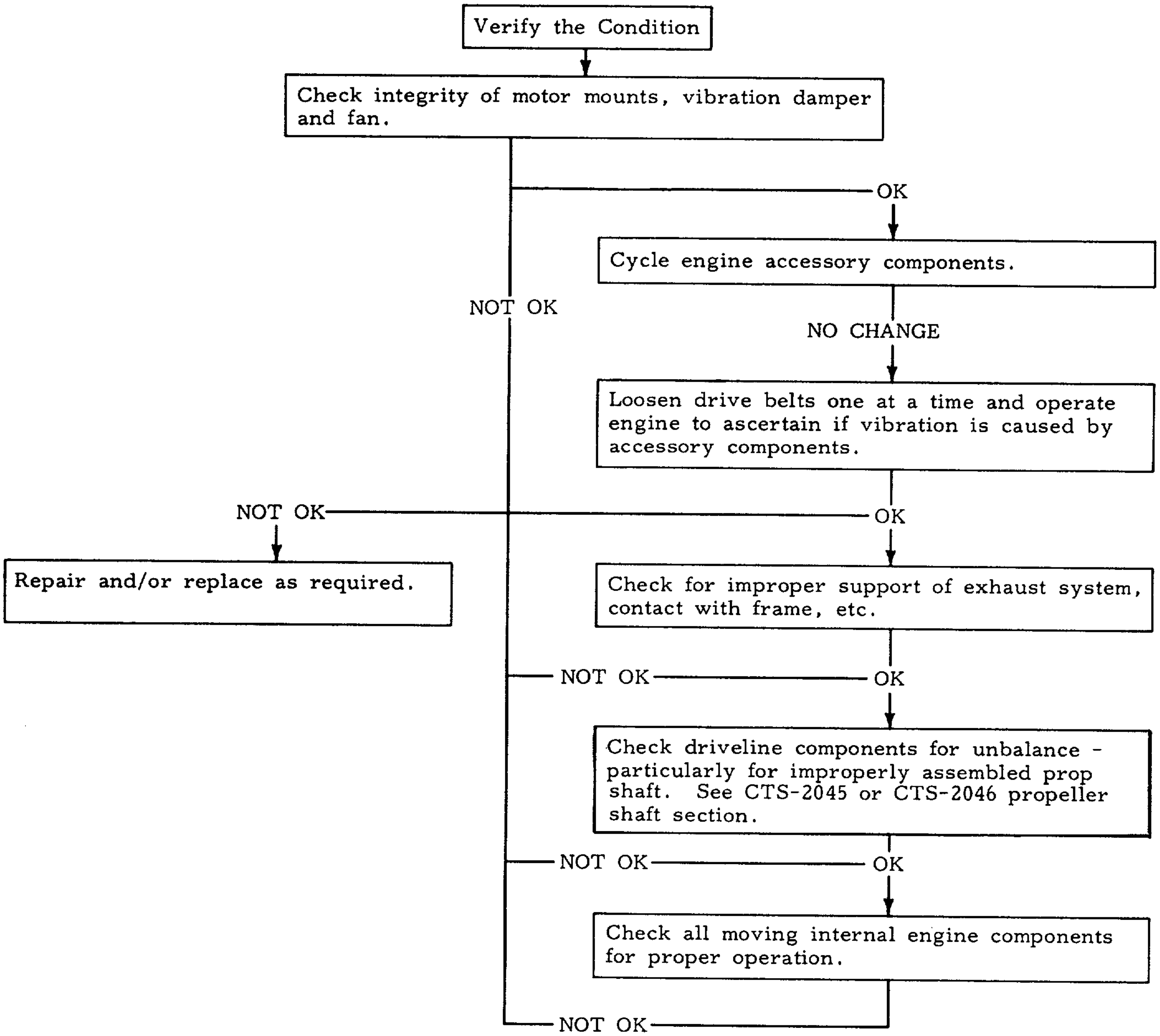
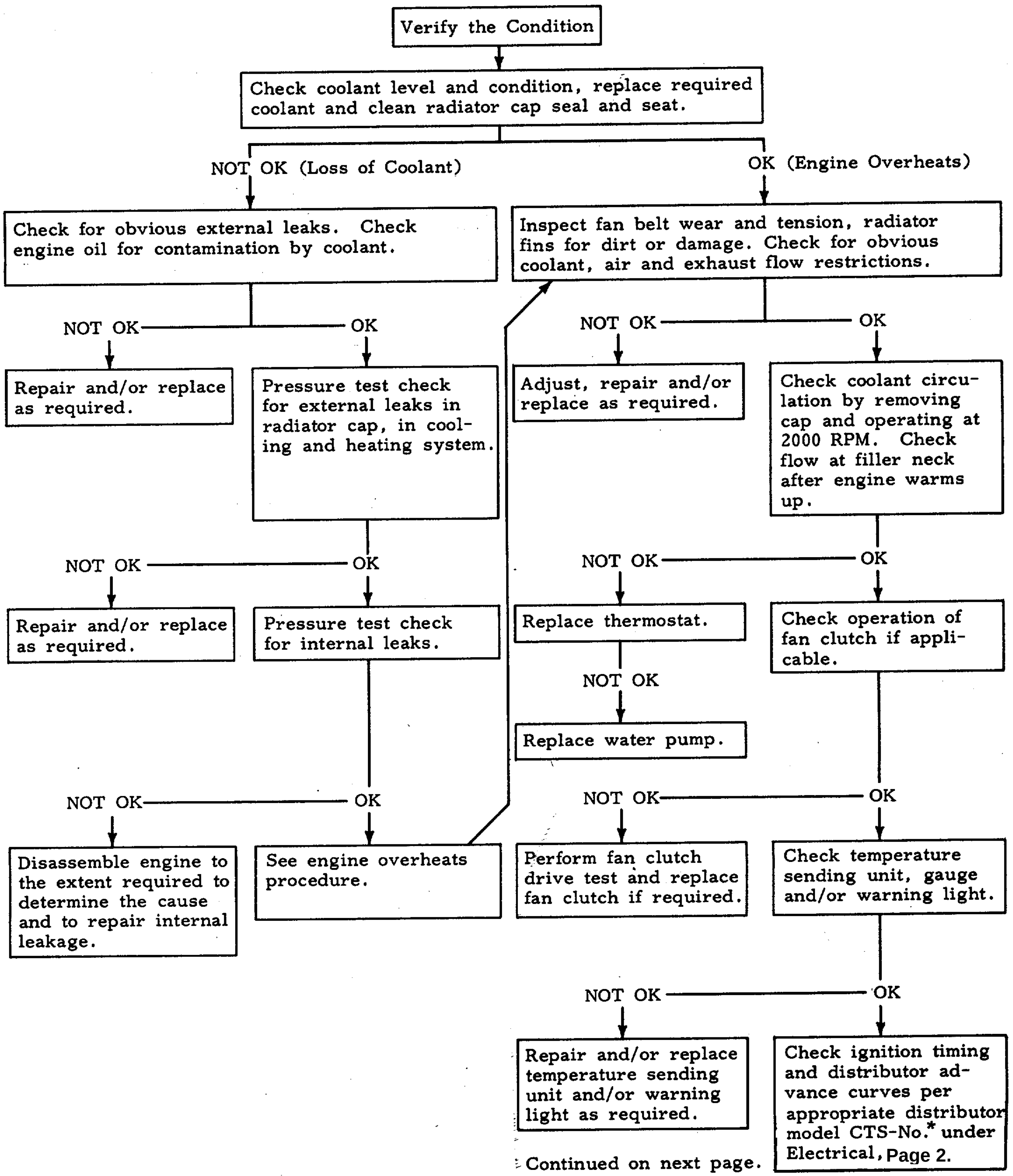


CHART NO. 20

LOSS OF COOLANT OR ENGINE OVERHEATING



*See CTS or CGES.

NOT OK — OK

NOT OK	OK
Repair and/or replace as required.	Check for restricted exhaust.

NOT OK	OK
Repair and/or replace as required.	Clean system with manufacturers recommended cooling system cleaner.

NOT OK	OK
Remove radiator. Clean and/or replace as required.	Remove water pump and check for damaged impeller etc.

NOT OK	OK
Replace water pump.	Disconnect radiator, remove thermostat and pressure flush block and head coolant passages.

NOT OK

Disassemble engine and check for blocked coolant passages. Repair as required.

CHART NO. 21

SMOKE FROM VEHICLE EXHAUST SYSTEM

The color or type of visible smoke from vehicle exhaust can provide clues as to the source of the problem. Three types of "smoke" are generally common to gasoline engines:

White Smoke

Visible white "smoke" in exhaust results from coolant entering the combustion chambers or exhaust system. Check for failed cylinder head gasket or cracked cylinder head casting. If ok, check for cracked crankcase.

Black Smoke

Results from over rich fuel mixture. Check for partially closed choke, or carburetor flooding condition. An over rich mixture usually causes rough engine operation. Perform steps covered in Diagnostic Chart No. 15.

Blue or Blue-gray Smoke

Results from oil entering the combustion chambers or exhaust system. Check PCV system per CTS* Emission Control section.

1. Blue smoke noted during wide open throttle operation indicates worn or stuck piston rings.

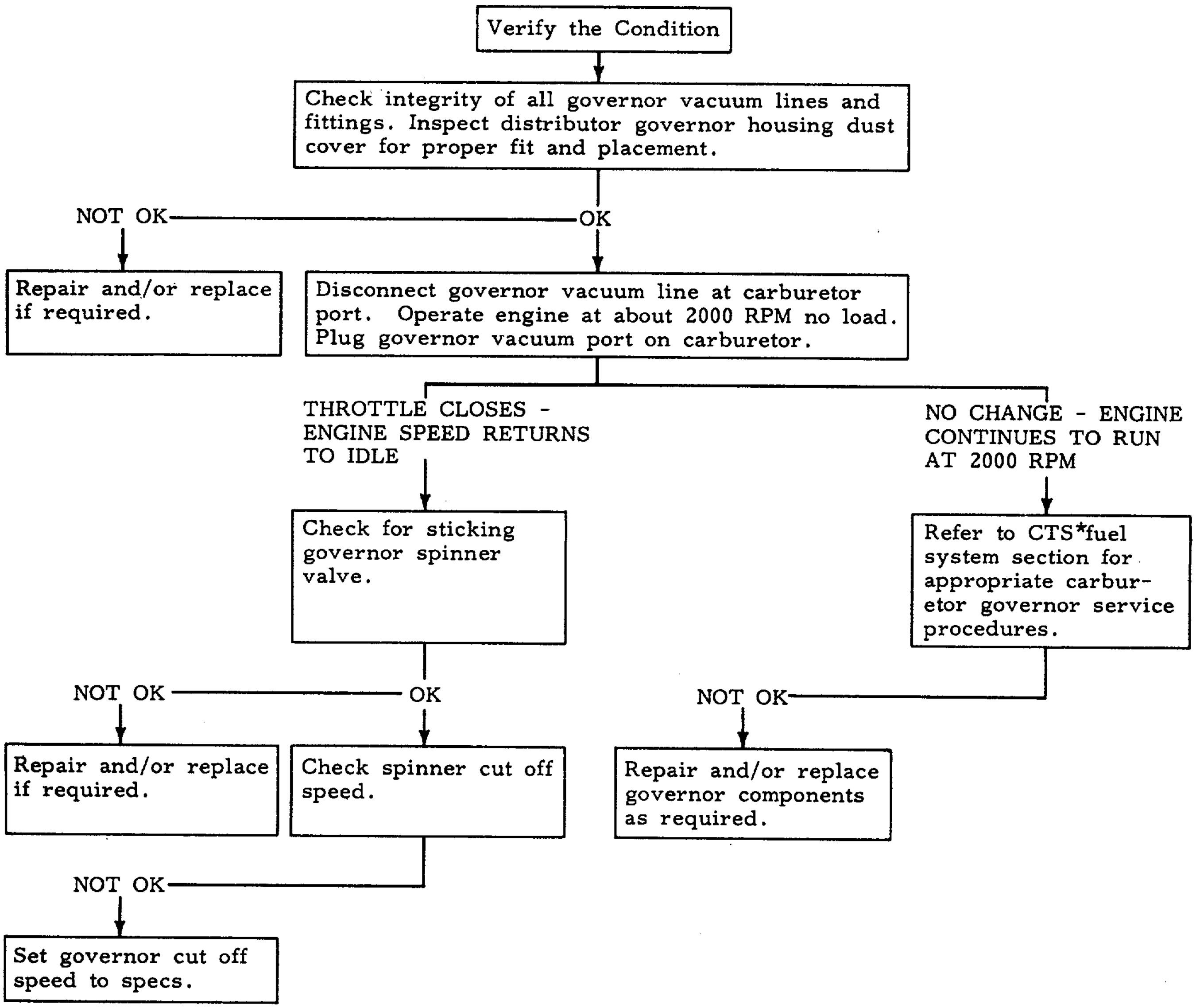
2. Blue smoke noted during deceleration (high vacuum) indicates failedor worn valve stem seals or worn valve guides.

Refer to appropriate CTS * engine section for repair of above difficulties.

* See CTS or CGES

CHART NO. 22

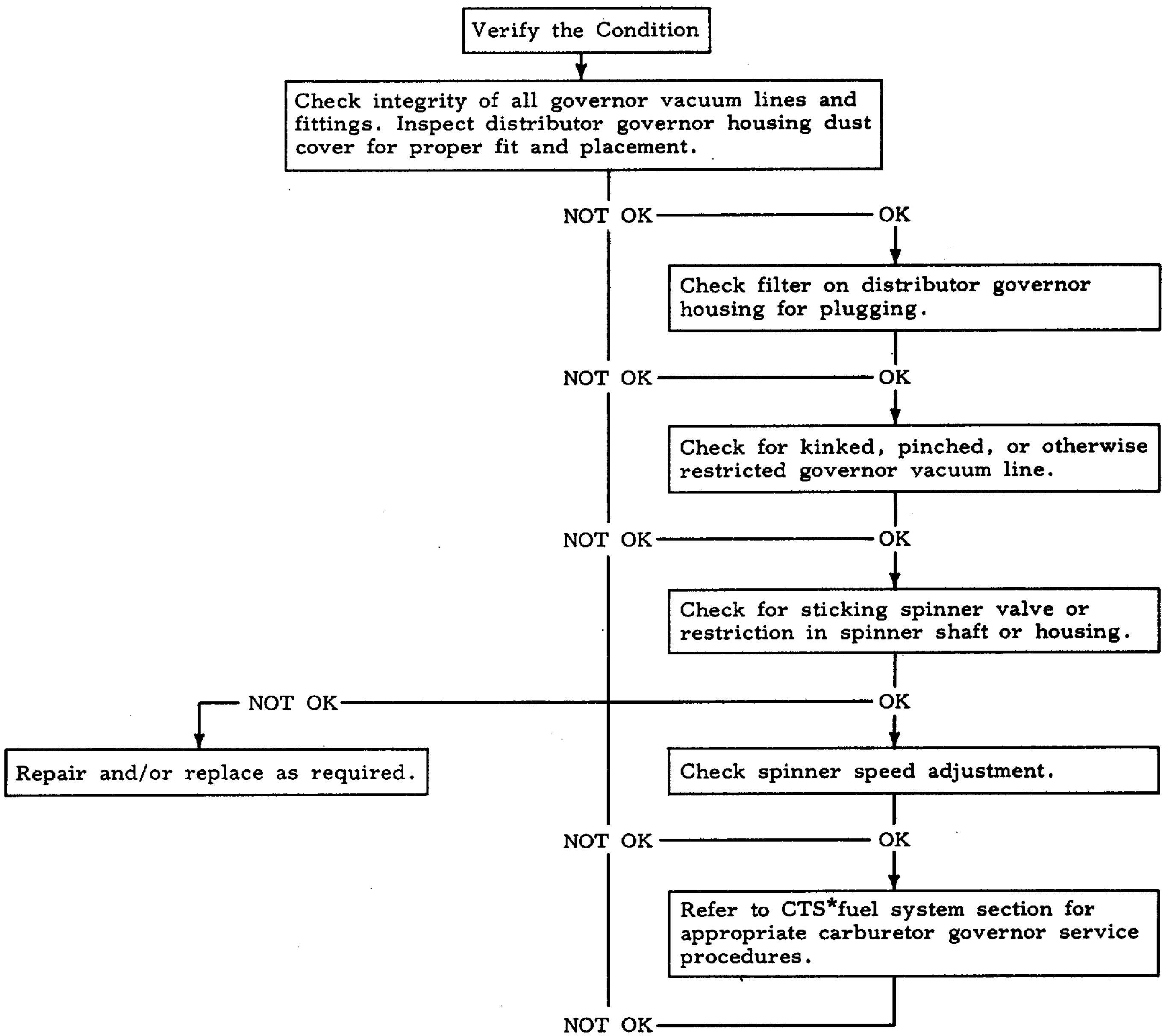
ENGINE GOVERNOR DOES NOT OPERATE - NO ENGINE SPEED CONTROL



*See CTS or CGES.

CHART NO. 23

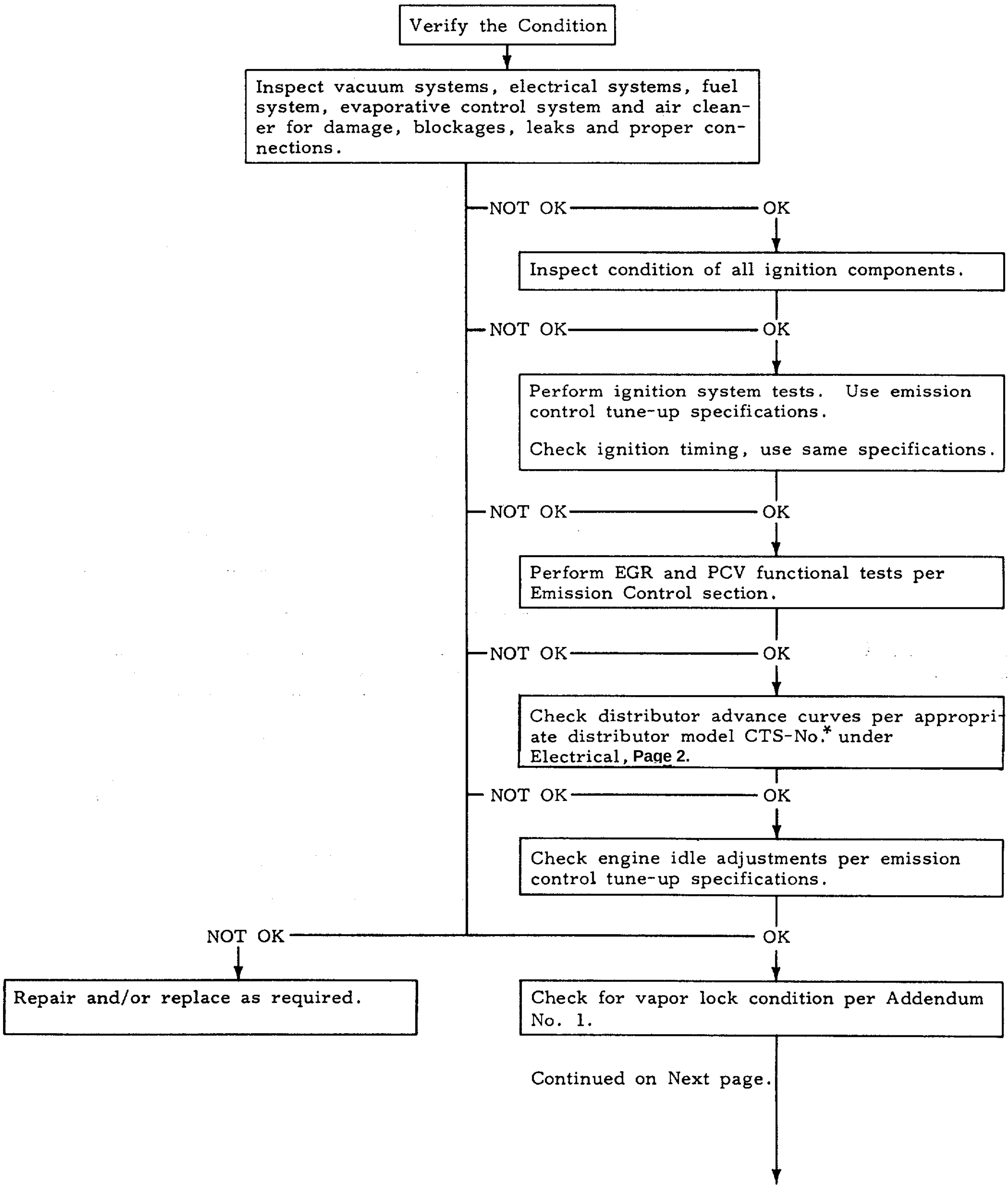
GOVERNOR CUTS OFF AT LOW SPEED - ERRATIC OPERATION



*See CTS or CGES.

CHART NO. 24

ENGINE SURGES BELOW GOVERNOR CUT OFF SPEED



*See CTS or CGES.

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OK

NOT OK

Repair vapor lock condition per Addendum No. 1.

Inspect carburetor for contamination in metering systems.

OK

NOT OK

Clean or overhaul carburetor appropriate carburetor model CTS-no.* under Fuel System, Page 2.

Perform compression and/or cylinder leakage tests per Addendum No. 2.

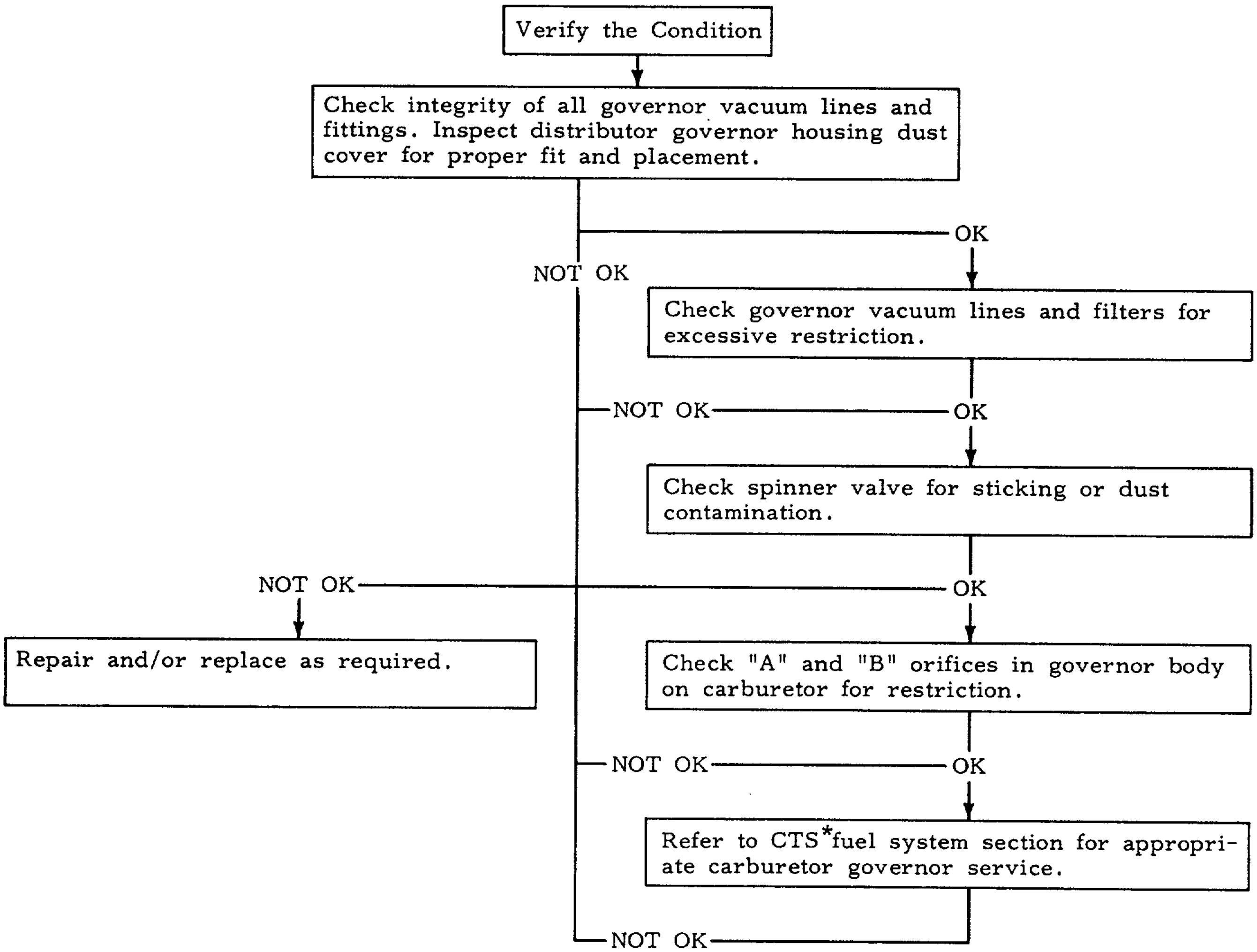
NOT OK

Refer to appropriate engine model CTS-No.* under Engine, Page 2.

*See CTS or CGES

CHART NO. 25

ENGINE SURGES AT GOVERNED SPEED



*See CTS or CGES

ADENDUM NO. 1

FUEL SYSTEM VAPOR LOCK

Vapor lock occurs when fuel system components become sufficiently heated to cause fuel to vaporize within fuel lines, filter, or fuel pump at a rate which prevents liquid fuel from reaching the carburetor. Vapor lock is generally associated with hot ambient conditions but can still occur in cooler climates when vehicle or engine is operated under heavy load. Vapor lock conditions are aggravated at higher altitudes.

To trouble shoot a suspected vapor lock condition, proceed as follows.

1. Do vapor lock conditions prevail? Look for hot fuel system components. Does engine run OK when cool?

2. Remove carburetor air cleaner and pump throttle by hand. Observe accelerator pump discharge. Absence of pump shot or weak discharge may indicate vapor lock. Check for presence of fuel in tank. Check for fuel system obstructions.

3. Check fuel pump discharge pressure by removing fuel line from carburetor inlet, connect fuel pressure tester to open end of fuel line (*) and crank engine. A vapor locked fuel pump will produce some pressure, although not necessarily specified pressure. Observed pump pressure as low as 1 to 2 psig indicates that the pump is probably OK but should be checked again when engine is running normally.

(*) NOTE: For this test, do not "tee" pressure tester into fuel line between fuel pump and carburetor. No pump discharge pressure would be observed because fuel vapor would be vented to the carburetor bowl through the open needle valve.

If fuel pump has measurable discharge pressure but does not pump liquid fuel when system is very hot, vapor lock is a likely cause.

4. If vapor lock is suspected as the cause for rough engine operation during cruise or acceleration it may be checked as follows.

   "Tee" fuel pressure tester fitting into fuel line between fuel pump and carburetor. Place test gauge in vehicle within view of driver or passenger. Connect to fitting with flexible fuel line. Operate vehicle on highway until rough operation occurs.

   Note fuel pressure during rough operation. If pressure drops to zero, vapor lock may be the cause. (Check fuel lines and filter for obstructions.)

   Remove fuel pressure tester and fitting from fuel line and allow fuel system components to cool; then check to see that normal engine operation has been restored. If engine does not run, refer to Trouble Shooting Charts 4 or 5.

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ADDENDUM NO. 2

COMPRESSION AND CYLINDER LEAKAGE TESTS

Compression Test

The compression test is performed to measure cylinder compression pressure. The absolute value of compression pressure is significant but cylinder to cylinder variation is even more important. Allowable variation from cylinder to cylinder is:

Lowest cylinder pressure must not be less than 75% of the highest cylinder pressure. Greater variation from cylinder to cylinder indicates need for mechanical repair which should be carried out in accordance with the appropriate CTS* ENGINE section. Perform engine compression test as follows:

1. Run engine until normal operating temperature is reached.
2. Remove all spark plugs and install compression gauge in No. 1 cylinder.
3. Remove coil secondary wire from distributor cap and ground it to prevent arcing. Block carburetor throttle open.
4. Connect remote starter switch to starter solenoid or have an assistant available to crank engine.
5. Crank the engine for at least 5 compression strokes or until compression gauge reaches its highest value. Note the number of compression strokes required to reach highest value. Record compression pressure and number of strokes.
6. Repeat the test for each of the other cylinders.
7. If one or more cylinders produce a low reading, squirt about a tablespoon of engine oil into low reading cylinders. Repeat compression test on those cylinders.
   a. If compression pressure improves significantly, worn or broken piston rings are at fault.'
   b. If compression pressure does not improve, valves are at fault or if two adjacent cylinders have low compression, a leaking cylinder head gasket may be the cause.

Cylinder Leakage Test (CLT)

The cylinder leakage test is supplemental to the compression test and can provide diagnostic information as to the cause for loss of compression. The CLT can identify leakage past intake or exhaust valves, leaking cylinder head gasket, worn or broken piston rings, or other cause for loss of compression.

Perform cylinder leakage test as follows.

1. Run engine until normal operating temperature is reached.
2. Remove spark plugs from engine.
3. Remove air cleaner and block carburetor throttle open.
4. Remove oil filler cap.
5. Remove radiator cap. If coolant is low, fill to prescribed level.
6. Turn crankshaft until No. 1 cylinder is at top dead center on compression stroke.
7. Connect and calibrate cylinder leakage tester in accordance with manufacturer's instructions.
8. Record cylinder leakage (usually in percent) and determine source of leakage by listening for air escaping through carburetor, exhaust system, or crankcase (oil filler tube). Look for air bubbles in coolant (radiator top tank).
9. Carefully turn crankshaft in normal direction of rotation until the next cylinder in firing order sequence is at top dead center. Connect CLT to that cylinder and repeat test.
10. Repeat test for each consecutive cylinder in firing order sequence.

When the cause for loss of compression has been identified, repair engine in accordance with the appropriate

*See CTS or CGES

ADDENDUM NO. 3

VACUUM SYSTEM HOSE LEAKAGE TEST

Perform engine vacuum system hose leakage test as follows:

1. Install vacuum gauge and tachometer. Care should be taken to insure that vacuum gauge is connected to manifold vacuum and not to some other vacuum such as ported spark or EGR signal vacuum.

2. Start and run engine until normal operating temperature is reached. Then, with engine running at curb idle speed, record vacuum gauge and tachometer reading (baseline).

3. With engine running at curb idle speed, remove each vacuum hose (one at a time) from vacuum source and plug source. When removing vacuum hose to distributor on engines which have straight manifold vacuum advance, apply at least 15 In.Hg. vacuum to vacuum advance using hand vacuum pump SE-2499 to prevent change in spark timing during test.

4. As each vacuum circuit is checked, record vacuum gauge and tachometer reading. If no change in reading is observed (from baseline), no vacuum leak exists in that particular vacuum hose circuit. If a change in reading is observed, a vacuum leak does exist in that particular vacuum hose circuit and can be located as follows:

   a. Remove plug and reinstall vacuum hose.

   b. Remove other end of same vacuum hose at next downstream connection and plug.

   c. Record vacuum gauge and tachometer readings.

   d. Repeat steps 4a through 4c at each hose connection until leak is isolated. Leak is isolated to last component checked when reading returns to baseline value. Replace leaking hose(s) or component(s) identified.

5. Continue procedure until the integrity of all vacuum circuits is verified or restored.

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FUEL PUMPS

INDEX

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FUEL PUMP SPECIFICATIONS

Engine Model	Type Drive	Fuel Delivery Capacity	Fuel Delivery Pressure	Pump to Engine Speed Ratio
4-152,4-152E 4-196,4-196E	Angular lever and cam	24.3 gal. Per hr. up to 4000 rpm	*4 to 5-1/2 psi	1/2
BG-241,241E BG-265,265E	Angular lever and cam	20-1/2 gal. per hr. up to 3500 rpm	*3-1/2 to 4-1/2 psi	1/2
BD-282 BD-308	Angular lever and cam	20-1/2 gal. Per hr.	3 to 4-1/2 psi up to 3500 rpm	*1/2
RD-372,RD-406 RD-450,RD-501	Angular lever and cam	20 gal. per hr. up to 3500 rpm	*3-1/2 to 5-1/2 psi	1/2
6-232,6-258	Angular lever and cam	27 gal. per hr. up to 4000 rpm	*4 to 5-1/2 psi	1/2
V-266,266E V-304,304E V-345,345E V-392,392E	Angular lever and cam	27 gal. per hr. up to 4000 rpm	*4-1/2 to 5-3/4 psi	1/2
V-VS-401 V-VS-478 V-VS- 549	Angular lever and cam	30 gal. per hr. up to 4000 rpm	*4-1/2 to 5-3/4 psi	1/2
V-VS-401 V-VS-478 V-VS- 549	Electric In-Tank Mounting	NA	3 to 5 psi	Not Applicable
D-354	Angular lever and cam	18 gal. per hr. at 3000 rpm	5 to 8 psi	1/2
DV-462,DV-462B DV-550,DV-550B DVT-573	Electric In-Tank Mounting	NA	3 to 5 psi	Not Applicable

*NOTE: Pressures shown are those obtained on test equipment. Under operating conditions these readings may be lower depending on condition of carburetor, etc. Fuel pressure test must be taken at carburetor inlet height. The lower limit reading is obtained at open throttle and high limit reading at idle.

DESCRIPTION

The fuel pumps used on most gasoline type engines are of the mechanical type and are mounted on the engine, Fig. 1. The suction side of the pump is connected to the fuel tank and the discharge side is connected to the carburetor by tubing designed to carry the fuel. The purpose of the pump used on gasoline type engines is to suck fuel from the supply tank and push it into the carburetor float bowl as required by the engine.

Electric fuel pumps are also used to supply the fuel from the tank to the engine. In most cases the electric fuel pump is located in the fuel tank, Fig. 2.

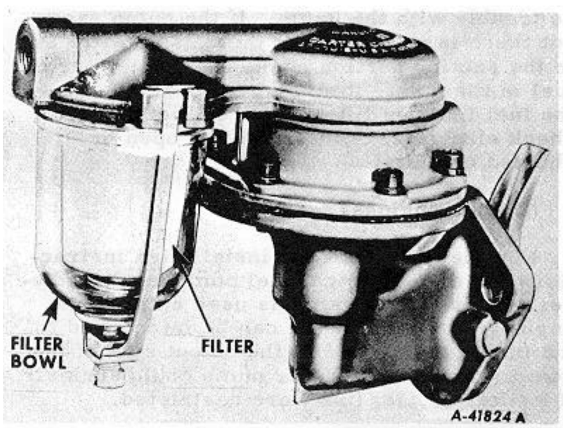

Fig. 1 Mechanical Fuel Pump (Side Mounted Bowl Type)

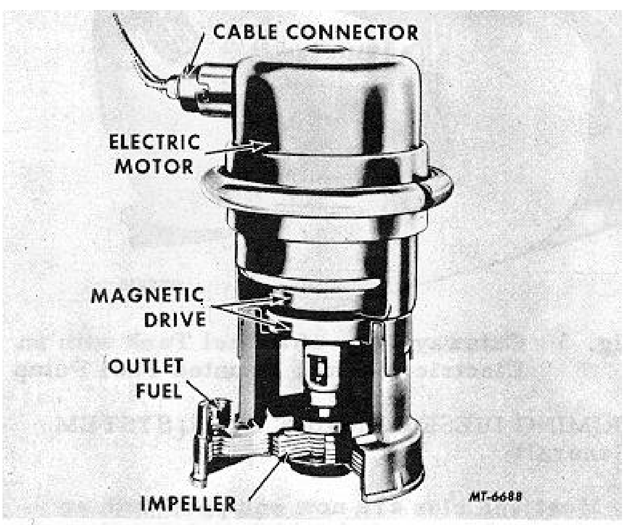

Fig. 2 In-Tank Mounted Electric Fuel Pump

OPERATION

Mechanical Fuel Pump

In general the pumping operation for all mechanical pumps is accomplished through a pump rocker arm which contacts a special cam on the engine camshaft. The rocker arm in turn actuates a diaphragm in the pump, and this action, together with the action of inlet and outlet valves in the pump, causes gasoline to flow through the pump. Pumping action is controlled, however, by fuel pressure in the pump outlet line. When the float needle valve in the carburetor is not seated and the fuel passage into the carburetor float chamber is open, gasoline will flow to the carburetor. When the needle valve is closed and held in place by the pressure of the fuel in the bowl and on the float, the pump will continue to build up pressure until it overcomes the pressure of the pump diaphragm spring. This pressure results in almost complete stoppage of diaphragm movement until further fuel is needed.

Electric Fuel Pump (In-Tank Mounted)

The in-tank mounted electric fuel pump is cushioned in neoprene to dampen vibrations and is supported by an adjustable hanger assembly, which makes it adaptable to all IH fuel tank depths. A spring-loaded latch permits easy motor replacement. Electrical connections are the sealed quick-disconnect type, Fig. 2.

MAINTENANCE

Efficient operation of the fuel pump depends on the proper maintenance of the fuel filter. For this reason the filter should be checked from time to time to note any accumulation of dirt, water, or other foreign objects. The interval for actual cleaning or replacing of the filter element is dependent on engine operating conditions.

Engines which are equipped with in-tank mounted electric fuel pump are either equipped with one or two fuel filters in the system, depending upon the type of engine. Gasoline type engines are equipped with an in-line fuel filter. A primary and secondary fuel filter are both used on diesel engine applications. The primary filter is the first filter in the line from the fuel tank. The secondary fuel filter is usually located on the engine.

To clean the wire screen: disc type filter, remove the filter bowl and filter and wash these parts in a commercial carburetor cleaning solvent. Blow dry with compressed air. In some cases where the paper filter -s used, it is advisable to simply replace the filter. This is particularly true where fuel additives are used. Such additives can become trapped in filters, and their accumulation may cause a restriction in flow. Restricted filters are usually slippery to the touch.

When reinstalling the fuel filter and bowl always make sure the gasket and spring are in place and that the retainer screw is tight enough to prevent leakage. A leak at the gasket will cause erratic action of the pump and thus retard fuel delivery to the carburetor.

REPAIR OR REPLACEMENT

If it has been determined that fuel system troubles are being caused by a faulty fuel pump, then the pump can either be repaired or replaced. Instructions on the different types of fuel pumps are covered in subsequent paragraphs.

If fuel trouble is encountered on any chassis having an electric fuel pump, Fig. 2, and the pump is suspected, check the pump as follows: Disconnect the fuel line at the carburetor or transfer pump and turn on the ignition switch. If ample fuel flows, you do not have pump trouble. If the pump races but fuel does not flow in sufficient volume, the cause is an air leak in the suction portion of the fuel system (no fuel). If fuel does not flow at all, inspect the fuel lines or filters for restrictions or check the electrical connections for a shorted or open circuit. If all is in order and the pump still does not operate, remove the pump and replace.

INSTALLATION

Mechanical Fuel Pump

Be sure to use a new mounting gasket between the mechanical fuel pump mounting flange and the pad on the crankcase when mounting the pump on the engine. Tighten the capscrews securely.

Connect the fuel lines, first making sure that there is no dirt on the fittings which might be drawn into the system.

If the carburetor has not been removed, there will usually be sufficient fuel in it to run the engine long enough to fill the fuel pump filter bowl. If there is an air leak between the filter bowl and gasket, the pump cannot draw fuel into the bowl. To remedy this, install a new gasket and see that the bowl seats squarely. Tighten the retainer screw securely with the fingers only.

If the fuel pump bowl still does not fill, the trouble may be due to an air-bound condition. In this case, the bowl should be loosened slightly so that the air can escape, and by blowing in the gasoline tank filler neck, fuel will be forced into the pump. Then tighten the bowl securely and start the engine.

Electrical Fuel Pump (In-Tank Mounted)

(Gasoline Engines)

Connect the fuel lines, first making sure that there is no dirt on the fittings which might be drawn into the system.

After the pump is installed and fuel and electrical connections are made, turn on the ignition switch. If ample fuel flows, there is no trouble with the pump. If the pump races but there is no fuel flow, there is an air leak in the suction portion of the fuel system or no fuel in the tank. If no fuel flows at all, inspect the fuel lines or filters for restrictions or check electrical connections for open or shorted circuits.

(Diesel Engines)

For the most part the installation instructions for the electrical fuel pump used on diesel engines is the same as used on gasoline engines, except that air can be introduced to the fuel system even on the output side of the pump, since the transfer pump could suck air if a filter or fuel line were restricted.

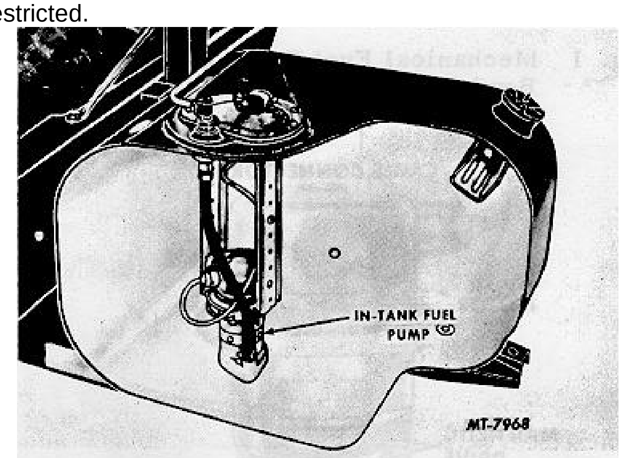

Fig. 3 Cutaway View of a Fuel Tank with an Electric In-Tank Mounted Fuel Pump

PRIMING DIESEL ENGINE FUEL SYSTEM (General)

Most vehicles are now equipped with an electric primer switch which is located on the instrument panel and is used to purge air from the fuel system.

Priming the fuel system will be required whenever a fuel filter is changed, lines are disconnected or when the electric in-tank fuel pump is replaced.

1. Be sure fuel tank has sufficient fuel.

2. Turn switch key to "ON" position. (Do not start engine.)

3. Hold primer switch to "ON" position to energize electric fuel pump.

4. Open vent valve on top of primary filter, close valve when fuel flows out in solid stream.

5. Open vent valve on secondary filter; close valve when fuel flows out in a solid stream.

6. Release primer switch.

PRESSURE CHECKING DIESEL ENGINE FUEL SYSTEM (General)

The locations for making "on-engine" transfer pump pressure checks or lift pump pressure checks are as follows:

1. Transfer Pump Pressure: This check is now made directly on injection pump. Install an adapter fitting to priming inlet at front of injection pump and connect compound test gauge (SE2004-1) or test kit (SE-2239). Operate engine under load and check transfer pressure (25-40 psi).

2. Lift Pump Pressure (now electric fuel pump): This check is made at primary filter. Install adapter and compound test gauge (SE-2004-1) or test kit (SE-2239) to priming vent on primary filter. Operate engine under load and check pressure (3 to 5 psi).

SERVICE FUEL PUMP

<u>Screen Filter Type</u>

<u>Disassembly</u>

The disassembly of mechanical pumps having the screen filter, Fig. 4, can be accomplished in the following manner:

1. Remove the cover bolt, cover and cover gasket. Also remove the screen disc filter.

2. Match-mark the valve housing and pump body to assure correct re-assembly of parts.

3. Remove the screws which hold the valve housing on the pump body. Separate the housing from the body.

4. Remove the fuel valve retainer screws and retainer and lift the inlet and outlet valves and gaskets out of the valve housing.

5. Unhook the diaphragm from the diaphragm lever and pull the diaphragm and pull rod assembly straight out to prevent damage to the oil seal. Remove the diaphragm spring.

6. Remove the oil seal retainer and oil seal from the pump.

7. If necessary to replace the cam lever, remove the pin retainers from the end of the rocker arm pin. Drive out the pin and withdraw the cam lever spring and diaphragm lever from the pump body.

<u>Inspection</u>

If a fuel pump is overhauled, the diaphragm gaskets, valves, cam lever, spring and diaphragm lever should always be replaced whether these old parts appear serviceable or not. Fuel pump repair kits containing these parts are available. All other parts should be inspected as follows:

1. Inspect the pump body and valve housing for cracks and breakage.

2. Check the pump body, valve housing and cover against a flat surface for warpage.

3. Examine the pump body and valve housing for stripped or crossed threads.

4. Replace screen.

5. Check the cam lever for wear at the camshaft pad and also for wear at the point contacted by the diaphragm lever.

6. Check the springs for corrosion, fracture or weakness.

<u>Assembly</u>

All fuel pumps having the screen filter will have an assembly procedure similar to the following. Refer to Fig. 4 for numbers in parentheses.

1. If the cam lever (21) was removed, place seal (16), seal retainer (15) and spring (14) in pump body (17) and install pull rod of diaphragm assembly (13) through spring, retainer and seal. Assemble diaphragm lever (22) with cam lever (24) and insert hooked end of lever through opening in pump body (17) and engage with diaphragm pull rod. Make sure lever spring (19) is also in place. Obtain a piece of welding rod or

stock having a diameter slightly less than the cam lever pin (24), and using this rod as an aligning tool, temporarily hold the rocker arm and lever assembly in place.

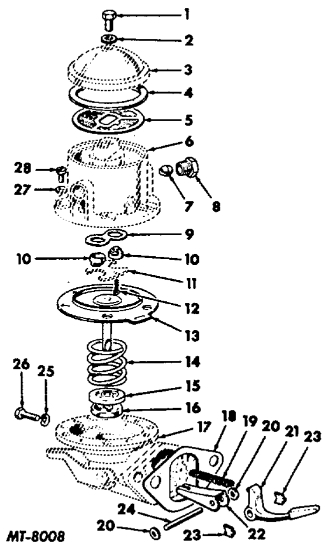

Fig. 4 Exploded View Screen Filter Type Fuel Pump

Legend for Fig. 4

Key	Description
1	BOLT, Cover
2	WASHER, Cover Bolt
3	COVER
4	GASKET, Cover
5	SCREEN, Filter
6	HOUSING, Valve
7	SLEEVE, Compression Tube
8	NUT, Compression Tube
9	GASKET, Inlet and Outlet Valve
10	VALVE, Inlet and Outlet
11	RETAINER, Valve
12	SCREW, Valve Retainer
13	DIAPHRAGM, Pump
14	SPRING, Diaphragm
15	RETAINER, Oil Seal
16	SEAL, Oil
17	BODY, Pump
18	GASKET, Mounting
19	SPRING, Lever
20	WASHER, Rocker Arm
21	LEVER, Cam
22	LEVER, Diaphragm
23	RETAINER, Pin
24	PIN, Cam Lever
25	WASHER, Lock, 5/16 Medium
26	BOLT, Hex Head, 5/16 NF x 7/8
27	WASHER, Housing Screw
28	SCREW, Housing

2. Push new pin (24) through the body and cam lever assembly as the aligning rod is drawn out. Install new washer (20) on the end of the pin and install new pin retainers in pump body.

3. Place gasket (9) and valves (10) in valve housing (6) and hold the valves in place with valve retainer (11) and screws (12). To make sure the valves are installed correctly, note that the flat side of the outlet valve must face toward the diaphragm and that the inlet valve is just opposite.

4. Depress the rocker arm enough to bring the diaphragm level with the pump body and hold the rocker arm in this position by means of a wedge or tool. Place pump valve housing (6) over the diaphragm, matching up the alignment marks of the valve housing with the pump body.

5. Install cover screws (28) and lockwashers (27) and partially tighten the screws but do not compress the lockwashers. Remove the wedge or tool from the rocker arm and operate the rocker arm a few times before tightening the valve housing down securely.

6. Place screen assembly (5) and gasket on the valve housing. Then position the cover (3) on pump assembly and install the cover bolt (1) and washer (2).

<u>Suspended or Side-Mounted Bowl Type</u>

The suspended bowl type fuel pump, Fig. 5, and the side-mounted bowl type fuel pump, Fig. 6, are disassembled in the following manner:

1. Loosen the fuel bowl retainer and remove the retainer, fuel bowl gasket and paper or ceramic element.

2. Use pliers and remove the cam lever return spring.

3. Pry out the cam lever shaft seal plug and also remove the shaft retaining spring pin to permit removal of the cam lever pin. Take out the cam lever.

4. Match-mark the edges of the valve housing assembly and pump body assembly with a file to assure correct alignment at reassembly.

5. Remove the valve housing-to-pump body mounting screws and separate the valve housing assembly from the pump body.

6. Pull the diaphragm and spring assembly from the pump body.

7. Take out the two valve housing-to air dome and filter cover mounting screws and separate the valve housing from the air dome and filter cover. Remove the air dome diaphragm.

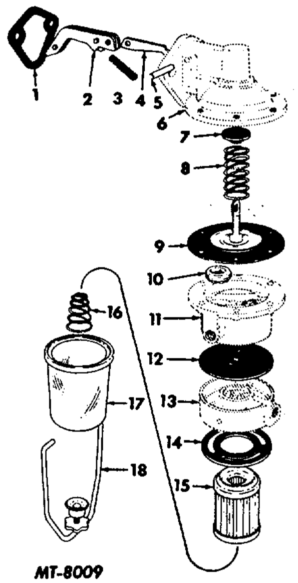

Fig. 5 Exploded View of Suspended Bowl Type Fuel Pump

Legend for Fig. 5.

Key	Description
1	GASKET, Mounting
2	LEVER, Cam
3	SPRING, Cam Lever
4	LEVER, Diaphragm
5	PIN, Cam Lever
6	BODY, Pump
7	SEAL, Oil Assembly
8	SPRING, Diaphragm
9	DIAPHRAGM, Pump
10	VALVE, Inlet and Outlet
11	HOUSING, Valve
12	DIAPHRAGM, Air Dome
13	COVER
14	GASKET, Element Bowl
15	ELEMENT, Paper or Ceramic
16	SPRING, Element (If Used)
17	BOWL, Fuel
18	RETAINER, with SCREW

Inspection

Whenever the fuel pump is serviced there are some parts which should always be replaced whether the old parts appear serviceable or not. These parts are the diaphragm assembly, air dome diaphragm, filter bowl gasket, ceramic or paper filters, valve and cage, cam lever shaft seal plug and the pump-to-crankcase gasket. Fuel pump repair kits containing all these parts are available. All other parts should be inspected as follows:

1. Inspect the pump body, valve housing, air dome and filter cover for cracks or breakage in castings.

2. Check the mating surfaces of castings for warpage.

3. Inspect the body and cover for stripped screw threads.

4. Check the rocker arm for wear at the camshaft contact point and also at the pivot point.

Assembly

All suspended or side-mounted bowl type fuel pumps will have an assembly procedure similar to the following. Refer to Fig. 6.

1. Place new air dome diaphragm (9) on the dome section of air dome and filter cover (10). Position the open half of the diaphragm over the inlet section of the air dome.

2. Install the valve and cage assembly in the valve housing if they were removed.

3. Assemble valve housing assembly (7) to the air dome and filter cover assembly so that the intake side of the housing mates with the intake side of the air dome. Insert two mounting screws (6) with lockwashers and tighten securely.

4. Install new diaphragm assembly (5) to pump body (20).

5. Insert cam lever (1) into the opening in the pump body. Compress the diaphragm spring slightly so that the forked end of the cam lever engages under the retainer on the end of the diaphragm spring.

6. Fasten the cam lever in the pump body with cam lever pin (21) and secure the pin with cam lever shaft retaining spring pin (4). Seal the pin opening in the pump body with cam lever shaft seal plug (3).

7. Check the match marks made at the time of disassembly on the pump body and valve housing assembly and install the valve housing assembly to the pump body.

8. Install mounting screws (8) with lockwashers but tighten only enough for the screws to just touch the lockwashers.

9. Clamp the pump in a vise having soft jaws. Pull the cam lever to the full intake position and hold while tightening the housing to the pump body mounting screws. This will allow the diaphragm to position itself properly.

10. Place filter bowl gasket (11), new filter (12T, filter spring (14) and filter bowl (15) over the cover section of air dome and filter cover (10) and secure in place with retainer (16).

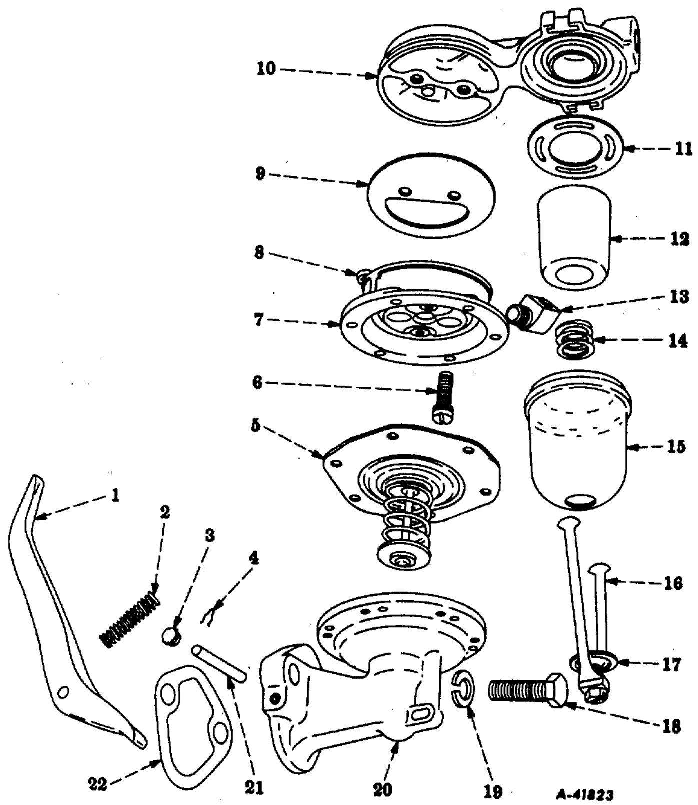

Fig. 6 Exploded View of Side-Mounted Bowl Type Fuel Pump

Legend for Fig. 6

Key	Description	Key	Description
1	LEVER, Cam	12	FILTER, Glazed Ceramic or Paper
2	SPRING, Cam Lever Return	13	ELBOW
3	PLUG, Cam Lever Shaft Seal	14	SPRING, Filter
4	PIN, Spring, Cam Lever Shaft Retaining	15	BOWL, Filter
5	DIAPHRAGM, Assembly	16	RETAINER, with Screw Assembly
6	SCREW, with Lockwasher, Assembly	17	WASHER, Filter Bowl Retaining
7	HOUSING, Valve Assembly	18	BOLT, Hex Head
8	SCREW, with Lockwasher, Assembly	19	LOCKWASHER
9	DIAPHRAGM, Air Dome	20	PUMP BODY
10	AIR DOME and FILTER COVER	21	PIN, Cam Lever
11	GASKET, Filter Bowl	22	GASKET, Pump-to-Crankcase

Electric In-Tank Mounted Type

There is no service on the in-tank mounted electric fuel pump--only complete replacement of the pump itself. Do not disassemble the electric fuel pump.

GENERAL INFORMATION

INDEX

1. GENERAL INSTRUCTION

Adequate protection and storage of new vehicles is a strict responsibility of the dealer or branch.

The following procedures are to be used for storing all vehicles. Satisfactory storage arrangements are less costly and troublesome in the long run than haphazard, unplanned methods.

Claims arising from loss and damage that occur while the vehicle is in storage will not be considered for reimbursement by the Warranty Processing Center.

As rapid stock turnover is desirable, sales efforts should be centered on those vehicles that have been on hand and in storage for the longest period of time.

Check your own arrangements against the following suggestions and correct situations which create unnecessary expense and selling problems.

Parking Area

Whenever possible, vehicles should be stored indoors in a dry, well ventilated area and protected from sunlight. When circumstances do not permit, definite precautions must be taken to eliminate conditions which would result in product deterioration, unwarranted expense, and later customer dissatisfaction.

CAUTION:

A. Do not park near transformers or electrical motors, as when the protection wax contained in the tire compound cracks, ozone in the air will attack the exposed area.

B. Do not park near trees, or where high weeds or grass exist. This will prevent damage from birds, tree and weed sad or insects which cause stain.

C. Do not park near railroad tracks, industrial smoke areas, paint shops, or where street and road splash could contact vehicle.

D. When the vehicle cannot be parked on a level surface, block wheels.

Body-Cab

A. If necessary wash vehicle. Washing should be followed by wiping of horizontal surfaces to remove any water. Never wash the vehicle in the direct rays of the hot sun nor when the sheet metal is hot to the touch, as this may cause streaks on the finish. Do not use hot water or strong soaps or detergents or wise off dirt when the surface is dry as this will scratch the paint.

B. WAXING OR POLISHING NEW VEHICLES

Prior to use of any wax or polish, vehicle must be thoroughly washed.

C. Carefully check the paint and touch up) all exposed primed or raw metal surfaces to prevent rust.

D. Clean and wax all chrome and Stainless steel metal parts with a thick coat of custom auto wax to prevent discoloration from the elements. NOTE: After each washing be sure that the chrome and bright metal parts are rewaxed as necessary.

2. FOURTH MONTH STORAGE SERVICE

The operations defined below should be performed on all new vehicles which have been in storage four months.

Operations To Be Performed

A. Start engine and operate at fast idle until normal engine operating temperature is reached.

B. Operate air conditioner (if equipped) for a few moments.

C. Rinse wash vehicle.

D. Touch up any paint damage.

E. Clean and wax bright metal.

F. Check battery water level and specific gravity. NOTE: If gravity is under 1.225, recharge battery.

G. Check radiator coolant level. Also check coolant for adequate freeze protection.

H. Install fuel tank rust inhibitor kit No. 285037-C91 (steel tanks only).

I. Check to assure all tires are inflated (visually).

J. Drive vehicle to parking area. Refer to parking area Cautions outlined under General Instructions.

K. Drain air brake reservoir(s), then close drain cock.

L. Cover end of vertical exhaust stacks.

M. Disconnect battery(s) ground cable. This will prevent accidental starting, or shorting of the electrical system.

N. To prevent fading of the interior trim when the vehicle is exposed to the ultraviolet rays of the sun, spray or apply a coating of Bon-Ami or similar substance on the inside of the windshield and windows.

3. ONCE A MONTH STORAGE SERVICE AFTER FOUR MONTHS

A. Remove vertical exhaust stack covers.

B. Connect battery(s) ground cable.

C. Start engine and operate at fast idle until normal engine operating temperature is reached.

D. Operate air conditioner (if equipped) for a few moments.

E. IMPORTANT: Where vehicles are stored outside, particularly along coastal areas, paint and bright metal deterioration will be more rapid due to prevailing salt water atmosphere and high humidity. For this reason it may be necessary to wash the steel metal parts once a month. This operation must be determined by the brance or dealer.

F. Check tire pressure visually.

G. Engage and disengage clutch and parking brake.

H. Disconnect battery(s) ground cable. This will prevent accidental starting or shorting of the electrical system.

I. Install vertical exhaust stack covers.

BALL AND ROLLER BEARING MAINTENANCE

Important-In order to assure bearings being free of rust, dirt, or damage, the following procedure relative to handling, and installation is recommended:

1. Cleansing and Lubrication of Bearings

(a) Use clean kerosene or Stoddard Solvent in a clean container.

(b) Use clean, lint free rags or towels, and never use waste. Lint from waste may enter bearing.

(Note: Suitable wheel bearing cleaner equipment is available, which will facilitate bearing cleansing.)

(c) Dip bearing in kerosene several times, rocking bearing race rings slowly to dislodge grease from ball sockets.

(d) Spin bearing while repeatedly dipping into kerosene. Continue operation until bearing runs smoothly and quietly or until it is clean and ready for inspection.

(e) If bearing is found satisfactory, dip in a neutral oil or thin grease and wrap. (Note: Suitable wheel bearing grease packer equipment is available, which will produce excellent results.)

2. Removal and Installation of Bearings

(a) Shafts or housings must be clean and free from burrs.

(b) Use properly arranged press plates or arbors for installation or removal of bearings.

In pressing bearings into place the pressure or load should be so applied that it will not be transferred through the balls.

For example, if bearing is applied to or removed from shaft, pressure should be applied to inner bearing cone.

If bearing is being installed in or removed from a housing or case bore, pressure should be applied to outer bearing cup.

(c) Do not hammer on bearings. Lead or babbitt hammers may chip off and allow pieces to lodge in bearing. Wooden hammers may leave splinters in bearings. Steel hammers will chip, crack, or Brinell the bearing.

(d) If necessary to heat bearing for installation or removal, use a light or medium-weight oil heated to 225°F. Allow bearing to stand in this oil until thoroughly heated.

(e) Upon installation of bearing, lubricate bearing seat with light oil.

(f) Apply steady pressure. If bearing sticks or binds, ascertain cause. Correct fault and then proceed with operation. A bearing started in a cocked position will bind.

Burrs in housings or on shafts will cause severe binding and sticking.

Bearing should rest squarely against shoulder or in recess.

(g) Bearing should roll freely after installation unless individual specifications call for a preload. Test bearing for bind or drag by holding bearing outer race between thumb and finger, and test for side play. (A radial clearance of . 0001" will produce side play of approximately .005" to .006") Shafts mounted in bearings should rotate freely after installation unless individual specifications call for a preload. Test by revolving shaft assembly.

3. Intermixing of Component Parts -Roller Bearings

Wherever possible, intermixing of roller bearing component parts should be discouraged. Therefore, where possible, IH parts should be used to service IH assemblies.

STEEL AND ITS HEAT TREATMENT

The heat treatment of steel consists of annealing, hardening and tempering.

Annealing

Annealing consists of heating above the "critical range", then cooling slowly, for the purpose of refining the grain, softening the steel to machinability and relieving the internal strains set up in the steel by forging and hammering, these strains sometimes amounting to several thousand pounds per square inch.

Hardening

Hardening consists of heating above the critical range and cooling quickly, as by quenching in oil or water, the degree of hardness depending upon the carbon content of the steel and the severity of the quench.

Tempering

Water quenching is more severe than oil quenching and is frequently followed by tempering or drawing to reduce the brittleness imparted by the severity of the quench.

Casehardening or Carburizing

Carburizing, carbonizing or casehardening are names applied to the process wherein a piece of low-carbon steel is packed in a carbonaceous material such as bone or leather, or a commercial carburizing material and heated for a number of hours, just above the "critical range" of the steel, or above its point of decalescence, thereby causing the low-carbon steel to absorb carbon on the outer surface for a depth directly dependent upon the number of hours it is heated. Under such conditions, a carbonized case is produced which is capable of responding to ordinary hardening or tempering operations.

Brinell Test

The Brinell test is commonly made with a hydraulic testing machine in which a steel ball of ten millimeter diameter is pressed into the test piece by a load of three thousand kilograms. The diameter of the impression the ball produces in the test piece is then measured and checked against a standard. Thus an impression four millimeters in diameter indicates softer steel than a diameter of three and one half millimeters.

The Brinell test is definitely related to the ultimate strength of the material.

Scleroscope Test

The Shore Scleroscope test is made with a small instrument which drops a diamond-tipped hammer approximately ten inches through a small glass tube upon a smooth surface of the steel to be tested, and the height of the rebound of the hammer measured against a scale at the back of the glass tube. Hard steel is taken as being 100 hard on the Scleroscope and soft steel approximately 30 to 35 hard.

Tensile Test

A test bar of the standard S.A.E. form is machined from the material to be tested, and is held in threaded grips in a vertical position in the testing machine. The machine is set in motion and the test bar is slowly stretched until it is broken. The point at which the elongation ceases to be proportional to the load is designated as the elastic limit. This is the highest point at which, if the load were removed, the bar would resume its original length. This is also the point at which, if exceeded, failure of the part commences. The weight of the load at this point is read on the weighing beam of the testing machine and converted into pounds per square inch, to be checked against S.A. E. specifications for that particular steel from which the test bar was made.

GLOSSARY OF TECHNICAL AND MECHANICAL TERMS

Absorption

The action of a material in extracting substance from the atmosphere (water from air, etc.).

Allowance

Covers variation in dimensions to allow for different qualities of fits.

Alloy Steel

A steel which owes its characteristic properties chiefly to the presence of one or more elements other than carbon; i.e., nickel, chromium, vanadium, molybdenum, etc.

Angle

The difference in direction of two lines which meet or tend to meet. The lines are called sides, and the point of meeting' the vertex of the angle. They are measured by degrees and by radians. One degree is equivalent to the angle at the center of a circle, subtended by an arc whose length equals one three hundred sixtieth (1/360) of the circumference. One radian is equal to the angle at the center of a circle when subtended by an arc equal in length to the radius of the circle. One radian equals 57.2958 degrees; also 1 radian equals 180/ r.

The protractor is used for the measurement of angles. A right angle is one which is formed by the radius moving through 1/4 of the circumference. It is a square angle and contains 90°.

An acute angle is one containing less than 90°. An obtuse angle is one containing more than 90°.

An oblique angle may be any other than a right angle. A reflex angle is one containing more than 180°.

A helical angle is the angle of a thread at the pitch line with the axis of a threaded part; the lead angle of a thread is the total or included angle between the sides or walls of a thread measured on the axial line.

A dihedral angle is one formed by the opening between two intersecting planes.

The vertex of an angle is the point of intersection of the two lines which form the angle.

Brinell Test

A hardness-testing instrument, employing the hardened steel ball indentation method.

B.T.U.

Abbreviation for British Thermal Unit which represents the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near 37°F. There are 778 foot-pounds of energy in a B.T.U. and 42.4 B.T.U. to one horsepower.

Calibrate

To ascertain the accuracy of and to rectify same, as regards a precision measuring instrument, etc.

Calorie

Any of several thermal units, as: (a) The amount of heat (small calorie) required to raise the temperature of one gram of water one degree Centigrade. (b) The amount of heat (large or great calorie) required to raise a kilogram of water one degree Centigrade. (1 great calorie equals 1000 small calories.)

Cantilever

A projecting beam, bar, or member supported at one end only.

Center of Gravity

That point in a body about which all the parts exactly balance each other.

Center of Oscillation

If a body oscillates about a horizontal axis which does not pass through its center of gravity, there will be a point on the line drawn from the center of gravity perpendicular to the axis, the motion of which will be the same as if the whole mass were concentrated at that point. This point is called the center of oscillation.

Centrifugal Force

When a body revolves in a curved path, it exerts a force called the centrifugal force upon the arm or cord which restrains it from moving in a straight (tangential) line.

Chamfer

A bevel, or a corner or edge removed, a relief.

Cold Working

Changing the shape of steel parts by compressing, stretching, bending, or twisting, using stresses beyond the yield point and temperatures below the critical range. Cold-drawn steel is finished by being drawn through a die, while cold-rolled steel is finished between rollers.

Contour

Outline or profile of an object.

Cycle

Applied to the internal-combust; on, four-cycle engine, a cycle comprises four strokes for each piston (1, intake; 2, compression; 3, explosion; 4, exhaust) performed during two revolutions of the crankshaft. An interval or period of time occupied by one round or course of events, recurring in the same order in a series.

Ductility

Ability to withstand stretch without rupture. Ductility is usually measured by the percentage of elongation, after rupture over a gauge length laid off on a specimen before stretching, or by the reduction of area of the original cross section of a specimen when tested in tension.

Dynamic Balance

A crankshaft may be in perfect static balance, but if it is mounted in bearings and revolved at high speed great vibration may develop which would soon cause failure of engine bearings and possibly cause breakage of the shaft itself due to fatigue action.

Dynamic unbalance means that the weight sums of diagonally opposite portions are not equal. Take, for example, a pulley that is in perfect balance. Visualize the pulley mounted on a shaft supported by bearings. Attach a weight to the outer periphery on one edge of the pulley, then attach an exact counterweight to the opposite side of the pulley on the opposite edge. The pulley continues to be in static balance as evidenced by the fact that it turns freely and stops with the counterweights either up, down, or in any other position; but if the pulley is revolved at a high rate of speed its dynamically unbalanced condition will be very much evidenced by the vibration. This dynamic unbalance is eliminated in a crankshaft first by determination of the heavy points and next by drilling into these points until the necessary amount of metal and weight has been removed.

Elastic Limit

The term "elastic limit" is unfortunately used very loosely in general practice. In scientific usage the term is used to denote the highest unit stress at which material will completely recover its form after the stress is removed.

Endurance

In the physical laboratory this term is used to denote the number of cycles of repeated stress withstood by a specimen before failure.

Factor of Safety

Working stresses should never exceed the elastic limit. They are generally based on the ultimate strength of the material. The ratio of the ultimate strength of a given material to the allowable working strength called the "Factor of Safety".

Fatigue of Metals

The action which takes place in metals causing failure after a large number of applications of stress. Fatigue failures are characterized by their suddenness and by the absence of general deformation in the piece which fails. A wire broken by bending backward and forward is a characteristic fatigue failure.

Cause of Fatigue Failure

The cause of a fatigue failure may be attributed to a repetition of stresses which exceed the elastic limit of the steel. This may be subdivided as follows:

Manufacturer's Responsibility
1. Defective raw material.
2. Defective heat treatment.
3. Defective design.
4. Defective machining.

Truck Operator's Responsibility
1. Overloading.
2. Overspeeding.
3. Rough handling and driving.
4. Road conditions.

Fit

The different classes of fit of shafts in their holes most generally used are as follows:

Shrink Fit-For parts which have to be fitted together by means of an application of heat to expand the hole, at which time the shaft is inserted. On cooling the hole contracts, making a perfect union which requires no keys or other anchors of any kind. The bores are always machined to a smaller diameter than that of the shaft.

Force Fit --For parts which have to be fitted together by means of a press; they must be keyed if they are to be subjected to a twisting force.

Driving Fit --For parts which have to be fitted together with a soft hammer, but which can be afterwards disassembled.

Push Fit --For parts which have to be fitted together by hand without special force, and without having perceptible shake when assembled, they should remain motionless in each other.

Sliding Fit --For all parts which in functioning have to slide constantly on one another, without turning.

Running Fit --For parts which in functioning have to revolve constantly one in the other, at a medium speed and with very little play.

Easy Running Fit --Parts revolving with a relatively large amount of play.

Fillet

A narrow band of material, frequently in shop practice used to designate a radius on a shaft or other part.

Flute

The groove cut in taps and reamers to form the cutting edge and allow room for chips.

Friction

Is the resistance to motion which takes place when one body is moved upon another, and is generally defined as "That force which acts between two bodies at their surface of contact, so as to resist their sliding on each other."

Gauge or Gage

Master, Standard or Reference; terms applying to a nearly perfect gauge used for calibration of working gauges.

Gauge -Limit

A gauge having two sizes, the difference between them representing the tolerance or allowable variation. One size must go into or over the work being checked, and the other size must not go. These gauges are frequently referred to in shop practice as "tolerance gauges" and as "go" and "no go" gauges.

Gear Tooth Parts

The outside diameter of a gear is the diameter measured over the top of the teeth.

The root diameter of a gear is the diameter measured at the bottom or roots of the teeth.

The center distance is the distance between the centers of two meshing gears, the pitch circles of which are tangent to each other.

The diametral pitch of a gear is the number of teeth for each inch of pitch diameter, and is found by dividing the number of teeth by the pitch diameter.

The circular pitch is the distance from the center of one tooth to the center of the next, measured as an arc along the pitch circle.

The working depth is the depth to which the teeth in a meshing gear enter into the spaces between the teeth of the opposing gear.

The clearance is the amount by which the tooth space is cut deeper than the working depth.

The face of the tooth is that part of the tooth curve that is between the outside circumference and the pitch circle.

The flank of the tooth is that part of the working depth of the tooth which comes inside of the pitch circle.

Gravity

The attraction of bodies toward the center of the earth. Under the influence of gravity alone, all bodies fall to the earth with the same velocity and with the same acceleration. The acceleration increases with the latitude and decreases with the elevation above the level of the sea. Its value at the level of the sea in the latitude of New York is 32.16 feet per second. (In the metric system, Gravity equals 9.81 meters per second at 45 degrees latitude and sea level.)

Hardness

Is that property of a material by virtue of which it resists penetration.

Helix

A spiral. A coiled spring or a screw thread forms a helix.

Also, a spiral cut on the side of injection plunger for metering fuel.

Hydraulics

The science dealing with liquids in motion.

Hypoid

Hypoid (contraction of the word hyperboloid) meaning that the pinion is offset with respect to the center line of the ring gear.

Inch-Pounds

A term used to denote work or energy.

Land

One of the sharpened ridges which make up the cutting section of a tap, die, reamer or milling cutter after the flutes or chip clearance spaces have been removed.

Lead

The longitudinal distance which a screw thread advances when turned one complete revolution.

Horsepower

Horsepower (abbreviated H.P.) is the unit of power adopted for engineering work. One horsepower is equal to 33, 000 foot-pounds per minute, or 550 foot-pounds per second. The metric horsepower is equal to 75 kilogram-meters per second, or 542.5 foot-pounds per second, or 32, 550 foot-pounds per minute. The kilowatt used in electrical work equals 1.34 horsepower; or one horsepower equals 0.746 kilowatt.

Velocity

Velocity is distance divided by time, and is expressed in feet per minute, miles per hour, etc.

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Inertia

Inertia is that property of a body which causes it to tend to continue in its present state of rest or motion, unless acted upon by some force.

Micrographs

Micrographs are obtained by polishing the surface of a metal, etching the polished surface with a suitable reagent to bring out the metallographic structure, then reproducing, usually by photographic methods, the appearance of the surface as seen through the microscope. Photomicrograph and microphotograph are terms sometimes used for micrographs made by a photographic process.

Momentum

The momentum of a moving body is the intensity of that constant force which, resisting its movement, would bring it to rest in one second.

Momentum = mass X velocity in feet per second

$$\text{Momentum} = \frac{\text{weight}}{32.16} \times \text{velocity in feet per second}$$

Momentum should not be confused with the moment of a force.

Motion, Newton's Three Laws

1st Law: Every body continues in a state of rest or uniform motion in a straight line, except if it is acted upon by a force to change its state of motion or rest.

2nd Law: If a body is acted upon by several forces, it is acted upon by each of these as if the others did not exist. This is true whether the body is at rest or in motion. In other words, if two or more forces act upon a body at the same time, each produces exactly the same effect as if it acted alone; the total effect or resultant motion of all the forces may be found by a diagram in the same way as the resultant of forces is found.

3rd Law: To every action there is always an equal reaction or, in other words, if a force acts to change the state of motion of a body, the body offers a resistance equal and directly opposite to the force.

Physics

The science of phenomena of inanimate matter involving no chemical changes, comprising mechanics, magnetism, electricity, light, heat and sound.

Pi-π

The 16th letter of the Greek alphabet, corresponding to the English P, is used as a constant to denote the ratio (3.14159+) of the circumference of a circle to its diameter.

Pneumatics

That branch of physics treating of the mechanical properties of air and other gases, as of their weight, pressure, elasticity, etc.

Refrigerant

A substance which produces a refrigeration effect by its absorption of heat while expanding, vaporizing or evaporating. Evaporation is a cooling process.

Static Balance

Balancing of crankshafts is a very important factor in providing long engine life. Crankshafts must be balanced for equalization of weight so that when supported on knife blades the shaft will not revolve. This is the same condition of balance that would obtain with an automobile wheel if a slight counterweight were placed directly opposite the valve stem so that the wheel, if jacked up and given a spin, would stop and remain stationary wherever it was overtaken by inertia after the energy from the force of the spin had spent itself. If not in perfect balance, the wheel would either turn over another revolution or turn back until the heavy point was down.

Elimination of the heavy place on a crank shaft is termed static balancing. This is accomplished by grinding off portions of the balancing pads forged into both sides of each throw for that purpose.

Stress

An internal force which resists the destructive action of external force. Stresses are always accompanied by strains and deformations There are tensile stresses, compressive stresses, and shearing stresses. At any point on a stressed member the stress per unit area is called the "unit stress". Stress is the force applied, and:

Strain

Is the resulting deformation.

Specific Gravity

Is a number indicating how many times a certain volume of material is heavier than an equal volume of water at a temperature of 62° F. The weight of one cubic inch of pure water at 62° F. is 0.0361 pound. If the specific gravity of any material is known, the weight of a cubic inch of the material can, therefore, be determined by multiplying its specific gravity by 0.0361.

Tolerance

The range of distance between specified limits, as applied to machine shop practice.

Torsion

That force with which a twisted part tends to return to a state of rest.

Torque

Torque is that which produces or tends to produce rotation or torsion; the product of tangential force multiplied by the radius of the part it rotates. An engine is, therefore, essentially a device for producing torque, and torque is the energy available for producing work.

Toughness

Denotes a combination of strength and ductility, resistance to fatigue, tension and shear.

Vapor

The gaseous form of substances which are normally in the solid or liquid state and which can be changed to these states by increasing pressure or decreasing the temperature.

Volatile

Readily vaporizable (examples: freon, ether, gasoline, alcohol, L.P. gases, etc.).

GLOSSARY OF ELECTRONIC TERMS

Ampere: The practical unit of electrical current; the current produced by one volt acting through a resistance of one ohm.

Amplifier: An electrical device containing transistors, diodes and resistors used for controlling current flow.

Arc-Over: The result of electrical current passage through other than a designated route.

Biasing Resistor: Resistor used to develop a voltage drop and provide transistor operation at other than ground level.

Bypass Resistor. Resistor used to provide fixed current path around some circuit element.

Capacitor or Condenser: Device used to store electrical energy.

Diode: A small wafer-like electrical device that allows current to pass through itself in one direction only.

Epoxy: Bonding material used for mounting, joining, reinforcing or insulating electrical components.

Feed-Back Resistor: A resistor through which part of the output current of a device passes back to the input of the device to stabilize current flow.

Heat Sink: Electronic component mounting plate which also serves to dissipate heat from components.

Induced: Made or caused to be as indirect voltage in coil caused by the intermittent current flow through the coil primary windings inducing a voltage in the secondary windings.

Infinite: Greater than an assignable quantity-as applied to the reading of an ohmmeter.

Ohm: Electrical unit of resistance of a circuit in which a potential difference of one volt produces a current of one ampere.

Ohmmeter: Instrument for measuring resistance.

Panelboard: Mounting board for electrical components.

Pole Piece: Stationary and rotating parts of distributor which carry magnetic pulse used to trigger the amplifier.

Printed Circuit: Conductive paths applied to a nonconductive material to eliminate loose wires and condense package size.

Relay: Device to open or close circuits and controlled from a remote point. Resistor: A device used to limit the flow of current to a specified value.

Silicone Grease: A special lubricant having the quality of good heating or cooling conductivity.

Solenoid: A tubular coil for producing magnetic field and changing electrical energy to motion.

Timer Core: Rotating pole piece of magnetic pulse distributor.

Transistor: An electrical device which acts as a switch to control a circuit. It has no moving parts.

Trigger Transistor: Transistor serving as an off or on switch to replace contact points.

Volt: The unit of electromotive force; that electromotive force, which, if steadily applied to a conductor having a resistance of one ohm, will produce a current of one ampere.

Watt: A unit of electrical power or activity equal to the rate of work represented by a current of one ampere under a pressure of one volt, a volt-ampere. One horsepower is approximately equal to 746 watts.

WEIGHTS, MEASURES, EQUIVALENTS

STANDARD WEIGHTS AND MEASURES

LONG MEASURE

12 in.	1 ft.
3 ft.	1 yd.
16-1/2 ft.	1 rod
320 rods	1 mile
1,760 yds. or 5,280 ft.	1 mile

SQUARE MEASURE

144 sq. in.	1 sq. ft.
9 sq. ft.	1 sq. yd.
4,840 sq. yds., 43,560 sq. ft.	1 Acre
640 Acres	1 sq. mile

An Acre = A square whose side is 208.71 ft. long.

SOLID OR CUBIC MEASURE

1,728 cu. in.	1 cu. ft.
27 cu. ft.	1 cu. yd.

1 cord wood = A pile 4 ft. wide x 4 ft. high x 8 ft. long = 128 cu. ft.

LIQUID MEASURE

4 gills	1 pt.
2 pts.	1 qt.
4 qts.	1 gal.

The U.S. gallon = 231 cu. in. = .13373 cu. ft.
The English gallon = 277.274 cu. in.
The English gallon = 1.20032 U.S. gallons = The volume of 10 lbs. of water at 62°F.

U.S. DRY MEASURE

2 pts.	1 qt.
8 qts.	1 pk.
4 pks.	1 bu.
1 bu.	2150.42 cu. in. = 1.2445 cu. ft.

A heaped bushel equals 1-1/4 struck bushels as measured above.

COMMERCIAL MEASURE OF WEIGHT

Avoirdupois or Commercial Weight

437.5 grains	1 oz.
16 oz. or 7,000 grains	1 lb.
2,000 lbs.	1 net or short ton (commonly used)
2,240 lbs.	1 gross or long ton

BOARD MEASURE

The unit of solid measure for boards is the foot board measure (B.M.). This is a volume 1 in. in thickness, 12 in. in width, and 1 ft. in length. To obtain the number of feet B.M. of a board or piece of square timber, multiply the length in feet and the breadth in feet and the thickness in inches.

WEIGHT AND MEASURE EQUIVALENTS

1,728 cu. in.	1 cu. ft.	27 cu. ft.	1 cu. yd.
46,656 cu. in.	1 cu. yd.	128 cu. ft.	1 cord
2,150 cu. in.	1 bushel	1.24 cu. ft.	1 bushel
7,056 cu. in.	1 barrel	4.08 cu. ft.	1 barrel
231 cu. in.	1 gallon	20.75 cu. ft.	1 hay bale
144 cu. in.	1 bd.-ft.	10.75 cu. ft.	1 sm. bale
20-23 cu. ft.	1 cotton bale		

SIZE OF BARRELS AND BASKETS U.S. STANDARD BUSHEL

1 bu.	4 pks.	2445 cu. ft.	2150.42 cu. in.
1 pk.	8 qts.	3111 cu. ft.	537.61 cu. in.
1 qt.	2 pts.	0389 cu. ft.	67.20 cu. in.

U.S. STANDARD BARRELS FOR VEGETABLES, FRUIT AND DRY COMMODITIES, EXCEPT CRANBERRIES

1. Capacity .... 7,056 cu. in.
   105 dry qts.
   3.28 bu.
   Head diam. .... 17.125 in.
   Bilge diam. .... 20.37 in.
   Stave lgth. .... 27.125 in.
2. Capacity .... 5,826 cu. in.
   87 dry qts.
   2.709 bu.
   Head diam. .... 16.25 in.
   Bilge diam. .... 18.62 in.
   Stave lgth. .... 28.5 in.
3. Flour Barrel
   Weight .... 200 to 220 lbs.
   Head diam. .... 18 in.
   Bilge diam. .... 21 in.
   Stave lgth. .... 28.5 in.
4. Sugar Barrel
   Weight .... 300 to 360 lbs.
   Head diam. .... 20.5 in.
   Bilge diam. .... 25.0 in.
   Stave lgth. .... 30.0 in.
5. Syracuse Salt Barrel
   Weight .... 280 lbs.
   Head diam. .... 18 in.
   Bilge diam. .... 21 in.
   Stave lgth. .... 29 in.

ABBREVIATIONS FOR TERMS OF WEIGHT AND MEASURE

Following the name of each unit in the list below is given the abbreviation which the Bureau has adopted. Attention is particularly called to the following principles:

1. The period is omitted after the abbreviations of the metric units, while it is used after those of the customary system.

2. The exponents "2" and "3" are used to signify area and volume, respectively, in the case of the metric units instead of the longer prefixes "sq." or "cu." In conformity with this principle the abbreviation for cubic centimeter is "cm^3" instead of "c.c." or "c.m." The term "cubic centimeter" as used in chemical work is, in fact, a misnomer, since the unit actually used is the "milliter," which has a slightly larger volume.

3. The use of the same abbreviation for both singular and plural is recommended. This practice is already established in expressing metric units and is in accordance with the spirit and chief purpose of abbreviations.

4. It is also suggested that, unless all the text is printed in capital letters, only small letters be used for abbreviations except in the case of A, for acre, where the use of the capital letter is general.

Unit	Abbreviation
acre	A
area	a
avoirdupois	av.
barrel	bbl.
board foot	bd. ft.
bushel	bu.
carat, metric	c
centare	ca
centigram	cg
centiliter	cl
centimeter	cm
chain	ch.
cubic centimeter	cm^3
cubic decimeter	dm^3
cubic dekameter	dkm^3
cubic foot	cu. ft.
cubic hectometer	hm^3
cubic inch	cu. in.
cubic kilometer	km^3
cubic meter	m^3
cubic mile	cu. mi.
cubic millimeter	mm^3
cubic yard	cu. yd.
decigram	dg.
deciliter	dl
decimeter	dm
decistere	ds
dekagram	dkg
dekaliter	dkl.
dekameter	dkm.
dekastere	dks
dram or drachm, apothecaries'	dr. ap. or Z
dram, avoirdupois	dr. av.
dram, fluid	fl. dr.
fathom	fath.
foot	ft.
firkin	fir.
furlong	fur.
gallon	gal.
grain	gr.
gram	g.
hectare	ha
hectogram	hg
hectoliter	hl
hectometer	hm
hogshead	hhd.
hundredweight	cwt.
inch	in.
kilogram	kg
kiloliter	kl
kilometer	km
link	li.
liquid	liq.
liter	l
meter	m
metric ton	t
micron	u
mile	mi.
milligram	mg.
milliliter	ml
millimeter	mm
millimicron	mu
minim	min. or mu
ounce	oz.
ounce, apothecaries'	oz. ap. or Z
ounce, avoirdupois	oz. av.
ounce, fluid	fl. oz.
ounce, troy	oz. t.
peck	pk.
pennyweight	dwt.
point	pt.
pound	lb.
pound, apothecaries'	lb. ap.
pound, avoirdupois	lb. av.
pound, troy	lb. t.
quart	qt.
rod	rd.
scrupe, apothecaries	s. ap. or Z
square centimeter	cm^2
square chain	sq. ch.
square decimeter	dm^2
square dekameter	dkm^2
square foot	sq. ft.
square hectometer	hm^2
square inch	sq. in.
square kilometer	km^2
square meter	m^2

Unit	Abbreviation	Unit	Abbreviation
square mile	sq. mi.	ton	tn.
square millimeter	mm^2	ton, metric	t
square rod	sq. rd.	troy	t.
square yard	sq. yd.	yard	yd.
stere	s.		

UNITS OF WEIGHT AND MEASURE

(From Circular No. 47 of Bureau of Standards, Department of Commerce, Washington, D.C.)

THE METRIC SYSTEM: Metric units are naturally related. For example: 1 cubic decimeter equals, for all practical purposes, 1 liter, and 1 liter of water weighs 1 kilogram. The metric terms are formed by combining the words "meter," "gram" and "liter" with the six numerical prefixes, as in the following table:

Prefixes		Meaning	Units
milli-=one-thousandth	$\frac{1}{1000}$	.001	"meter" for length
centi=one-hundredth	$\frac{1}{100}$	.01	
deci-= one-tenth	$\frac{1}{10}$	.1	"gram" for weight or mass
Unit = one	$\frac{10}{1}$	1	
deka- = ten		10	
hecto- = one hundred	$\frac{100}{1}$	100	"liter" for capacity
kilo- = one thousand	$\frac{1000}{1}$	1000	

Definitions of Units

The following lists of units include most of those in general use. Simple conversions may be made from the values here given. For example, if a conversion into nautical miles is wanted, the conversion factor for statute mile given in the conversion tables may be used by multiplying it by the factor 1.151553 here given to show relation of nautical mile to statute mile.

Length

FUNDAMENTAL UNITS

A meter (m) is a unit of length equivalent to the distance between the defining lines on the international prototype meter at the International Bureau of Weights and Measures when this standard is at the temperature of melting ice (0°C.).

1 m. = $\frac{3937}{3600}$ yd.

A yard (yd.) is a unit of length equivalent to $\frac{3600}{3937}$ of a meter.

HIGHER AND LOWER UNITS

1 kilometer (km) = 1000 meters.
1 hectometer (hm) = 100 meters.
1 dekameter (dkm) = 10 meters.
1 decimeter (dm) = 0.1 meter.
1 centimeter (cm) = 0.01 meter.
1 millimeter (mm) = 0.001 meter = 0.1 centimeter.
1 micron (u) = 0.000 001 meter = 0.001 millimeter.
1 millimicron (mu) = 0.000 000 001 meter = 0.001 micron.

1 foot (ft.) = $\frac{1}{3}$ yard = $\frac{1200}{3937}$ meter.

1 inch (in.) = $\frac{1}{36}$ yard = $\frac{1}{12}$ foot = $\frac{100}{3937}$ meter.

1 link (li) = 0.22 yard = 7.92 inches.
1 rod (rd.) = 5-1/2 yards = 16-1/2 feet.
1 chain (ch.) = 22 yds. = 100 links = 66 feet = 4 rods.
1 furlong (fur.) = 220 yards = 40 rods = 10 chains.
1 statute mile (mi.) = 1760 yards = 5280 feet = 320 rods.
1 hand = 4 inches.

1 point = $\frac{1}{72}$ inch.

1 mil = 0.001 inch.
1 fathom = 6 feet.
1 span = 9 inches = 1/8 fathom.
1 nautical mile
1 seal mile
1 geographical mile
United States = 6080.20 feet = 1.151 553 statute miles = 1353.249 meters

Area

FUNDAMENTAL UNITS

A square meter (m^2) = 1.195985 sq. yd.
A square yard (sq. yd.) = 0.8361307 m^2.

HIGHER AND LOWER UNITS

1 square kilometer (km^2) = 1 000 000 square meters.
1 hectare (ha) or square hectometer (hm^2) = 10 000 square meters.
1 area (a), or square dekameter (dkm^2) = 100 square meters.
1 centare (ca) = 1 square meter.
1 square decimeter (dm^2) = 0.01 square meter.
1 square centimeter (cm^2) = 0.0001 square meter.
1 square millimeter (mm^2) = 0.000 001 square meter = 0.01 square centimeter.

1 square foot (sq. ft.) = $\frac{1}{9}$ square yard.

1 square inch (sq. in.) = $\frac{1}{1296}$ square yard = $\frac{1}{144}$ square foot.

1 square link (sq. li.) = 0.0484 square yard = 62.7264 square inches.
1 square rod (sq. rd.) = 30.25 square yards = 272.25 square feet = 625 square links.
1 square chain (sq. ch.) = 484 square yards = 16 square rods = 100 000 square links.
1 acre (A) = 4840 square yards = 160 square rods = 10 square chains.
1 square mile (sq. mi.) = 3 097 600 square yards = 640 acres.

Volume

FUNDAMENTAL UNITS

A cubic meter (m^3) = 1.307 9428 cu. yd.
A cubic yard (cu. yd.) = .017645594 m.

HIGHER AND LOWER UNITS

1 cubic kilometer (km^3) = 1 000 000 000 cubic meters.
1 cubic hectometer (hm^3) = 1 000 000 cubic meters.
1 cubic dekameter (dkm^3) = 1000 cubic meters.
1 stere (s) = cubic meter.
1 cubic decimeter (dm^3) = 0.001 cubic meter.
1 cubic centimeter (cm^3) = 0.000 001 cubic meter = 0.001 cubic decimeter.
1 cubic millimeter (mm^3) = 0.000 000 001 cubic meter = 0.001 cubic centimeter.

1 cubic foot (cu. ft.) = $\frac{1}{27}$ cubic yard.

1 cubic inch (cu. in.) = $\frac{1}{46656}$ cubic yard = $\frac{1}{1728}$ cubic foot.

1 board foot = 144 cubic inches = $\frac{1}{12}$ cubic foot.

1 cord (cd.) = 128 cubic feet.

Capacity

FUNDAMENTAL UNITS

A liter (l) is a unit of capacity equivalent to the volume occupied by the mass of 1 kilogram of pure water at its maximum density (at a temperature of 4°C. practically and under the standard atmospheric pressure of 760 mm). It is equivalent in volume to 1.00 027 cubic decimeters. One liter = 0.264168 gal.

A gallon (gal.) is a unit of capacity equivalent to the volume of 231 cubic inches. It is used for the measurement of liquid commodities only. 1 gal. = 3.785 332 liter. A British gallon is approximately 20 percent larger.

A bushel (bu.) is a unit of capacity equivalent to the volume of 2150.42 cubic inches. It is used in the measurement of dry commodities only. The bushel is the so-called stricken or struck bushel. Many dry commodities are sold by heaped bushel, which is generally specified in the State Laws to be the usual stricken bushel measure "duly heaped in the form of a cone as high as the article will admit" or "heaped as high as may be without special effort or design." The heaped bushel was originally intended to be 25 percent greater than the bushel. A British bushel is 3 percent larger.

HIGHER AND LOWER UNITS

1 hectoliter (hl) = 100 liters.
1 dekaliter (dkl) = 10 liters.
1 deciliter (dl) = 0.1 liter.
1 centiliter (cl) = 0.01 liter.
1 milliliter (ml) = 0.001 liter = 1.000 027 cubic centimeters.
1 liquid quart (liq. qt.) = 1/4 gallon = 57.75 cubic inches.
1 liquid pint (liq. pt.) = 1/8 gallon = 1/2 liquid quart = 28.875 cubic inches.
1 gill (gi.) = 1/32 gallon = 1/4 liquid pint = 7.21875 cubic inches.
1 fluid ounce (fl. oz.) = $\frac{1}{128}$ gallon = 1/16 liquid pint.
1 fluid dram (fl. dr.) = 1/8 fluid ounce = $\frac{1}{128}$ liquid pint.
1 minim (min.) = $\frac{1}{60}$ fluid dram = 1/4 80 fluid ounce.
1 firkin (fir.) = 9 gallons.
1 peck (pk.) = 1/4 bushel = 537.605 cubic inches.

1 dry quart (dry qt.) = 1/32 bushel = 1/8 peck = 67.200 625 cubic inches.
1 dry pint (dry pt.) = 1/64 bushel = 1/2 dry quart = 33.600 312 5 cubic inches.
1 barrel (bbl.) (for fruit, vegetables and other dry commodities) = 7056 cubic inches = 105 dry quarts (By U.S. Statute, March 4, 1915).

Mass or Weight

FUNDAMENTAL UNITS

A kilogram (kg) is a unit of mass equivalent to the mass of the International prototype kilogram at the International Bureau of Weights and Measures. One kg. = 2.204 622 341 lb. av.

An avoirdupois pound (lb. av.) = 0.453 427 7 kilogram. A gram (g) is a unit of mass equivalent to one-thousandth of the mass of the International prototype kilogram at the International Bureau of Weights and Measures.

A troy pound (lb. 61) is a unit of mass equivalent to 5760/7000 of that of the avoirdupois pound.

HIGHER AND LOWER UNITS

1 metric ton (t) = 1000 kilograms.
1 hectogram (hg) = 100 grams = 0.1 kilogram.
1 dekagram (dkg) = 10 grams = 0.01 kilogram.
1 decigram (dg) = 0.1 gram.
1 centigram (cg) = 0.01 gram.
1 milligram (mg) = 0.001 gram.
1 avoirdupois ounce (oz. av.) = $\frac{1}{6}$ avoirdupois pound.
1 avoirdupois dram (dr. av.) = 1/2 56 avoirdupois pound - 1/16 avoirdupois ounce.
1 grain (gr.) = $\frac{1}{7000}$ avoirdupois pound = $\frac{10}{4375}$ avoirdupois ounce = $\frac{1}{5760}$ troy pound.
1 apothecaries' pound (lb. ap.) = 1 troy pound = $\frac{5760}{7000}$ avoirdupois pound.

1 apothecaries' or troy ounce (oz. ap. or Z, or oz. t.) = $\frac{1}{12}$ troy pound = $\frac{480}{7000}$ avoirdupois pound = 480 grains.
1 apothecaries' dram (dr. ap. or Z) = $\frac{1}{96}$ apothecaries' pound = 1/8 apothecaries' ounce = 60 grains.
1 pennyweight (dwt.) = $\frac{1}{20}$ troy ounce = 24 grains.

1 apothecaries' scruple (s. ap. or S) = $\frac{1}{3}$ apothecaries' drum = 20 grains.
1 metric carat (c) = 200 milligrams = 0.2 gram.
The old carat in use in this country previous to July 1, 1913, was of 205.3 milligrams.
1 short hundredweight (sh. cwt.) = 100 avoirdupois pounds.
1 long hundredweight (1 cwt.) = 112 avoirdupois pounds.
1 short ton (sh. tn.) = 2000 avoirdupois pounds.
1 long ton (l. tn.) = 2240 avoirdupois pounds.

METRIC AND U. S. EQUIVALENT MEASUREMENTS

Measures of Length

METRIC		U. S.	
1	meter	39.37	inches, or 3.28083 feet
.3048	meter	1	foot
1	centimeter	.3937	inch
2.54	centimeters	1	inch
1	millimeter	.03937	inch, or $\frac{1}{22}$ inch nearly
25.4	millimeters	1	inch
1	kilometer	1093.61	yards, or .62137 mile

CONVERSION TABLE

INCH FRACTIONS AND DECIMALS TO MILLIMETERS

INCHES		mm	INCHES		mm	INCHES		mm	INCHES		mm
Fract.	Dec.		Fract.	Dec.		Fract.	Dec.		Fract.	Dec.	
—	.0004	.01	—	.3	7.620	—	.7874	20	—	1.969	50
—	.001	.0250	5/16	.3125	7.938	51/64	.7969	20.241	2	2.000	50.8
—	.0039	.10	—	.3150	8	13/16	.8125	20.638	2 1/8	2.125	54
—	.005	.127	21/64	.3281	8.334	—	.8268	21	—	2.165	55
—	.0079	.2	—	.3346	8.5	53/64	.8281	21.034	2 1/4	2.250	57.2
—	.0098	.25	11/32	.3438	8.731	27/32	.8438	21.431	—	2.362	60
—	.01	.254	—	.3543	9	55/64	.8594	21.828	2 3/8	2.375	60.3
—	.0118	.3	23/64	.3594	9.128	—	.8662	22	2 1/2	2.500	63.5
1/64	.0156	.397	—	.3740	9.5	7/8	.8750	22.225	—	2.559	65
—	.0157	.4	3/8	.375	9.525	57/64	.8906	22.622	2 5/8	2.625	66.7
—	.0197	.5	25/64	.3906	9.922	—	.9	22.860	2 3/4	2.750	69.9
—	.0236	.6	—	.3937	10	—	.9055	23	—	2.756	70
—	.025	.635	—	.4	10.160	29/32	.9063	23.019	2 7/8	2.875	73
—	.0276	.7	13/32	.4062	10.319	59/64	.9219	23.416	—	2.953	75
—	.0295	.75	—	.4134	10.5	15/16	.9375	23.813	3	3.000	76.2
1/32	.0313	.794	27/64	.4219	10.716	—	.9449	24	—	3.150	80
—	.0315	.8	—	.4331	11	61/64	.9531	24.209	3 1/4	3.250	82.6
—	.0354	.9	7/16	.4375	11.113	31/32	.9688	24.606	—	3.346	85
—	.0394	1	29/64	.4531	11.509	—	.9843	25	3 1/2	3.500	88.9
3/64	.0469	1.191	15/32	.4688	11.906	1	1.000	25.400	—	3.543	90
—	.0472	1.2	—	.4724	12	—	1.024	26	—	3.740	95
—	.05	1.270	31/64	.4844	12.303	1 1/16	1.062	26.988	3 3/4	3.750	95.3
—	.0551	1.4	—	.4921	12.5	—	1.063	27	—	3.937	100
—	.0591	1.5	1/2	.5	12.700	—	1.102	28	4	4.000	101.6
1/16	.0625	1.588	—	.5118	13	1 1/8	1.125	28.575	—	4.331	110
—	.0669	1.7	33/64	.5156	13.097	—	1.142	29	4 1/2	4.500	114.3
—	.075	1.905	17/32	.5326	13.494	—	1.181	30	—	4.724	120
5/64	.0781	1.984	—	.5315	13.5	1 3/16	1.188	30.16	5	5.000	127
—	.0787	2	35/64	.5469	13.891	—	1.221	31	—	5.118	130
—	.0906	2.3	—	.5512	14	1 1/4	1.250	31.75	5 1/2	5.500	139.7
3/32	.0938	2.381	9/16	.5625	14.288	—	1.260	32	—	5.512	140
—	.0984	2.5	—	.571	14.5	—	1.299	33	—	5.906	150
—	.1	2.540	37/64	.5781	14.684	1 5/16	1.312	33.34	6	6.000	152.4
—	.1024	2.6	—	.5906	15	—	1.339	34	—	6.299	160
7/64	.1093	2.776	19/32	.5938	15.081	1 3/8	1.375	34.93	6 1/2	6.500	165.1
—	.1181	3	—	.6	15.240	—	1.378	35	7	7.000	177.8
1/8	.125	3.175	39/64	.6094	15.478	—	1.417	36	—	7.087	180
—	.1378	3.5	—	.6103	15.5	1 7/16	1.438	36.51	7 1/2	7.500	190.5
9/64	.1406	3.572	5/8	.6250	15.875	—	1.457	37	—	7.874	200
5/32	.1563	3.969	—	.6299	16	—	1.496	38	8	8.000	203.2
—	.1575	4	41/64	.6406	16.272	1 1/2	1.500	38.10	8 1/2	8.500	215.9
11/64	.1719	4.366	—	.6496	16.5	—	1.535	39	—	8.661	220
—	.1772	4.5	21/32	.6563	16.669	1 9/16	1.562	39.69	9	9.000	228.6
3/16	.1875	4.763	—	.6693	17	—	1.575	40	—	9.449	240
—	.1969	5	43/64	.6719	17.066	—	1.614	41	9 1/2	9.500	241.3
—	.2	5.080	11/16	.6875	17.463	1 5/8	1.625	41.28	—	9.843	250
13/64	.2031	5.159	—	.6890	17.5	—	1.654	42.	10	10.000	254
—	.2165	5.5	—	.7	17.780	1 11/16	1.688	42.86	—	10.236	260
7/32	.2188	5.556	45/64	.7031	17.859	—	1.693	43	11	11.000	279.4
15/64	.2344	5.953	—	.7087	18	—	1.732	44	—	11.024	280
—	.2362	6	23/32	.7188	18.256	1 3/4	1.750	44.45	—	11.811	300
1/4	.25	6.350	—	.7283	18.5	—	1.772	45	12	12.000	304.8
—	.2559	6.5	47/64	.7344	18.653	—	1.811	46	13	13.000	330.2
17/64	.2656	6.747	—	.7480	19	1 13/16	1.813	46.04	—	13.780	350
—	.2756	7	3/4	.75	19.050	—	1.850	47	14	14.000	355.6
9/32	.2813	7.144	49/64	.7656	19.447	1 7/8	1.875	47.63	15	15.000	381
—	.2953	7.5	—	.7677	19.5	—	1.890	48	—	15.748	400
19/64	.2969	7.541	25/32	.7813	19.844	—	1.929	49	16	16.000	406.4

MATHEMATICAL FORMULAS USED IN

SALES ENGINEERING

ROAD SPEED FORMULAS

$$MPH = \frac{RPM \times r}{R \times 168}$$

$$RPM = \frac{MPH \times R \times 168}{r}$$

$$R = \frac{RPM \times r}{MPH \times 168}$$

$$WHEEL\ RPM = \frac{MPH \times 166}{r}$$

TRACTIVE EFFORT FORMULAS

$$TE = \frac{T \times 12 \times R \times E}{r}$$

$$T = \frac{TE \times r}{12 \times R \times E}$$

$$R = \frac{TE \times r}{T \times 12 \times E}$$

TRACTIVE FACTOR FORMULAS

$$TF = \frac{T \times 12 \times R \times E}{GVW \times r}$$

$$T = \frac{TF \times GVW \times r}{12 \times R \times E}$$

$$GVW = \frac{T \times 12 \times R \times E}{TF \times r}$$

$$R = \frac{TF \times GVW \times r}{T \times 12 \times E}$$

GRADE ABILITY FORMULAS

$$GA = TF - RR$$

$$TF = GA + RR$$

$$GA = \frac{T \times 12 \times R \times E}{GVW \times r} - RR$$

$$GVW = \frac{T \times 12 \times R \times E}{TF \times r}$$

$$T = \frac{TF \times GVW \times r}{12 \times R \times E}$$

$$R = \frac{TF \times GVW \times r}{12 \times T \times E}$$

HORSEPOWER FORMULAS

$$IHP = \frac{MEP \times A \times S \times N}{33000 \times C}$$

$$S = Stroke\ (Ft.) \times RPM$$

$$IHP = BHP + Friction\ HP$$

$$BHP = \frac{BMEP \times A \times S \times N}{33000 \times C}$$

$$BHP = \frac{2 \times RPM \times \pi \times T}{33000}$$

$$BHP = \frac{T \times RPM}{5252}$$

$$BHP = \frac{D \times RPM \times 0.75\ (Approx.)}{5252}$$

TORQUE FORMULAS

$$T = \frac{D \times BMEP}{150.8}$$

$$T = D \times 0.75\ (Approx.)$$

$$T = \frac{BHP \times 5252}{RPM}$$

DRAWBAR PULL

$$DBP = TE - RR$$

CLUTCH TORQUE CAPACITY

$$T = \left\{ \begin{array}{l} \text{Total Spring Pressure x} \\ \text{Mean Radius of Lining} \\ \text{x 2 Faces x .25 Coeffi-} \\ \text{cient of Friction} \div 12 \end{array} \right.$$

GRADE ABILITY—HORSEPOWER FORMULAS

$$GA = \frac{33750 \times BHP}{GVW \times MPH} - RR$$

$$GVW = \frac{33750 \times BHP}{MPH \times TF}$$

$$MPH = \frac{33750 \times BHP}{GVW \times TF}$$

$$HP = \frac{GVW \times MPH \times TF}{33750}$$

KEY TO SYMBOLS USED ABOVE

A	= Area of piston head in sq. in.
BHP	= Brake horsepower.
BMEP	= Brake mean effective pressure.
C	= No. cycles (4 for IH).
D	= Piston displacement in cu. in.
DBP	= Drawbar pull.
E	= Mechanical efficiency (.90 direct, .85 in other gears).
GA	= Grade ability, factor (G x 100 = % Grade).
GVW	= Gross weight, lb.
IHP	= Indicated horsepower.
MEP	= Mean effective pressure.
MPH	= Miles per hour.
N	= Number of cylinders.
r	= Effective tire radius (loaded) (inches)
R	= Total reduction to 1.00.
RPM	= Engine speed revolutions per minute (r.p.m.)
RR	= Rolling or road resistance (.012 lbs. for good concrete roads.
S	= Piston speed in feet per minute.
T	= Torque—lb.-ft.
TE	= Tractive effort, lb.
TF	= Tractive factor, lb. per lb. gross.
π	= Pi = 3.1416; ratio of diameter to circumference of circle.

INSTRUMENTS
S-SERIES

INDEX

PRINTED IN UNITED STATES OF AMERICA

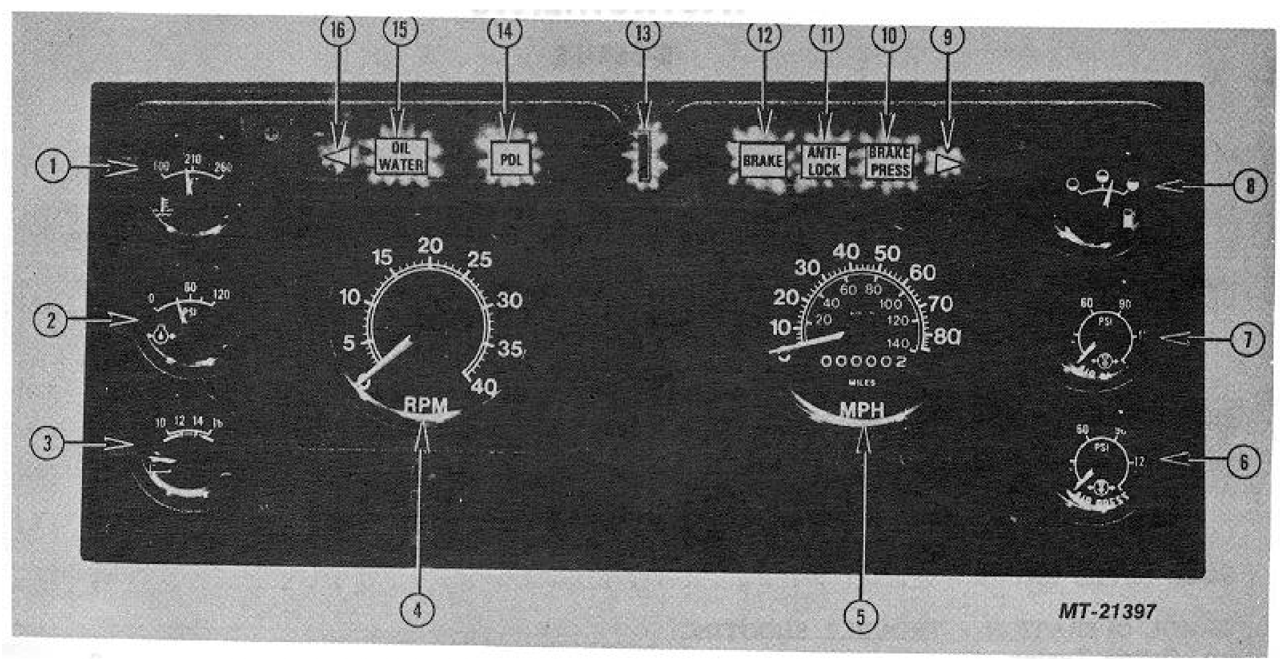


Fig. 1 S-Series Instruments (Typical)*

Legend for Fig. 1

Key	Description	Key	Description
1	GAUGE, Water Temperature	9	INDICATOR, Right Hand Turn Signal
2	GAUGE, Oil Pressure	10	INDICATOR, Brake Air Pressure
3	VOLTMETER	11	INDICATOR, Antilock Mounting
4	TACHOMETER	12	INDICATOR, Parking Brake
5	SPEEDOMETER	13	INDICATOR, High Beam
6	GAUGE, Air Pressure	14	INDICATOR, Power Divider Lock
7	GAUGE, Air Pressure	15	INDICATOR, Oil Pressure/Water Temperature
8	GAUGE, Fuel Level	16	INDICATOR, Left Hand Turn Signal

* Gauges which read totally metric are also available

DESCRIPTION SYSTEM

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 the aforementioned instruments are located on the instrument panel in a demountable instrument cluster (Fig. 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.

Remove Complete Cluster

1. Unscrew the four cluster mounting screws.
2. Tilt or lift out cluster assembly from instrument panel (Fig. 2).
3. Pull wiring harness connector from printed circuit on back of cluster assembly (Fig. 3).

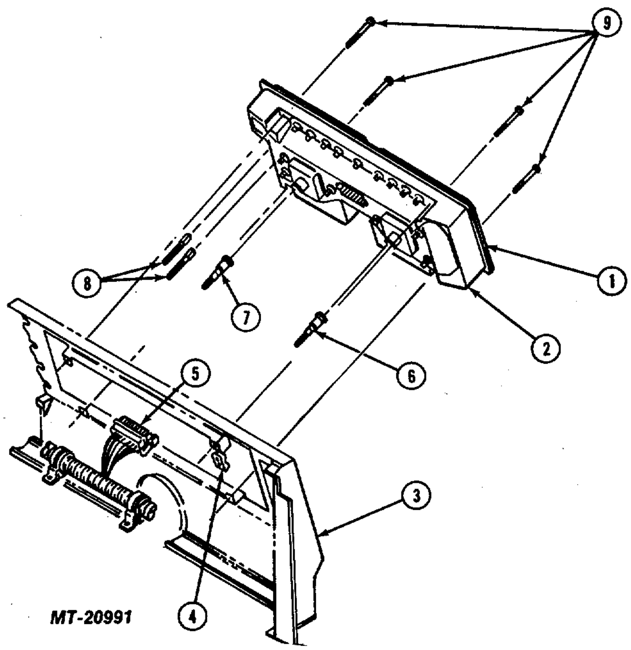


Fig. 2 Removing Instrument Cluster

Legend for Fig. 2

Key	Description
1	BEZEL, Instrument Cluster
2	CLUSTER, Assembly
3	PANEL, Instrument
4	NUT, Spring 8-18
5	CONNECTOR, Wiring Harness
6	CABLE, Tachometer
7	CABLE, Speedometer
8	HOSE, Air Pressure
9	SCREW, Mounting #8-18 x 2-1/4

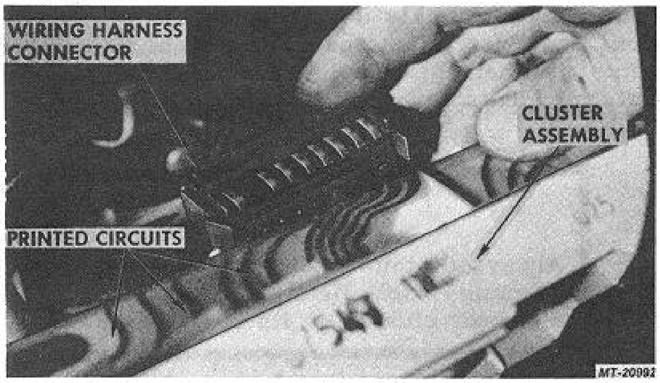


Fig. 3 Removing Wiring Harness Connector

4. Press down on quick-connect spring clasp (Fig. 4) and disconnect flexible cables from back of speedometer and tachometer.

5. Unscrew air or vacuum lines from fittings (Fig. 5) on back of air or vacuum gauges. Two gauges are used with air braked trucks --one gauge only with vacuum (hydraulic) braked trucks.

6. Instrument cluster assembly is now free to be removed from instrument panel.

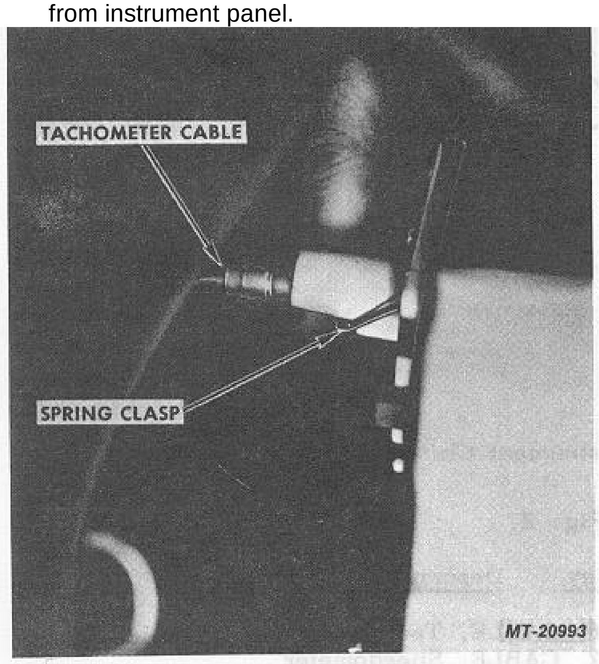


Fig. 4 Releasing Speedometer and Tachometer Cable

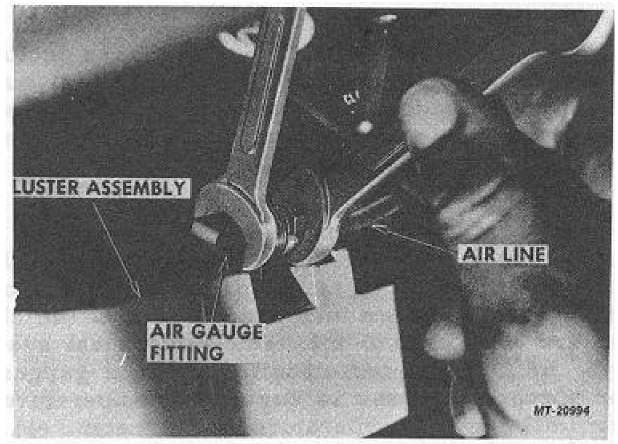


Fig. 5 Removing Air or Vacuum Lines

Remove 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 front center of cluster bezel and detach bezel (Fig. 6).

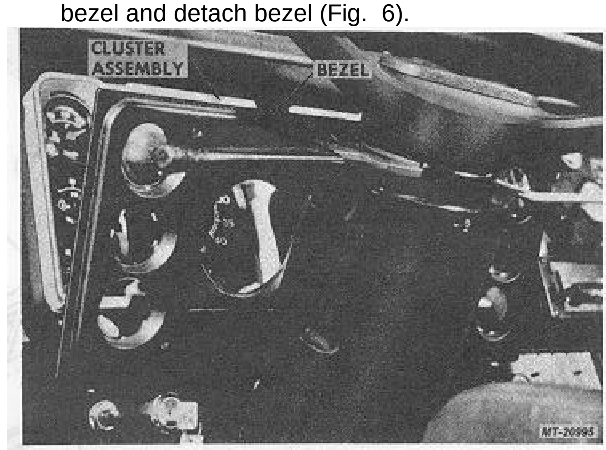


Fig. 6 Removing Instrument Cluster Bezel

2. Individual gauges can now be removed by loosening gauge mounting screws as required. All electrically actuated gauges (Fig. 7) are removed from front and have plug-in spring loaded connections. Speedometer and tachometer (Fig. 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.)

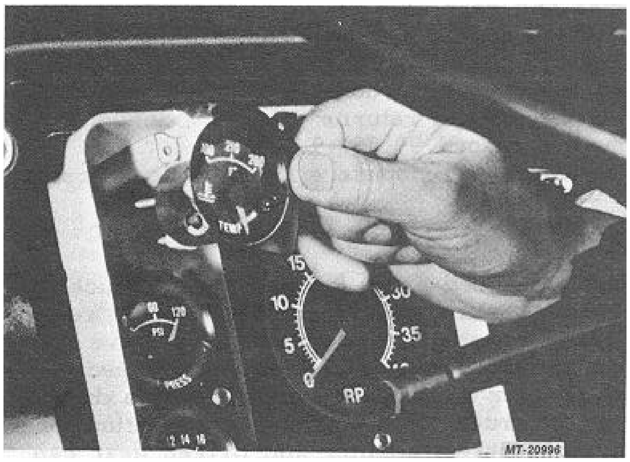


Fig. 7 Removing Electrically Actuated Water Temperature Gauge

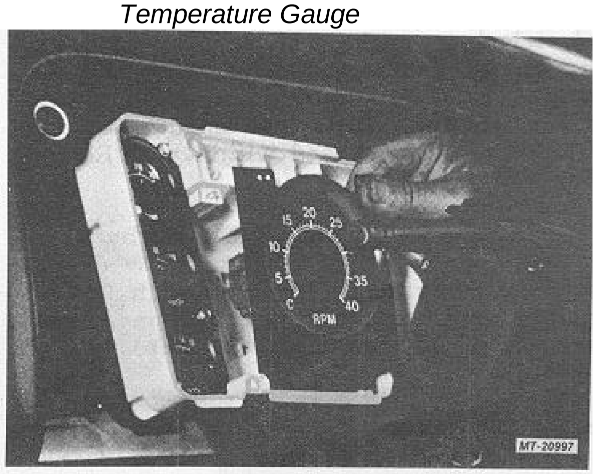


Fig. 8 Removing Tachometer

3. Mechanical type air gauges (Fig. 9) are front serviceable after removing air line fittings from rear of cluster (Fig. 5).

IMPORTANT

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 screw threads.

4. Light bulbs are plug-in, spring-loaded type and are serviceable from either front or rear of instrument cluster (Figs. 10 & 11).

Fig. 9 Removing Air Gauges

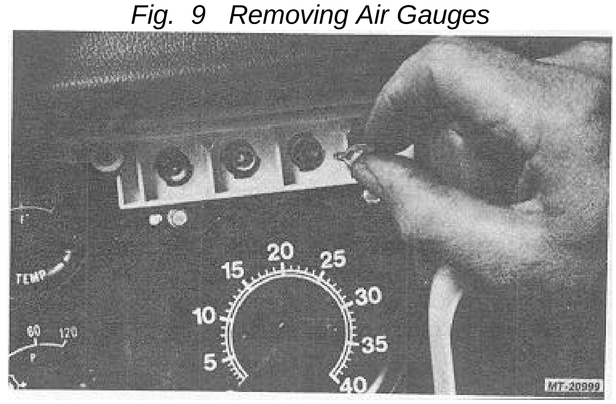
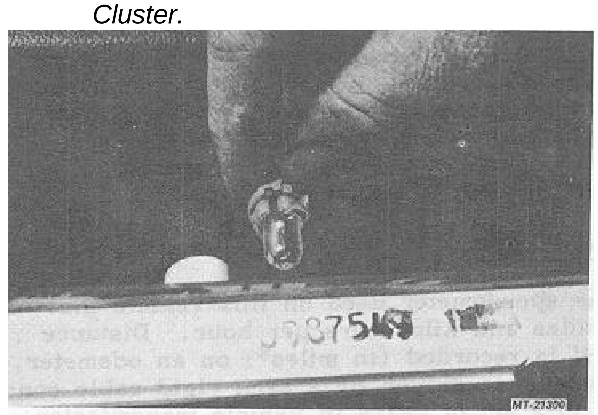


Fig. 10 Removing Bulb from Front of Cluster

Fig. 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 flexprinted 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 trouble shooting, individual circuits on the printed circuit are easily checked. This is accomplished with cluster removed (Fig. 12).

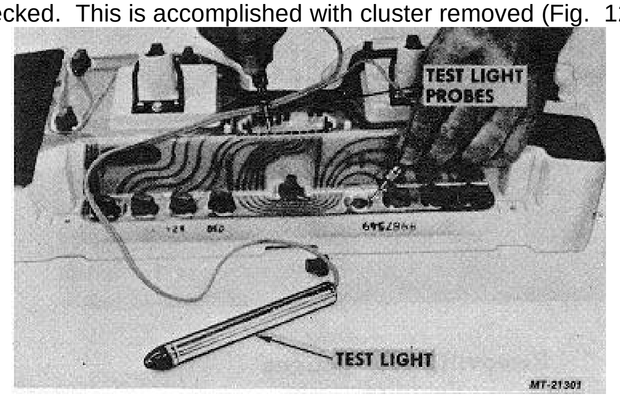


Fig. 12 Checking Printed Circuit Continuity

Testing

Obtain SE-2060-4 Test Light or equivalent tester and position test probes on a selected circuit in a manner similar to that shown in Fig. 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.

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 Fig. 13.

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 anti 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 <u>mechanical tachometer</u> (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 <u>mechanical tachometer</u> 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 tachometer on S-Series Trucks.

This cable consists of (1) an outer case or cable assembly with nut and ferrule at lower end and a quick disconnect ferrule at upper end, and 2) a wire wound flexible inner cable or core assembly with squared drive at upper end and floating tip (Fig. 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.)

The cable outer case is formed from an inner nylon liner, an intermediate ply of wire braid and an outer polypropylene or polyethylene case (Fig. 15).

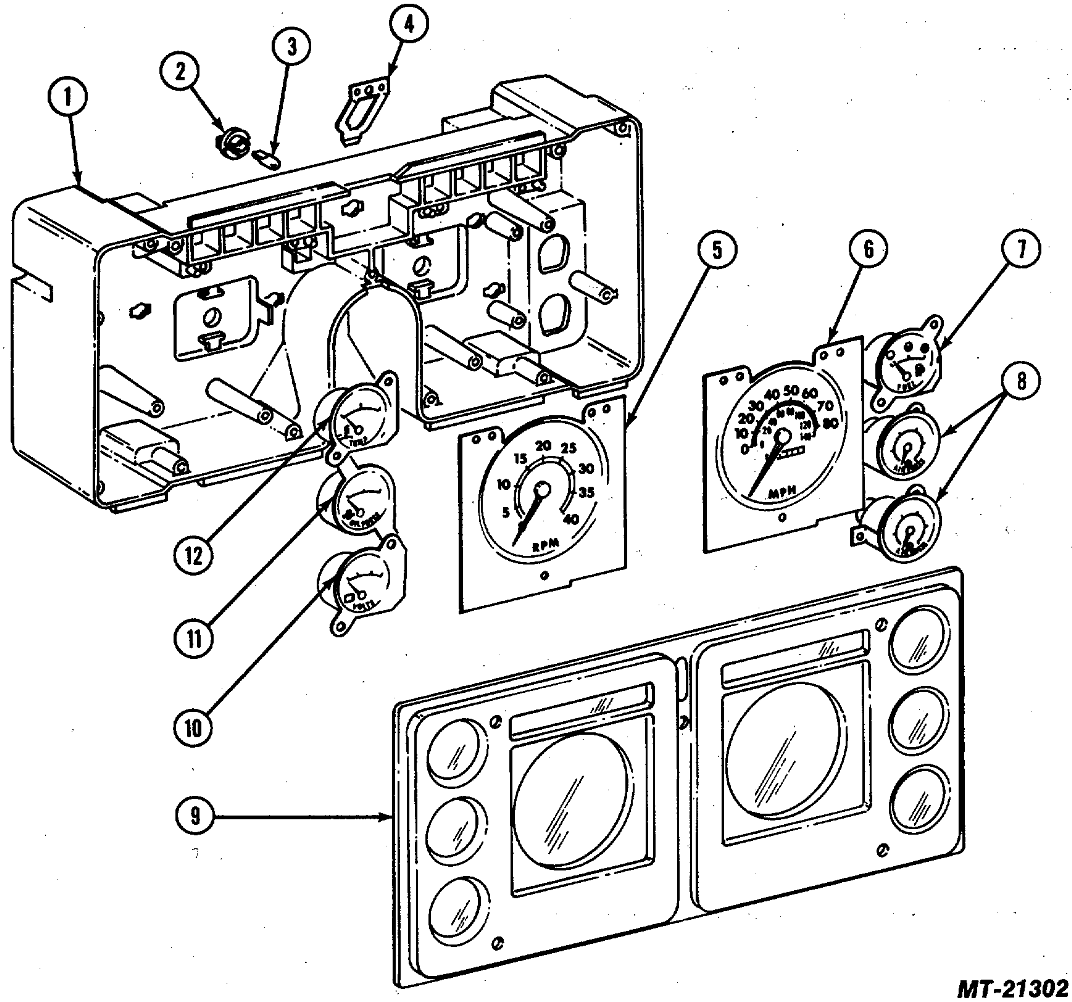


Fig. 13 Components of Instrument Cluster

Legend for Fig. 13

Key	Description	Key	Description	Key	Description
1	CLUSTER, Asm. w/Printed Circuit	5	TACHOMETER	9	BEZEL
2	SOCKET, Bulb	6	SPEEDOMETER	10	VOLTMETER
3	BULB	7	GAUGE, Fuel Level	11	GAUGE, Oil Pressure
4	CLASP, Spring	8	GAUGE, Air	12	GAUGE, Water Temperature

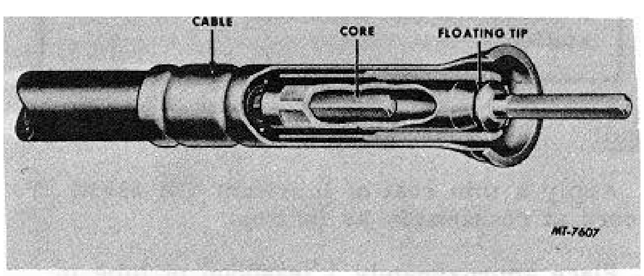


Fig. 14 Semi-Rigid Cable End Details

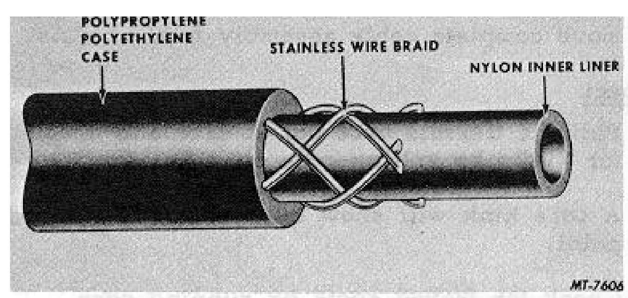


Fig. 15 Semi-Rigid Cable Outer Case

SPEEDOMETER, TACHOMETER AND CABLE TROUBLE SHOOTING

Problem	Probable Cause	Solution
Inoperative	1. Cable disconnected.	1. Connect cable.
	2. Broken core.	2. Repair or replace.
	3. Damaged speedometer or tachometer.	3. Replace.
Indicator pointer fluctuates	1. Kinked core.	1. Repair or replace.
	2. Cable improperly routed.	2. Route cable correctly.
	3. Cable improperly installed in speedometer or tachometer head.	3. Install cable correctly.
Noisy, clicking or squealing	1. Damaged or worn parts in speedometer or tachometer.	1. Replace.
	2. Damaged core.	2. Repair or replace.
	3. Cable improperly routed.	3. Route cable correctly.
Reads incorrectly	1. Wrong adapter.	1. Install correct adapter.
	2. Cable improperly installed.	2. Install cable correctly.
	3. Speedometer or tachometer not calibrated.	3. Replace.

Remove

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 (Fig. 4).
3. Unscrew cable lower or drive end from adapter at either transmission or engine component.
4. Unfasten cable from any ties or clips and remove complete cable assembly from chassis.

Inspect

1. Pull the flexible core out of case and check for kinks by rolling core on a flat surface.
2. A core kink will show up as a hop at kinked point.
3. Check for frayed spots by running core loosely through fingers.

Repair or Replace Core

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.

IMPORTANT

If replacement core is used, be sure core is not too long. A long core will cause a damaging thrust to head of speedometer or tachometer when installed.

Install

Apply a thin coat of lubricant (IH #251H 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.

GAUGE OPERATION TROUBLE SHOOTING

Except for air pressure gauges which are mechanical--Bourdon tube type--all gauges are of the electro-magnetic 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 a simple test procedure using a universal type Gauge Tester SE-2781 (Fig. 16) is suggested. This testing instrument eliminates time consuming trial and error methods of checking out the gauges.

IMPORTANT

To insure full power to all instruments in cluster, connector lock tabs on both sides of harness connector, must be solidly engaged with cluster socket.

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. Warning lights (except Anti-Lock) come on.

With power to cluster off, gauge pointers may move to any point on gauge scale. This is inherent to instrument and does not indicate a faulty part.

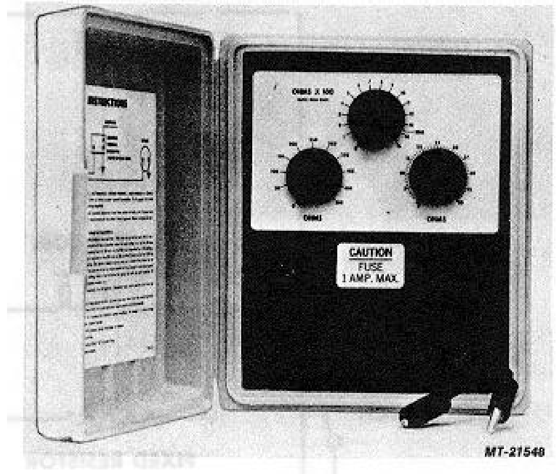


Fig. 16 Gauge Tester (SE-2781)

Test Application

Gauges can be tested on vehicle, without detaching them, by removing sender to gauge wire at sender unit and connecting in the SE-2781 Gauge Tester. Test continuity on gauge circuits with the SE-2060-4 Test Light. Details of this procedure are covered in later paragraphs.

FUEL LEVEL GAUGE

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 Fig. 17.

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 gage circuit diagram (Fig. 17) 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.

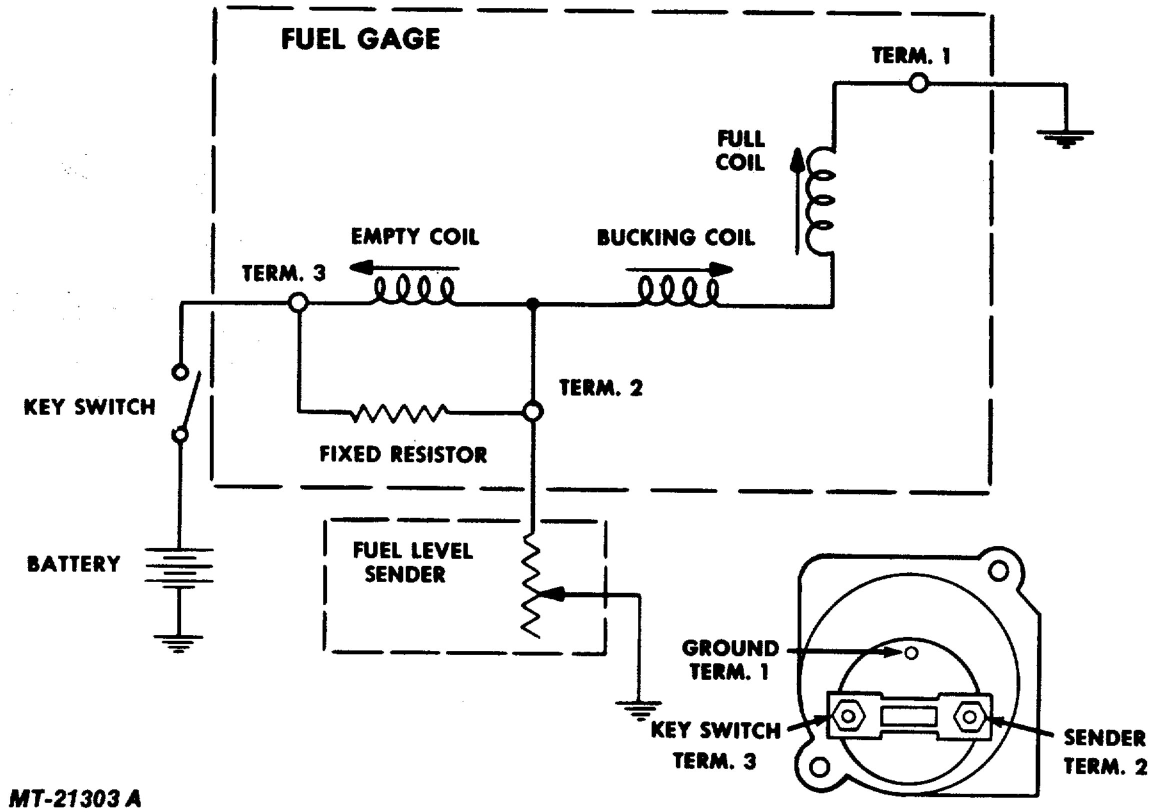


Fig. 17 Fuel Gauge Circuit Diagram

- the fuel level sender only when in its empty position.

It will be noted that 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 (Fig. 18). The odd terminal is the ground terminal.

The sender terminal is the first terminal clockwise from ground terminal when viewed from back side of gauge.

IMPORTANT

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.

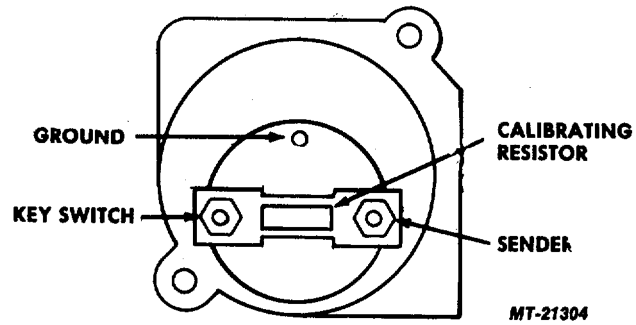


Fig. 18 Fuel Gauge (Rear View)

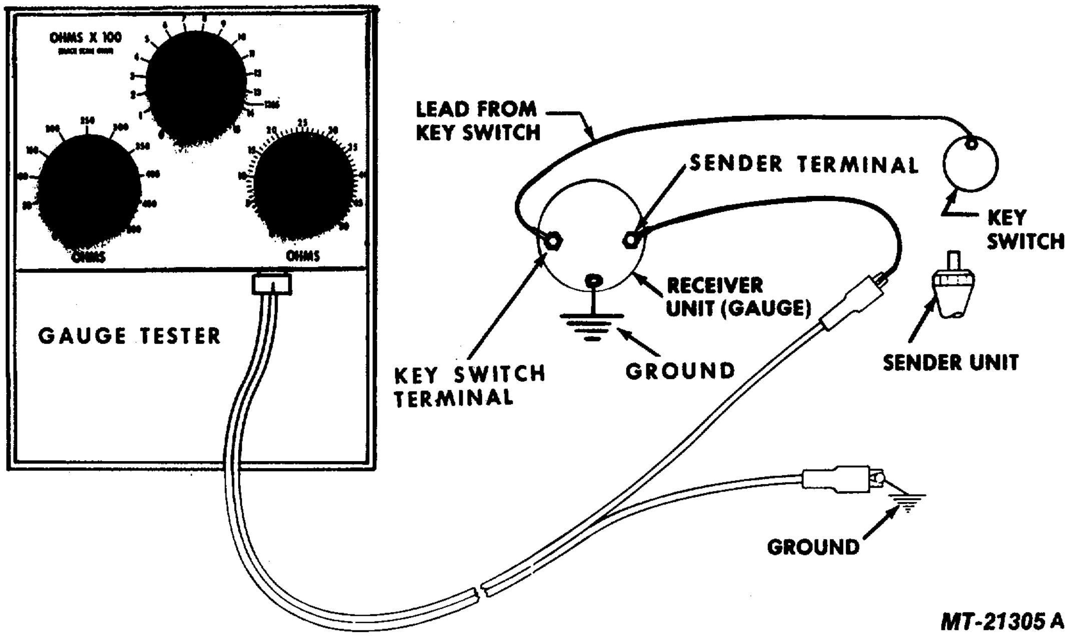


Fig. 19 Checking Fuel Level Gauge System with Gauge Tester

Test for faulty component as follows.

1. Disconnect wire at tank sender unit (Fig. 19).

2. Connect one lead of SE-2781 Gauge Tester to end of sender unit wire and second lead to ground (tester substitutes for sender unit).

3. Turn key switch "on".

4. Set gauge tester for 88 ohms (left hand control knob to "50" and right hand knob at "38"). Fuel gauge should read slightly above "full". (Pointer within ball).

5. Next set left hand knob at "0" and right hand knob at "44". Fuel gauge should read at "1/2" mark. (Pointer within ball).

6. Finally set left hand knob at "0" and right hand knob at "1". Gauge should now read "empty". (Pointer within ball).

If fuel gauge reads properly, gauge and wiring between gauge and sender is OK and trouble is in sender grounding or sender itself. Replace float assembly if proper grounding does not correct the problem.

If fuel gauge does not read properly, check continuity of circuit with standard test light (Fig. 12). If continuity is OK and gauge still does not respond, replace gauge.

WATER TEMPERATURE GAUGE

The water temperature gauge system consists of two basic components--the instrument cluster gauge and the thermister sending unit. The gauge indicates water temperature while the sender controls the gauge reading. The two units are connected electrically as shown in Fig. 20.

The operating principle of the temperature indicating system can be understood by reference to the temperature gage circuit diagram (Fig. 20). 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 enclosed 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 1000 F position. The magnetic 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 temperature

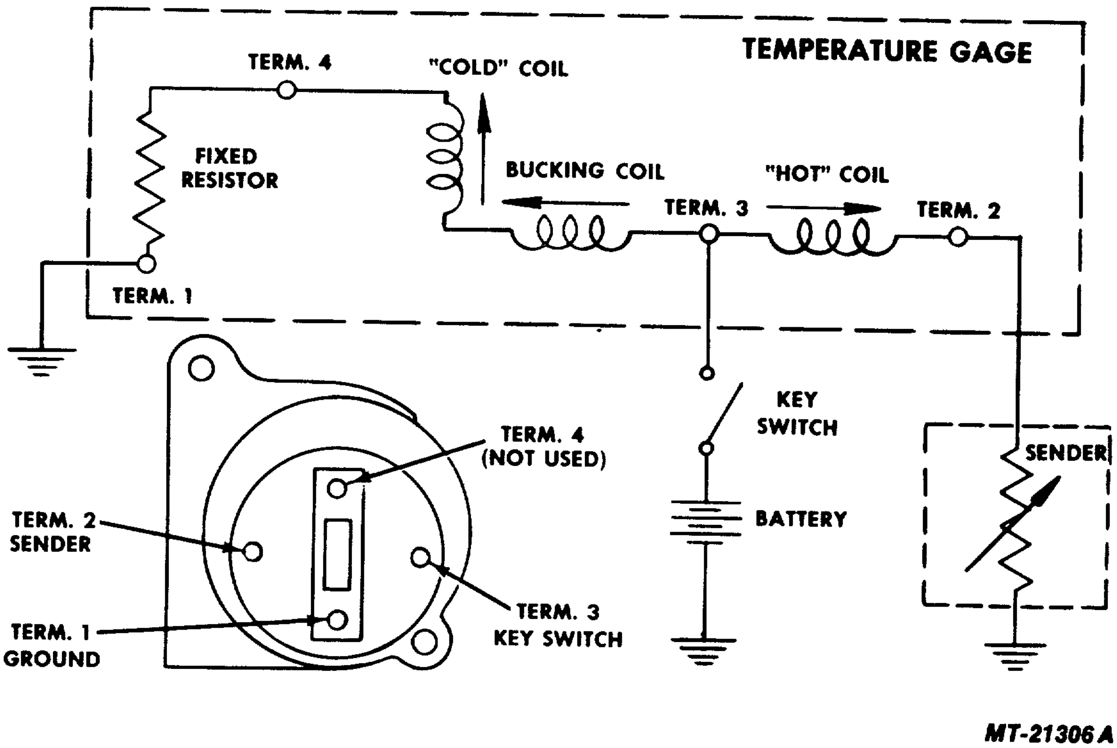


Fig. 20 Water Temperature Gauge Circuit Diagram

temperature coefficient. The decrease in sender resistance increases the current flowing in the "hot" coil, reaching a maximum at the full-scale temperature. With maximum current in the "hot" coil, the pointer and armature assembly will align itself with the resultant magnetic field produced by the three coils 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.

IMPORTANT

The gauge is grounded to chassis through the ground terminal when plugged into the instrument cluster printed circuit.

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.

Check for faulty components as follows:

1. Disconnect sender wire at sender (Fig. 20).
2. Connect one lead of SE-2781 Gauge Tester to sender wire and the other lead to a good ground.
3. Set the gauge tester for 55 ohms (left knob at "50" and right knob at "5"). Turn key switch on and. gauge should read at full scale. (Pointer within 2 pointer widths of hash mark).
4. Set gauge tester for 113 ohms (left knob at 100 and right knob at 13 ohms). Gauge should read at half scale. (Pointer within 2 pointer widths of hash mark).
5. Set gauge tester for 1365 ohms (center knob at "1365" and other knobs at "O"). The gauge should now read at low scale. (Pointer within 2 pointer widths of hash mark).

If results of Steps 3 thru 5 are satisfactory gauge is OK and sender must be replaced.

IMPORTANT

Sometimes sealant or dirt on threads of sender (thermister) prevent a good electrical contact necessary for sender grounding. Check for this condition before replacing sender.

If results of Steps 3 thru 5 are unsatisfactory check continuity of circuit with a standard test light. If continuity is OK and gauge still does not respond, replace gauge.

OIL PRESSURE GAUGE

The oil pressure gauge is electrically actuated and consists of two basic components--the instrument cluster mounted gauge and the engine oil gallery mounted sending unit. The sending unit: senses the pressure of oil in the engine oil gallery during engine operation and registers the pressure on the gauge.

The operation of the oil pressure gauge system (Fig. 21) is the same as for fuel level gauge except that sender is a diaphragm unit in oil gallery instead of a float.

Testing for a defective oil pressure system component is also the same. See FUEL LEVEL GAUGE for testing procedure.

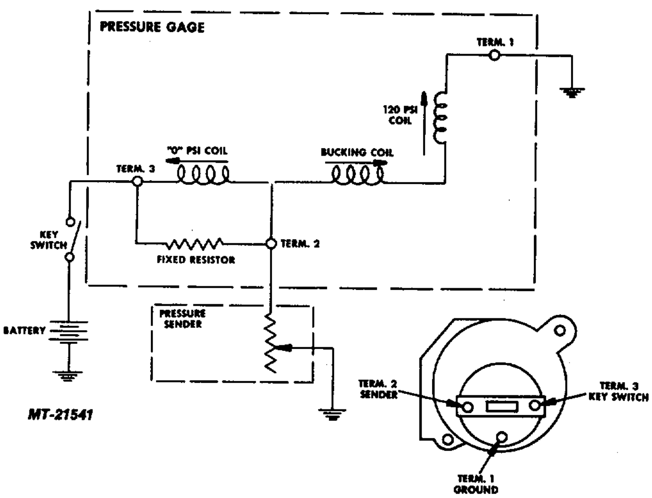


Fig. 21 Oil Pressure Gauge Circuit Diagram

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. OPTIONAL TEMPERATURE GAUGE

The optional temperature gauges (Fig. 22) are also electro-magnetic type and are actuated by sending units (variable resistance thermisters). Sending units are located in the component on which temperature monitoring is desired (engine, transmission, rear axles, etc.)

Operating and testing of optional temperature gauges is the same as for comparable temperature systems previously covered. See SPECIFICATIONS for variable resistance value (ohms) required for checking these gauges.

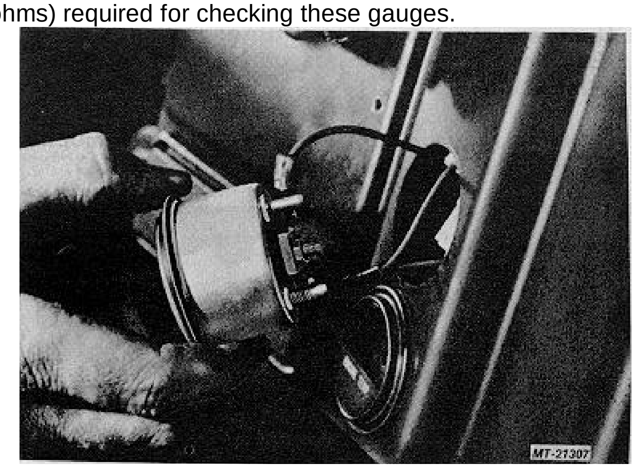


Fig. 22 Servicing Optional Gauge

AIR PRESSURE GAUGE

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 (Fig. 23) 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.

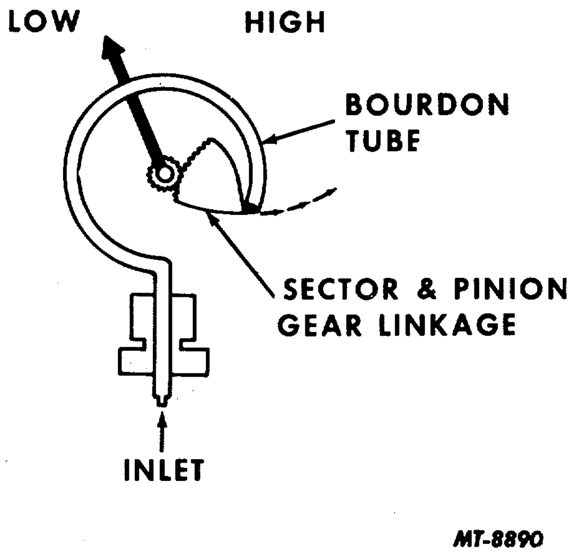


Fig. 23 Air Pressure Gauge Details

Remove

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 (Fig. 24).

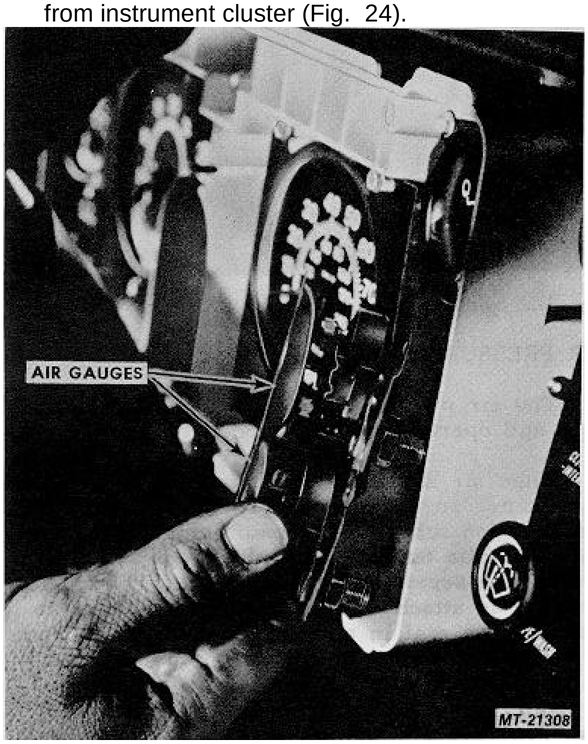


Fig. 24 Removing Air Pressure Gauges

4. Separate individual gauges from bracket.

Test

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.

IMPORTANT

Always make a comparison test with a gauge known to be reading correctly before discarding a questionable gauge.

Install

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

The voltmeter or battery-charging system gauge (Fig. 25) 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.

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 normal 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

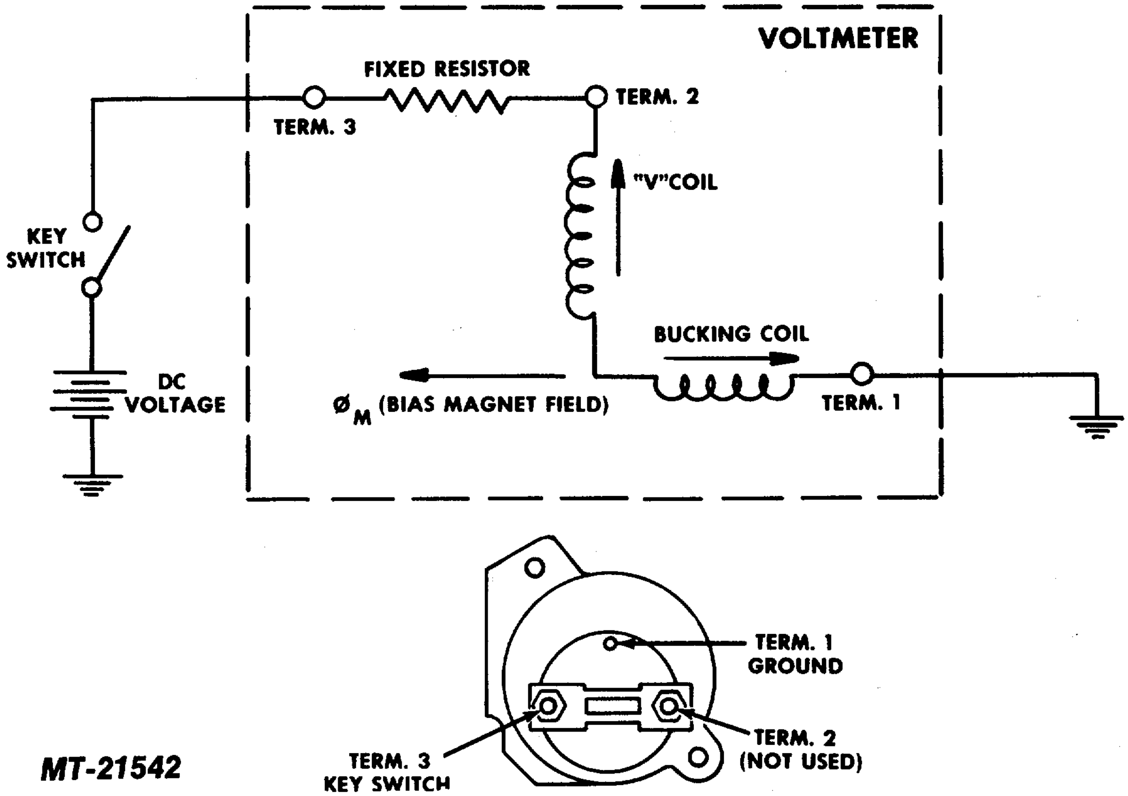


Fig. 25 Voltmeter Circuit Diagram

complete check of battery and charging system is required. See appropriate alternator section of Service Manual under ELECTRICAL.

If voltmeter does not read as expected, you can check operation of this instrument by connecting voltmeter terminals to an independent voltage source (12V Battery). The voltmeter should indicate the voltage supplied by battery $\pm$ 0.5 volts.

If test is unsatisfactory, replace voltmeter.

If test is satisfactory, voltmeter is OK and problem is in wiring. Check continuity with test light.

GAUGE TESTING (TABLE A)

A summary of necessary gauge testing specifications is given in "Table A". When the service man becomes familiar with the SE-2781 Gauge Tester, this table will provide a handy reference.

QUICK CHECK (TABLE B)

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", that is sometimes used for automotive gauge testing. While this is 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.

SPECIFICATIONS

Gauge Testing Variable Resistance Values * (Ohms)				
Type Gauge		Gauge Reading: Low Scale	Half Scale	Full Scale
Fuel Level		1	44	88
Water Temperature		1365	113	55
Oil Pressure		1	47	88
Oil Temperature	(Engine)	1365	63	28
	(Transmission)	1365	63	28
	(Rear Axle)	1365	63	28
* For use with SE-2781 Gauge Tester				

TABLE A

Quick Check of Gauge Function (Disconnect and Ground Test)			
Type Gauge		Gauge Reading: Sender Wire Disconnected	Sender Wire Grounded
Fuel Level		Above Full Scale	Below Low Scale
Water Temperature		Below Low Scale	Do not Ground Will Burn Out Gauge
Oil Pressure		Above Full Scale	Below Low Scale
Oil Temperature			
	(Engine)	Below Low Scale	Do Not Ground Will Burn Out Gauge
	(Transmission)	Below Low Scale	Do Not Ground Will Burn Out Gauge
	(Rear Axle)	Below Low Scale	Do Not Ground Will Burn Out Gauge

TABLE B

LUBRICATION INSTRUCTIONS

FOR LUBRICATION INTERVALS REFER TO OPERATORS MANUAL

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 greatly to the service life of the vehicle 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, the vehicle may require lubrication after every twenty-four (24) hours of operation.

In some operations, such as in deep water, mud, or unusually dusty conditions, the interval of inspection and lubrication should be more frequent than twenty-four (24) hours.

Only lubricants of the best quality, having proper body or viscosity, and supplied by reputable manufacturers, should be used. The use of inferior or non-compatible products might reduce the service life of the vehicle or result in failure of its components.

The International Harvester Company Truck Division does not attempt to specify any particular manufacturer's product. High-grade lubricants can be obtained from any reputable oil company.

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.

IMPORTANT

When adding lubricant, it should be the same weight and viscosity which is already being used.

Definitions of symbols used in designation of type lubricants recommended in LUBRICATION INSTRUCTIONS.

Symbol	Type Lubricant
A	Light Weight Engine Oil
B	Cam and Ball Bearing Lubricant
C	IH 251 HEP Grease or equivalent NLGI #2 Multi-Purpose Grease
D	Stick Lubricant
E	SAE 85W-140 gear lubricant or SP type lubricant, SAE-90 viscosity year around, meeting MIL-L-2105B specification (SP must not contain zinc). For abnormally high temperature severe service (hot climate off highway operation where vehicle is in low speed heavy hauling for prolonged periods), use SAE-140. For traclok rear axles, add 20CC (2/3 ounce) of IH-LS additive for each .47 liter (pint) of SP lubricant, at every 10,000 miles 16,000 kilometers of operation.
F	**SPICER** Engine Oil (SE, CC, DD). SAE-30 Below -18 deg. C (O deg. F) SAE-30, 40, 50 Above -18 deg. C (O deg. F)

Symbol	Type Lubricant			
G	Dexron Automatic Transmission Fluid			
H	SAE-10W Engine Oil for temperatures -18 deg. C (0 deg. F) and up. For temperatures below -18 deg. C (0 deg. F) use three parts SAE-10W engine oil to one part kerosene. The mixture can safely be used in temperatures up to 0 deg. C (32 deg. F).			
J	Lock Oil			
K	SAE-10W-40 Engine Oil			
L	Super Heavy Duty "DOT 3"			
M	SAE-85W-140 Gear Lubricant or SAE-90 SP Type Lubricant, meeting MIL-L-2105B Specification.			
N	Penetrating Oil			
O	**WARNER**			
	Engine Oil (SE, CC, CD)	SAE-30	Below	0 deg. C (+32 deg. F)
		SAE-50	Above	0 deg. C (+32 deg. F)
	Mineral Gear Oil	SAE-80	Below	-18 deg. C (0 deg. F)
	(Rust and Oxidation Inhibited)	SAE-80,90	Below	0 deg. C (+32 deg. F)
		SAE-90,140	Above	0 deg. C (+32 deg. F)
P	Use straight mineral oil SAE-90 for temperatures -18 deg. C (0 deg. F) and up. Use SAE-80 for temperatures below -18 deg. C (0 deg. F). Special recommendations: Where temperature is consistently below -18 deg. C (0 deg. F) and where parked vehicles are exposed to unusual cold for long periods, use SAE-75. Where temperatures are consistently above 32 deg. C (90 deg. F) or unusually hot, use SAE-140 straight mineral oil.			
Q	**FULLER-NEW PROCESS**			
	Engine Oil (SE, CC, CD)	SAE-30	Below	-12 deg. C (+10 deg. F)
	SAE-40,50		Above	-12 deg. C (+10 deg. F)
	Mineral Gear Oil	SAE-80	Below	-12 deg. C (+10 deg. F)
	(Rust and Oxidation Inhibited)	SAE-90	Above	-12 deg. C (+10 deg. F)
R	SAE-30 heavy duty engine oil or rear axle gear lubricant.			
S	SAE-20W-30 Engine Oil. Is compatible with symbol G.			
T	Clean element when air restriction exceeds 51 cm (20 in.) of water or 3.8 cm (1.5 in.) of mercury. Air Pressure Cleaning: Compressed air can be used to blow out the element from the clean air side out. Washing Procedure: . Filter element can be washed with any good non-sudsing, household detergent. Use warm water 49 deg. 60 deg. C (120 deg. 140 deg. F). Flush filter with gentle stream until drain water is clean. Air dry element before using. Also inspect after every cleaning for damage or rupture. Wipe all internal parts clean before reassembling. Replace gasket regularly.			

Symbol		Type Lubricant		
U	**CLARK**			
	Gear Lubricant	SAE-80,90	Above	-7 deg. C (+20 deg. F)
	Engine Oil	SAE-50	Above	-7 deg. C (+20 deg. F)
	Mineral Oil	SAE-80,90	Above	-7 deg. C (+20 deg. F)
	Gear Lubricant	SAE-80,90	-29 to 16 deg.	C (-20 deg. F to +60 deg. F)
	Engine Oil	SAE-30	-20 to 16 deg.	C (-20 deg. F to +60 deg. F)
	Mineral Oil	SAE-80,90	-29 to 16 deg.	C (-20 deg. F to +60 deg. F)
	Mineral Oil	SAE-75	Below	-18 deg. C (0 deg/ F)
V	**IH**			
	Engine Oil (SE, CC, CD)	SAE-5W20 or 10W40	Below	-18 deg. C (0 deg. F)
		SAE-20, 20W30 or any of the above	Above	0 deg. C (+32 deg. F)
		SAE-30 10W40, 20W40	Above	32 deg. C (90 deg. F)

Description	Type Lubricant (See symbol)
Accelerator Linkage	A
Air Cleaner (Dry Type)	T
Air Cleaner (Oil Bath)	Engine Oil (Same Viscosity as Crankcase)
Alternator	B
Brake Camshafts (Service)	C
Brake Hydraulic Booster Pump (Hy-Power - Dual Power) Not Master Cylinder	GM Power Steering Fluid
Brake Linkage (Mechanical)	A
Brake Master Cylinder	L
Brake Shoe Anchor Pins	C
Brake Shoe Camshafts	C
Brake Slack Adjusters	C
Cab Latch	A
Cab Lock Levers	C
Cab Tilt Pump	S
Clutch Control Cable	C
Clutch Master Cylinder	L
Clutch Pedal Linkage	A
Clutch Pedal Relay Shaft	C
Clutch Pedal Shoulder Bolt	C
Clutch Release Bearing	C
Clutch Release Fork Shaft	C
Clutch Release Sleeve Fork	C
Clutch Slave Cylinder Yoke Pin	A
Differential (Front And Rear Axles)	E
Door Check	A
Door Hinges	A
Door Latch	D
Door Latch Striker Plate Or Pin	D
Door Lock Cylinders	J
Drag Link Ends	C
Electronic Ignition System:	

Multi-wire connectors of the electronic ignition system are treated with a special conductive lubricating/sealing compound (grease). Its purposes are to lubricate the metal contact surfaces and to prevent entry of moisture into the connection. The lubricant/sealer should not be cleaned from the connector terminals.

At the time of the ignition system service, connectors should be protected by filling the female cavities of connectors with lubricant/sealer before assembly. The lubricant/sealer compound is available through IH parts outlets under part number 472141-C1.

ENGINE:

Oil types and grades recommended for engines used in IH truck applications are as follow:

IH GASOLINE ENGINES

Temperature	Straight Viscosity Grade	Multi Viscosity Grade
20 to 120 F (-7 to 49 C)	SAE 30	SAE 10W-30, 10W-40, 20W-40, 20W-30
0 to 90 F (-18 to 32 C)	SAE 20W	SAE 10W-30, 10W-40, 20W-40, 20W-30
-10 to 70 F (-23 to 21 C)	SAE 10W	SAE 10W-30, 10W-40
Below -10 F (23 C)	--------	SAE 5W-20, 5W-30

Use engine oils meeting service classification "SE" or "CC" (MIL-L-46152).

IMPORTANT: When a universal engine oil (SE-CD) is preferred, the engine oil must have passed the Volvo B-20 Cam and tappet test and contain a minimum 0.1% alkyl zinc.IH #1 engine oil meets this requirement.

IH D-150 D-170 D-190 DIESEL ENGINES

Temperature	Straight Viscosity Grade	Multi Viscosity Grade
20 to 120 F (-7 to 49 C)	SAE 30	SAE 10W-30, 10W-40, 20W-40, 20W-
0 to 90 F (-18 to 32 C)	SAE 20	SAE 10W-30, 10W-40, 20W-40
Below 0 F (-18 C)	------	SAE 5W-20, 5W-30

Use engine oils meeting API service classification "IH No. 1 (CD/CC/SE),", "SE", "CC (MIL-L-46152)" or "CD (MIL-L-2104C)".

IH DT-466 DIESEL ENGINE

Temperature	Straight Viscosity Grade
20 to 120 F (-7 to 49 C)	SAE-30
-10 to 70 F (-23 to 21 C)	SAE-10W
10 to -30 F (-12 to 34 C)	SAE-10W with a pour point 10 F (-12 C) below lowest ambient air temperature or SAE-10W diluted with 10% kerosene

Use engine oils meeting service classification "IH No. 1 (CD/CC/SE)", "CD/CC/SC (MIL-L-2104C)" or "CD (MIL-L-45199B)".

DESCRIPTION	LUBRICANT
CATERPILLAR	Use oils meeting the following engine service classification: SC and SD (MS - Motor Severe Oils) CB (Supplement 1 Oils) CC (MIL-L-2104B Specification Oils) CD or (MIL-L-2104C) Use SAE 10W-30, 10W-40 or SAE 30 grade oils for temperatures above freezing. Use SAE 10W, 10W-30 or 10W-40 grade oils for temperatures below freezing. Below -23° C (-10° F) it may be necessary to warm the oil so the engine can be cranked and oil can circulate freely.
CUMMINS	

Light Service Only (Stop-and-Go) All Diesel Models	Naturally Aspirated Diesel Models	Turbocharged Diesel Models	All Natural Gas Models All Service
API Class CC/SC [2/5] 1.85% Maximum Sulfated Ash Content [3]	API Class CC [1] 1.85% Maximum Sulfated Ash Content [3]	API Class CC/CD [2] 1.85% Maximum Sulfated Ash Content [3]	API Class CC .03 to .85% Sulfated Ash Content [4]

[1] API classification CC and CD quality oils as used in turbocharged engines and API classification CC/SC quality oils as used for stop-and-go service are satisfactory for use in naturally aspirated engines.

[2] API classification CC/SC and CC/CD indicate that the oil must be blended to the quality level required by both specifications.

The range of oil quality permitted by the CC classification is so broad that some oils that meet the classification will not provide adequate protection (varnish and ring sticking) for engines operated in certain applications. For example, turbocharged engines require the additional protection provided by the CD classification. Engines operated in stop and go service require the additional protection provided by the SC classification.

[3] A sulfated ash limit has been placed on all lubricating oils for Cummins engines because past experience has shown that high ash oils may produce harmful deposits on valves that can progress to guttering and valve burning.

[4] Completely ashless oils or high ash content oils, are not recommended for use In gas engines a range of ash content is specified.

[5] SD or SE may be substituted for SC.

Operating Temperatures Vs. Viscosity

Ambient Temperatures	Viscosity
-23° C (-1° F) and Below	See Table A
-23 to -1° C (-10 to 30° F)	10W
-7 to 16° C (20 to 60° F)	20-20W
4° C (40° F) and Above	30

Table A - Arctic Oil Recommendations

Parameter (Test Method)	Specifications
Performance Quality Level	API Class CC/SC or API Class CC/CD
Viscosity	10,000 Centistokes Maximum @ -34° C (-30° F) 5.75 Centistokes Minimum @ 99° C (210° F)
Pour Point (ASTM D-97)	At least -12° C (10° F) below lowest expected ambient temperature.
Ash, Sulfated (ASTM D-874)	1.85% by Weight Maximum

IMPORTANT

Due to extreme operating conditions, oil change intervals should be carefully evaluated paying particular attention to viscosity changes and total base number decrease. Oil designed to meet MIL-L10295-A, which is now void, and SAE 5W mineral oils should not be used.

DETROIT DIESEL

Detroit Diesel engines have given optimum performance and experienced the longest life with MIL-L2104B (API designation "CC"), SAE 40 oils with the following physical property limitations.

1. Sulfated ash (ASTM D-874) of 1.00 percent maximum weight, except lubricants that contain only barium detergent dispersants where 1.50 percent by-weight is allowed.

2. Zinc, as zinc diorganodithiophosphate, shall be a minimum of 0.07 percent by weight. SAE 40 grade oil is recommended for year-round use.

An SAE 30 oil should be used only when the ambient temperatures and engine cranking capabilities resalt in difficult starting. The use of lower viscosity oils (below 30 grade) or multigrade products will usually result in less than normal engine life.

Description	Type Lubricant (See symbol)
Hood Latch	C
Hood Linkage	A
Hood Pivot Bar Bracket	C
Hood Tilt Linkage	C
King Pin Bushings (Steering Knuckles)	C
Manifold Heat Control Valve	N
Power Divider	E
Power Divider Lock Yoke Pin	A
Power Steering Pump Reservoir (Sheppard)	SAE-10W-40 Engine Oil
Power Steering Pump Reservoir (Not Sheppard)	GM Power Steering Fluid
Power Take-Off Shift Control	A
Propeller Shaft Center Bearing	C
Propeller Shaft Slip Joint	C
Propeller Shaft Universal Joints	C
Radiator Shutter and Linkage:	

KYSOR

Vehicles equipped with automatic modulated control radiator shutters (thermostat element mounted in bottom tank or radiator). Do not oil pins and sliding surfaces at frequent intervals. Vane bearings should be cleaned with light or penetrating oil and blown out with air only when servicing complete shutter assembly.

Description	Type Lubricant (See symbol)
CADILLAC	Do not oil Cadillac Shutters
Seat Adjuster Slides	C
Shift Motor (Two Speed Axle)	H
Shift Linkage (Front Drive Axle)	C
Speedometer Cable	C
Speedometer Head	A
Springs (Auxiliary)	C
Spring Pins	C
Spring Shackles	C
Spring Seat Connecting Tube Bearing	C
Starting Motor	K
Steering Column Flexible Coupling	C
Steering Column Mounting Bracket	C
Steering Column Slip Joint	C
Steering Column Universal Joint	C
Steering Drive Joints (Front Axle)	C
Steering Gear (Manual)	M
Steering Gear Relay Lever Pillar Block Bearing	C
Tachometer Cable	C
Tachometer Head	A

Description	Type Lubricant (See symbol)
Tie Rod Ends	C
Transfer Case (Not Code 13143)	P
Transfer Case (Code 13143)	G
Transfer Case Shift Control	C
Transmission (Auto.)	G
Transmission - Clark	U
Transmission - Fuller (Main and Auxiliary)	Q
Transmission - IH (T-495, 496)	V
Transmission - New Process	Q
Transmission - Spicer (Main and Auxiliary)	F
Transmission - Warner Gear	O
Transmission Air Cylinder Shift Linkage	H
Transmission - Remote Control Rod	C
Transmission - Remote Control Rod Universal Joints	C
Transmission - Remote Control Shift Lever Housing	K
Winch	E
Winch Prop-Shaft Center Bearing	C
Winch Rollers	C
Winch Shift Linkage	C
Window Regulator	C
Wheel Bearings (Grease) (Front and Rear)	C
Wheel Bearings (Oil) (Front)	R
Wheel Bearings (Oil) (Rear)	E

PROPELLER SHAFT

INDEX

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 trasmission 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.

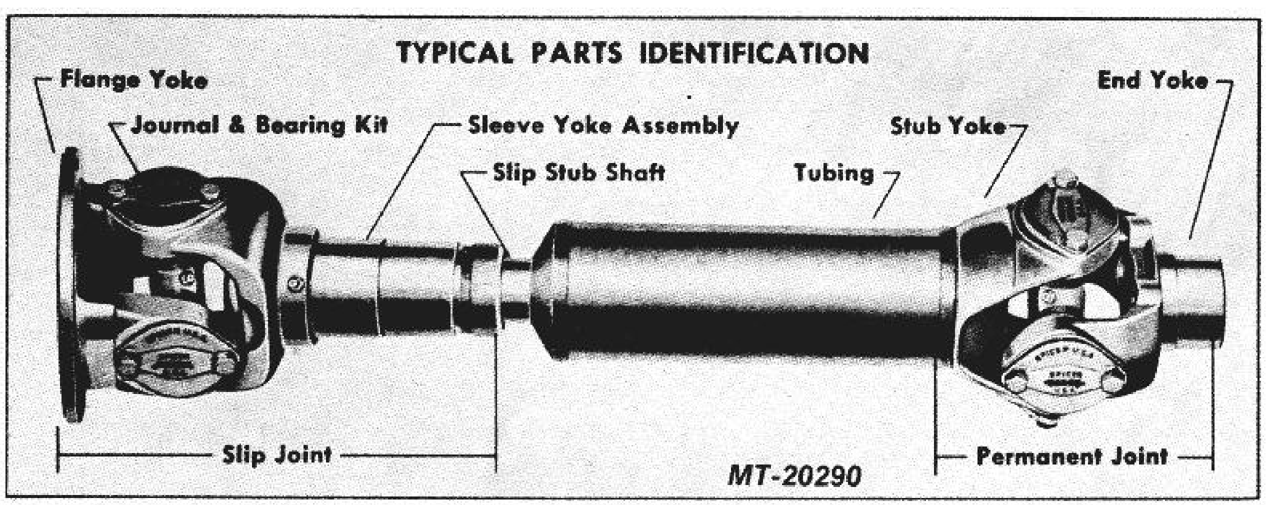

FIG. 1

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 vary 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 coated to resist galling and to reduce sliding friction.

COMPONENTS
LEGEND FOR FIGS. 2, 3, 4, 5, 6, 7 & 8

Key	Description
2	FLANGE YOKE
3	SLEEVE YOKE ASSEMBLY
4	END YOKE
5	JOURNAL ASSEMBLY
6	BEARING ASSEMBLY
7	SNAP RING
14	DUST CAP
15	STEEL WASHER
16	CORK WASHER

Key	Description
27	STUB YOKE & TUBE ASSEMBLY
28	STUB YOKE
30	TUBING
40	SLIP STUD SHAFT, Welded Tube
53	MIDSHIP STUB SHAFT, Center Bearing
70	CAP & BOLT ASSEMBLY
82	YOKE SHAFT
94	U-BOLT ASSEMBLY

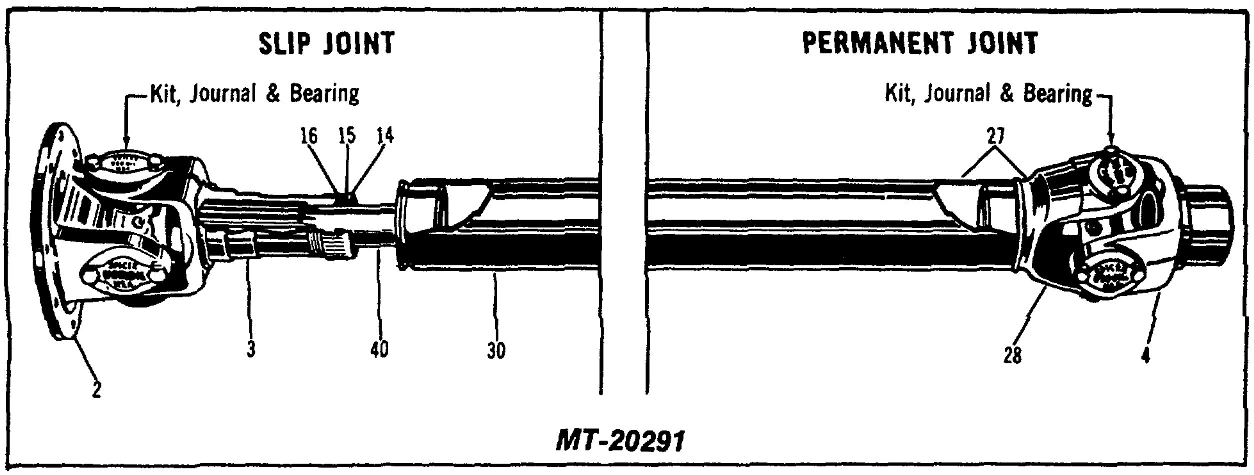

Fig. 2

COMPONENTS

PERMANENT JOINT

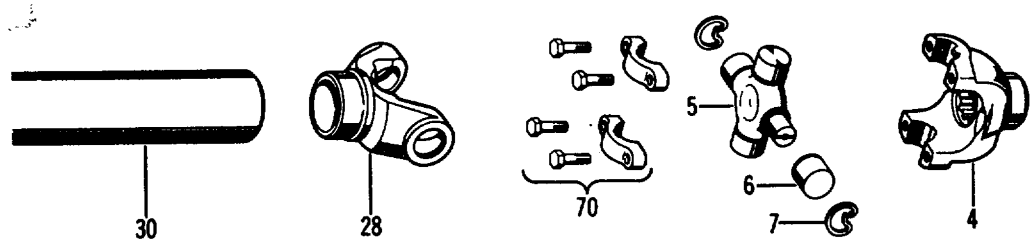

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Fig. 3

CENTER BEARING ASSEMBLY

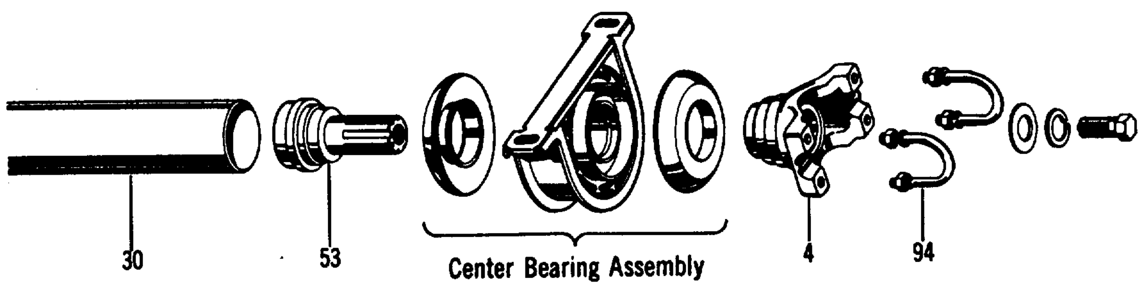

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Fig. 4

SLIP JOINT

SLIP JOINT

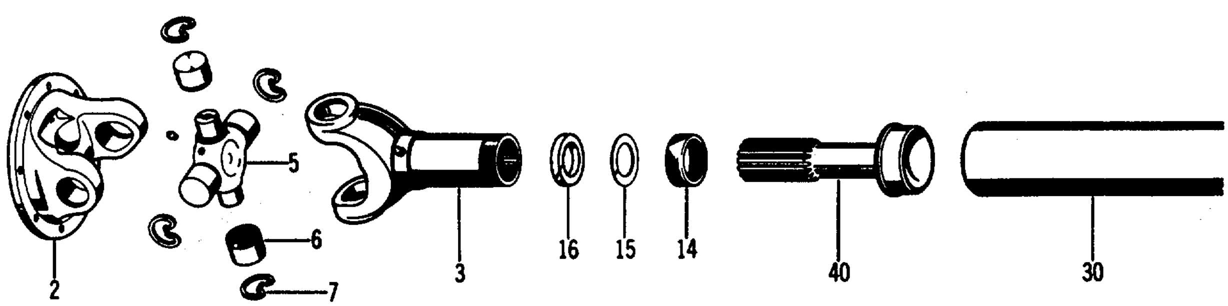

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Fig. 5

COMPONENTS

SHORT-COUPLED JOINT

SHORT-COUPLED JOINT

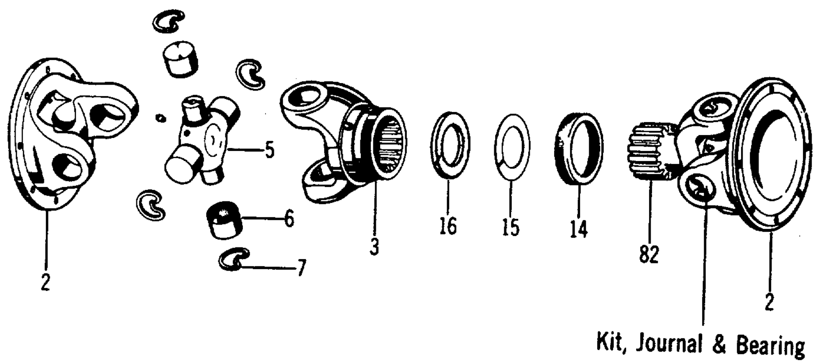

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Fig. 6

ALTERNATE YOKE CONSTRUCTIONS

ALTERNATE YOKE CONSTRUCTIONS

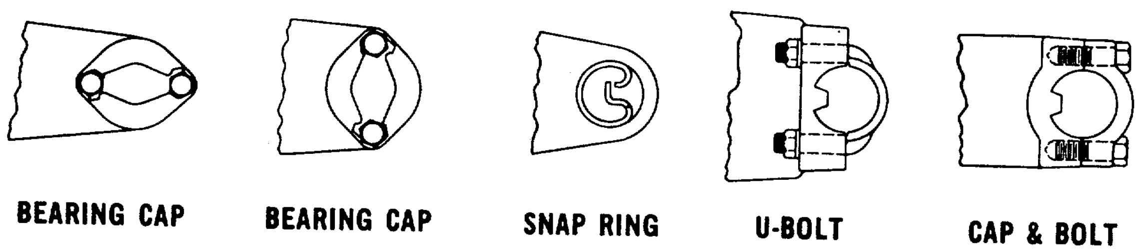

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Fig. 7

ALTERNATE COMPANION FLANGE-FLANGE YOKE

ALTERNATE COMPANION FLANGE—FLANGE YOKE

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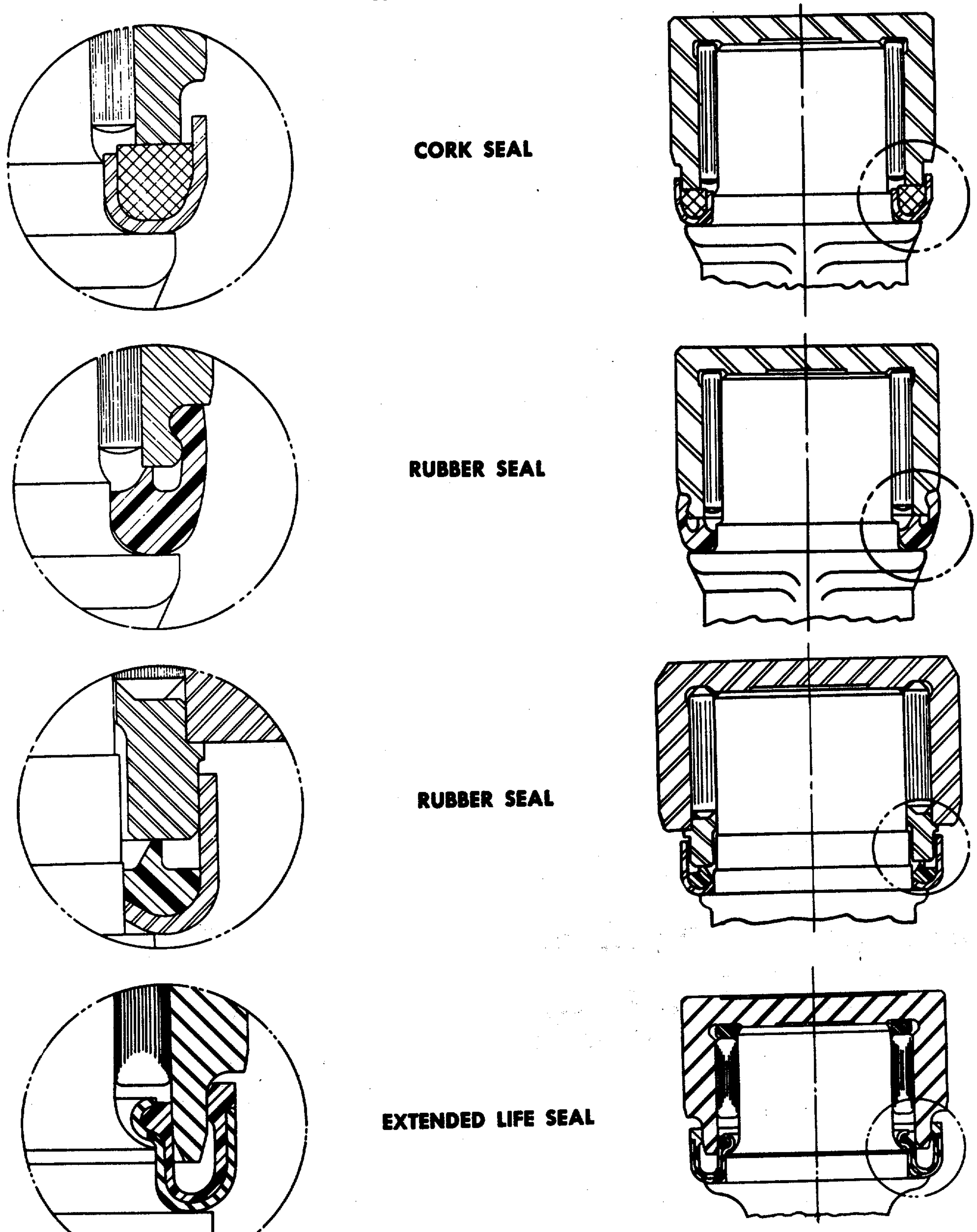
Fig. 8

UNIVERSAL JOINT SEALS



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LUBE SPECS

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.

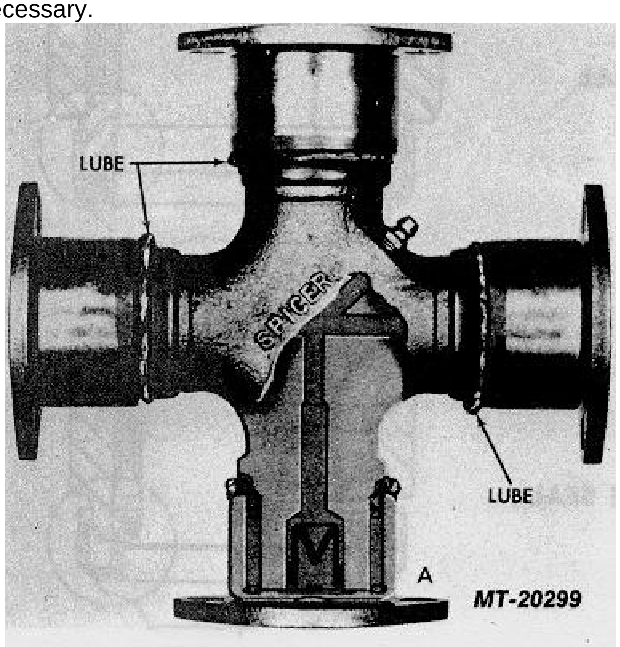


Fig. 10

DRIVE SHAFT ASSEMBLY

Factory assembled drive shafts are lubricated at the plant prior to shipment. However, shipping, 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.

LUBRICANT

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.

LUBE SPECS

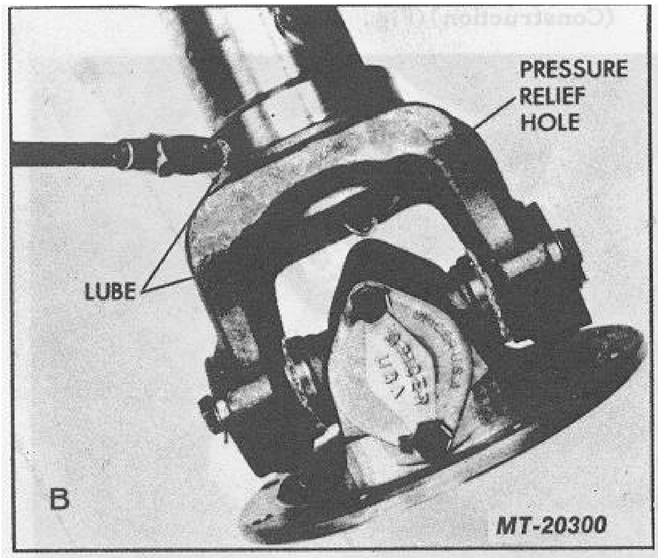


Fig. 11

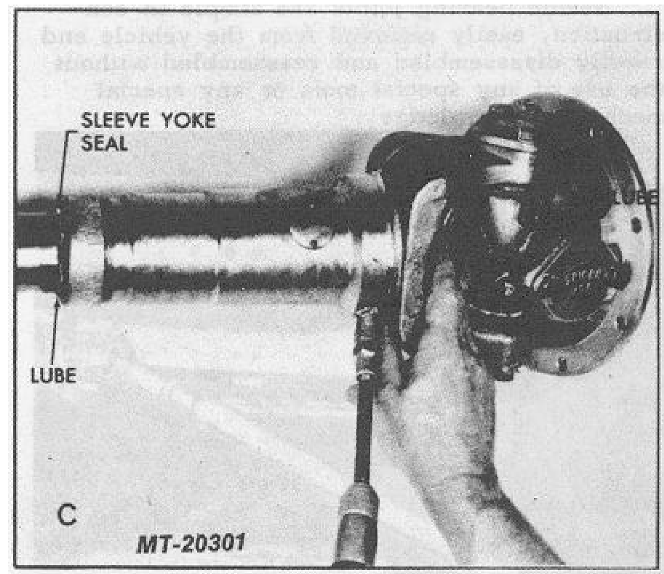


Fig. 12

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.

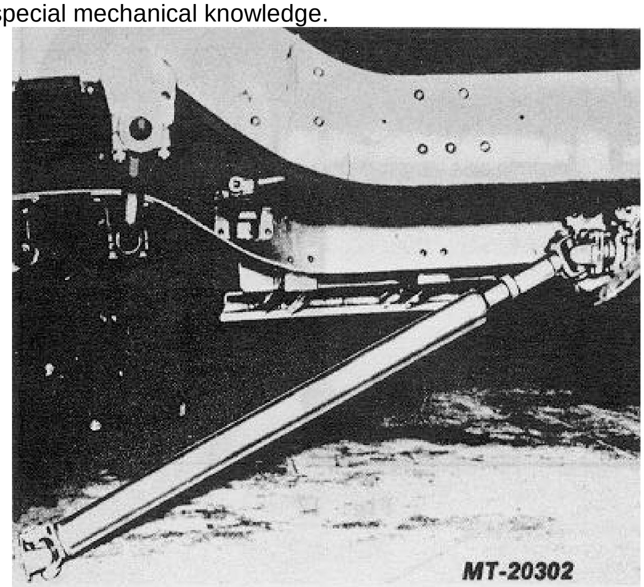


Fig. 13

REMOVAL FROM THE VEHICLE

1. Double Flange, Yoke Types (Bearing Cap and Snap Ring Construction)(Fig. 13)

All Double Flange Yoke Type Joints are removed 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.

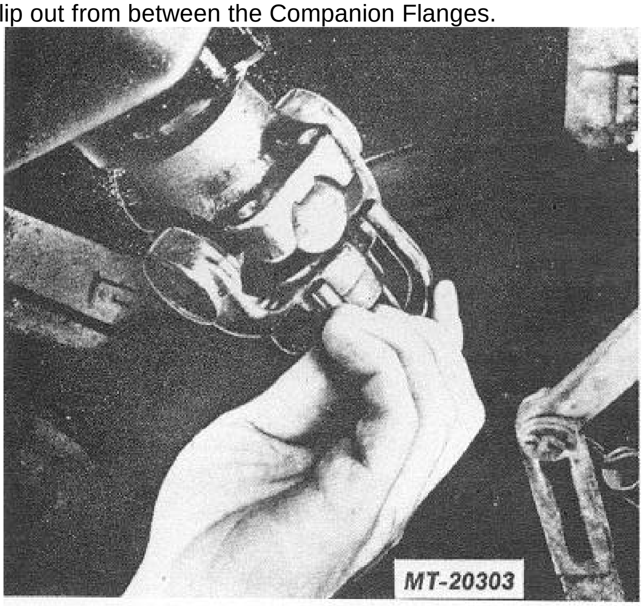


Fig. 14

2. Double End, Yoke Type (U-Bolt (Construction) (Fig. 14)

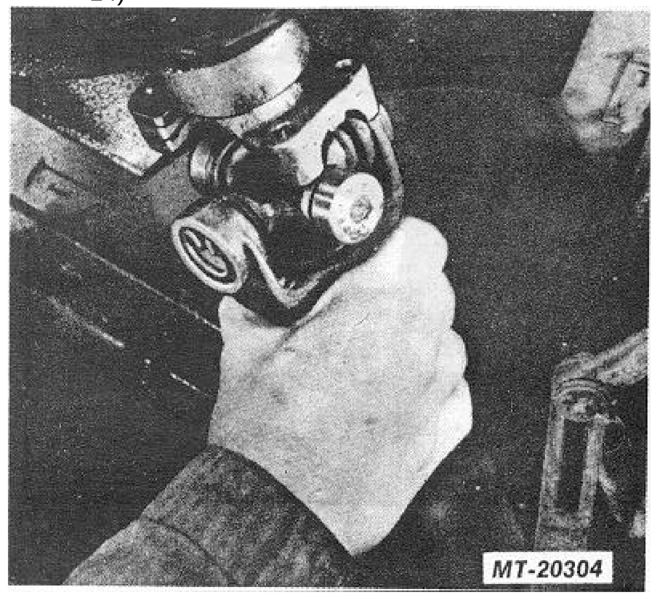


Fig. 15

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.

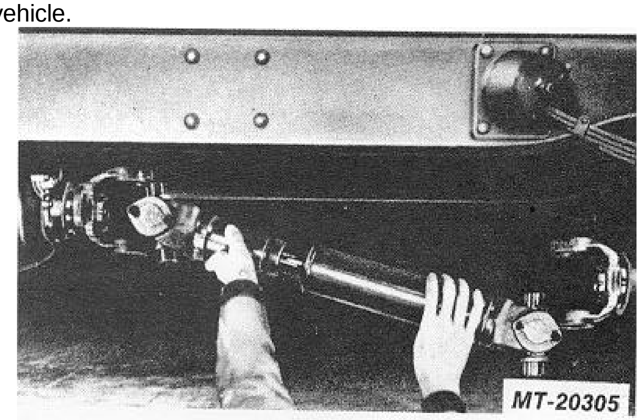


Fig. 16

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.

SERVICE INSTRUCTIONS

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.

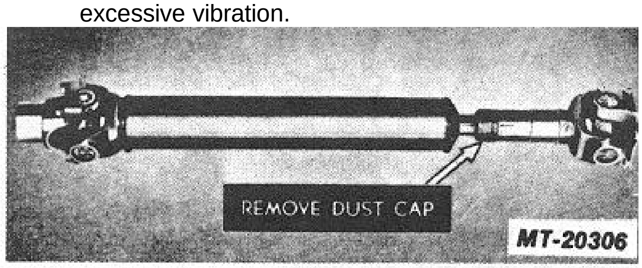


Fig. 17

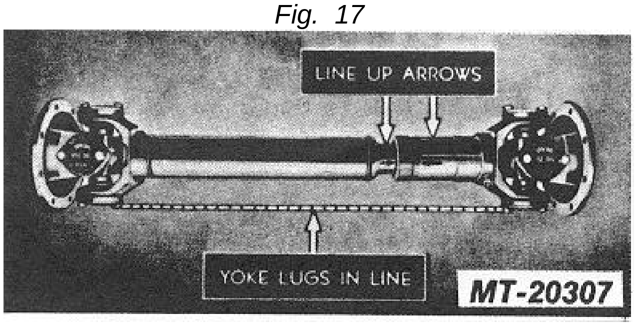


Fig. 18

DISASSEMBLING UNIVERSAL JOINT MEDIUM AND HEAVY DUTY

1. LOCK STRAP Bend down the locking lugs with a screwdriver and remove the capscrews.

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 subassembly 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

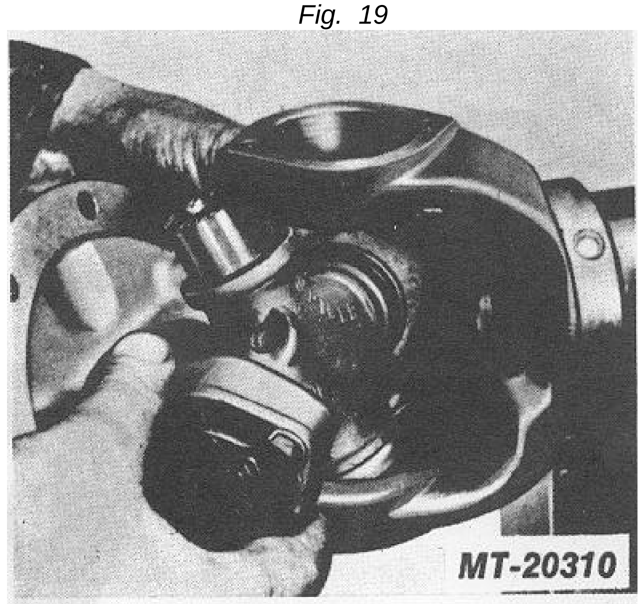


Fig. 20

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.

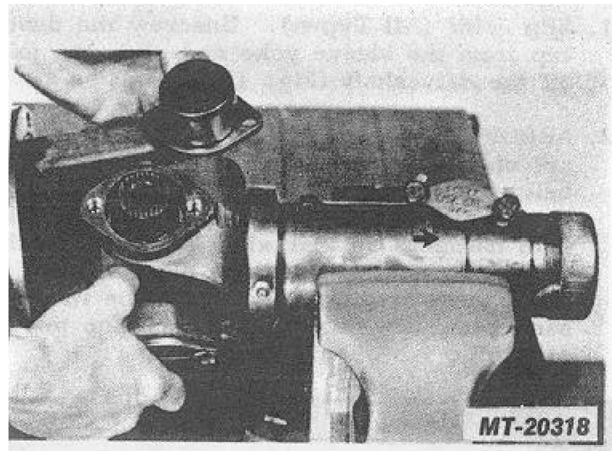


Fig. 22

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 MEDIUM AND HEAVY DUTY

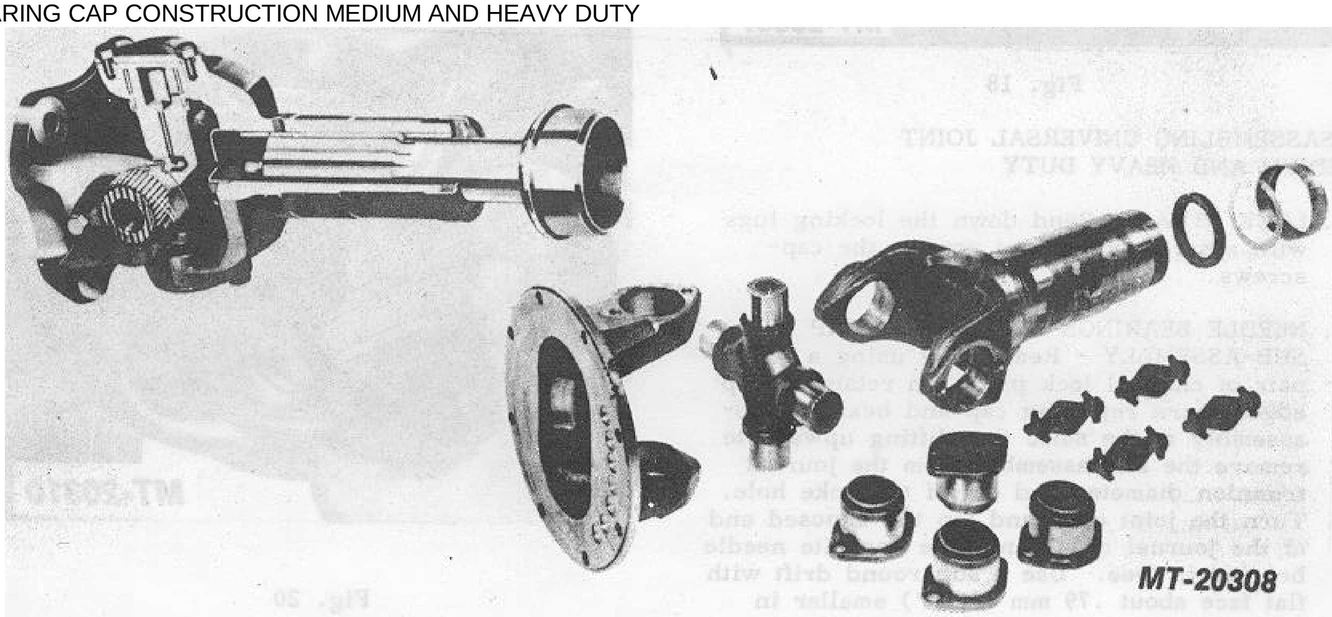


Fig. 23

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.

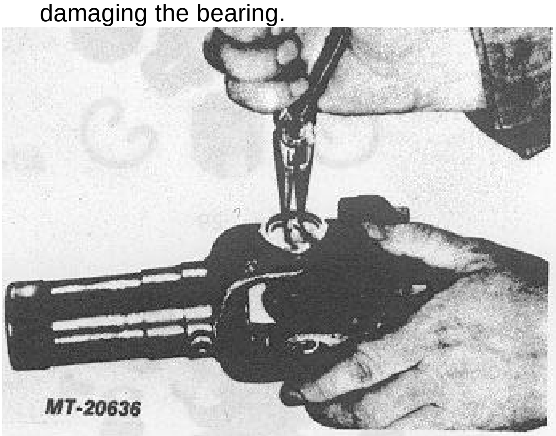


Fig. 24

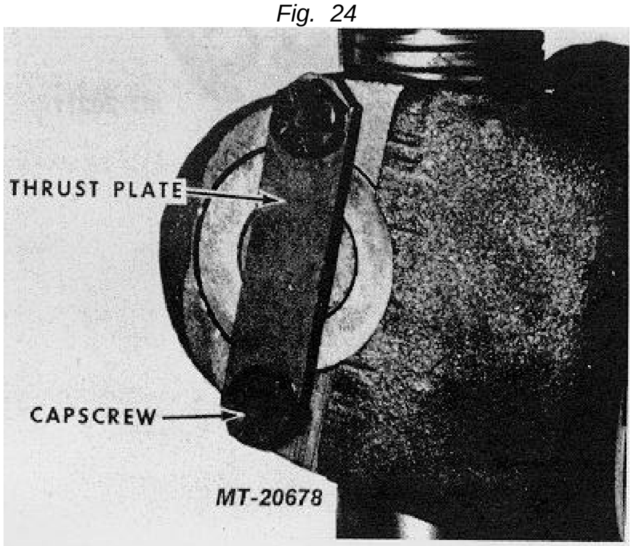


Fig. 25

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).

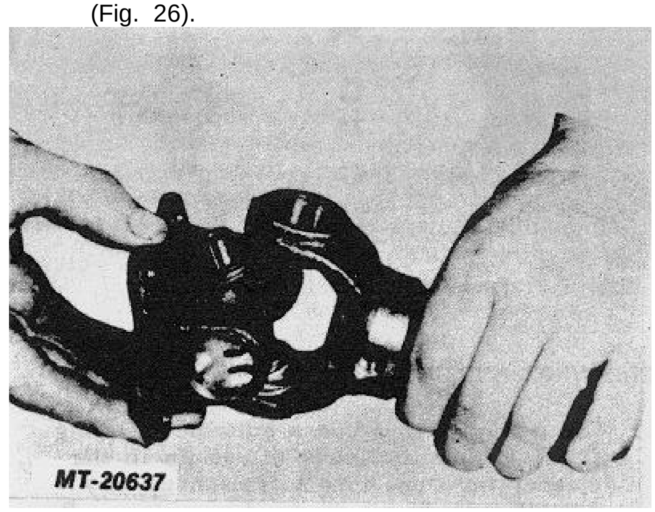


Fig. 26

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).

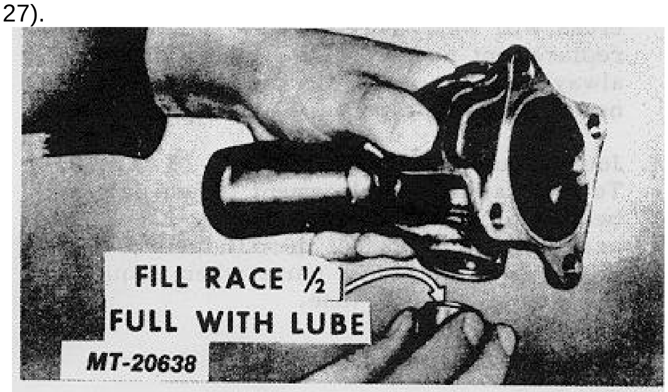


Fig. 27

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.

SERVICE INSTRUCTIONS

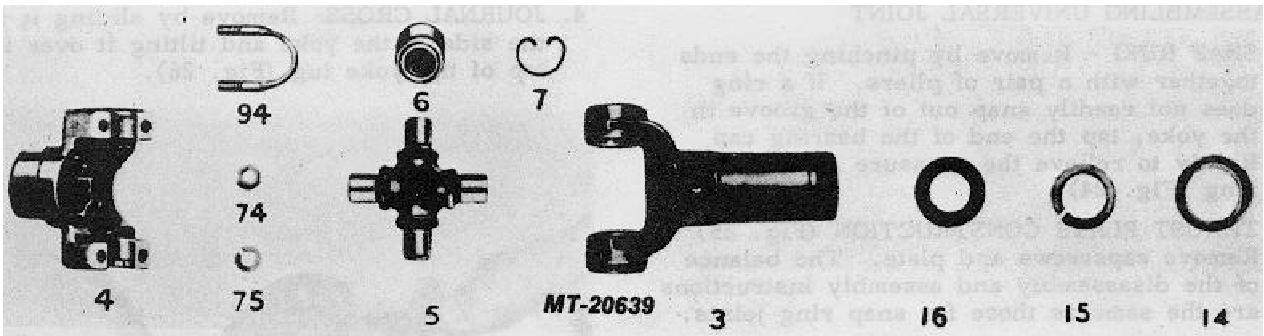


Fig. 28

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. Remove 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.

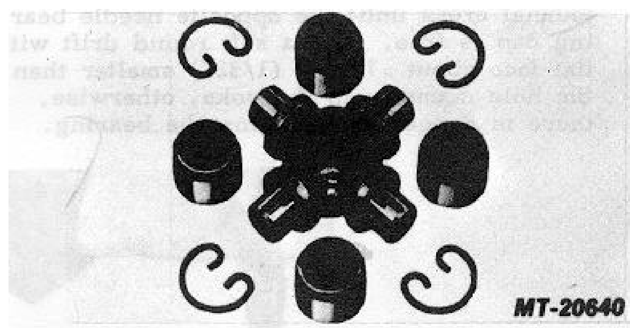


Fig. 29

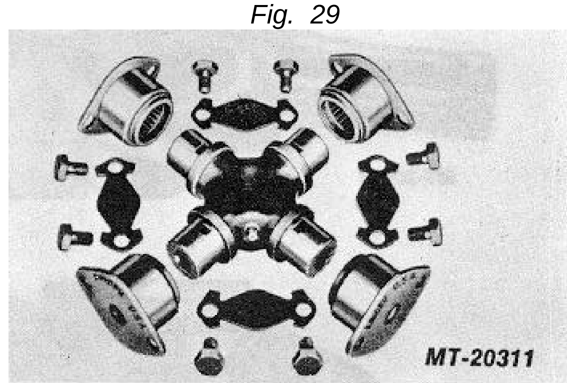


Fig. 30

TYPICAL FAILURES

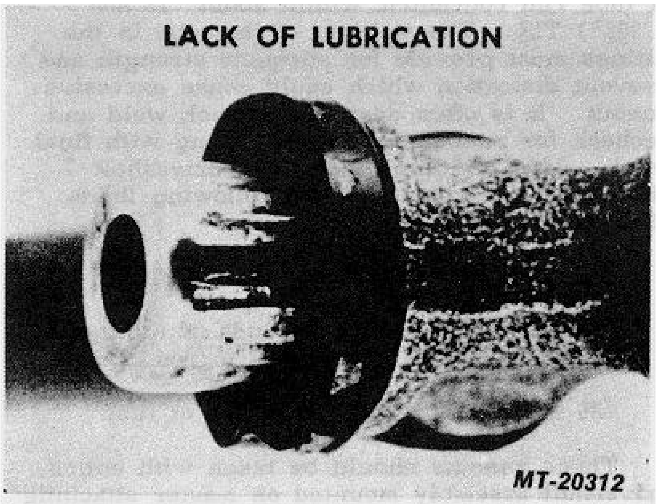


Fig. 31

Fig. 32

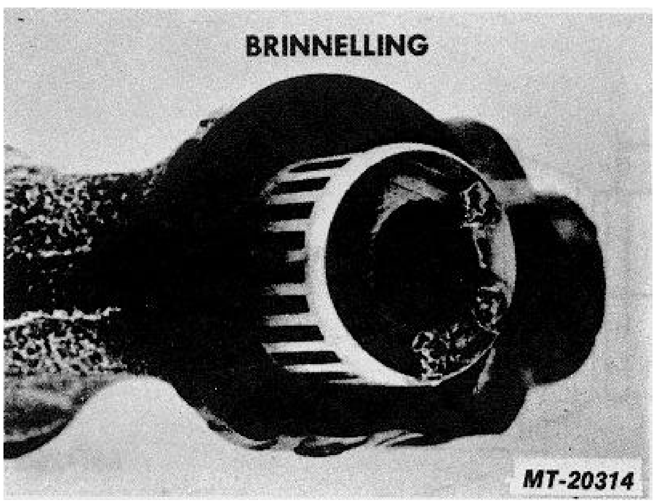


Fig. 33

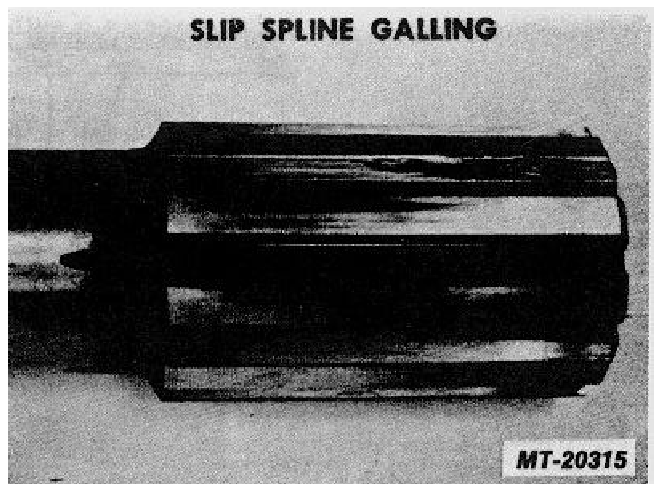


Fig. 34

REBUILDING DRIVESHAFTS

BALANCING

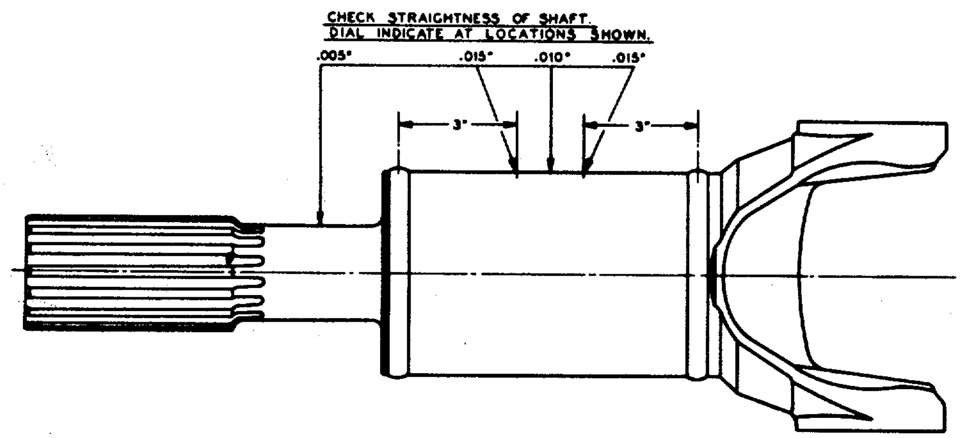
The rebuilding of a driveshaft assembly usually consists of replacing worn journal cross and bearings with a new kit. These kits replace the part of a driveshaft most subject to wear in operation. The slight off-center condition present in the journal cross assemblies makes it desirable to balance the 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 driveshaft 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") TIR. The welding of the tube in the fittings must provide for adequate strength and prevent distortion which could cause excessive run-out. It is often desirable to tack weld and recheck for run-out 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
.38 mm (.015") TIR	On ends of tubing 76.2 mm (3") from welds
.25 mm (.010") TIR	In center of tube

These run-outs 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.



MT-20316

Fig. 35

INSTALLATION

Fig. 36

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 driveshaft 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 capscrews 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, however, the lower torques are required to prevent bearing race distortion.

ASSEMBLING SLIP JOINT ON SHAFT

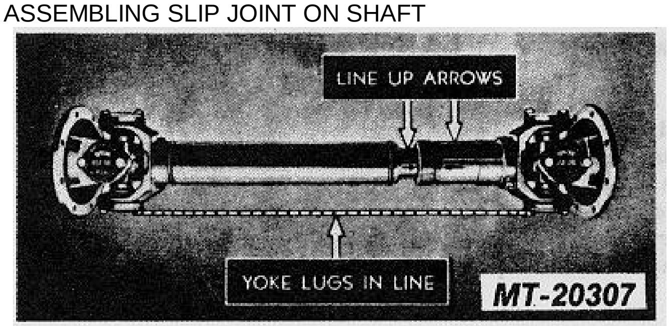


Fig. 37

INSTALLATION

Lubricate the splines thoroughly (refer to page 9) 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 is 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 run-out if not previously done during assembly. The run-out on the tube should not be more than .38 mm (.015") indicator reading, and on the neck of the slip stub shaft the run-out 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.

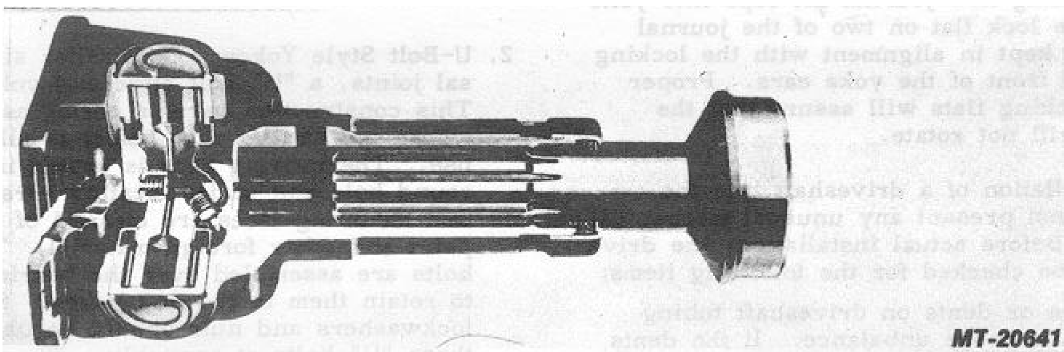


Fig. 38

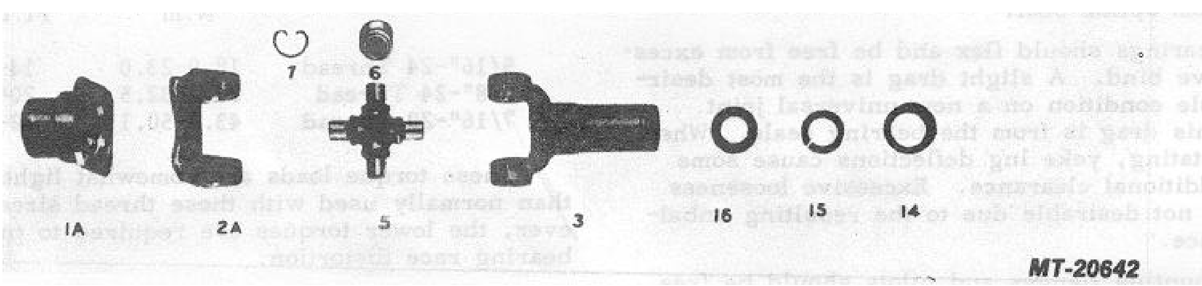


Fig. 39

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 main shaft 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 deg., 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

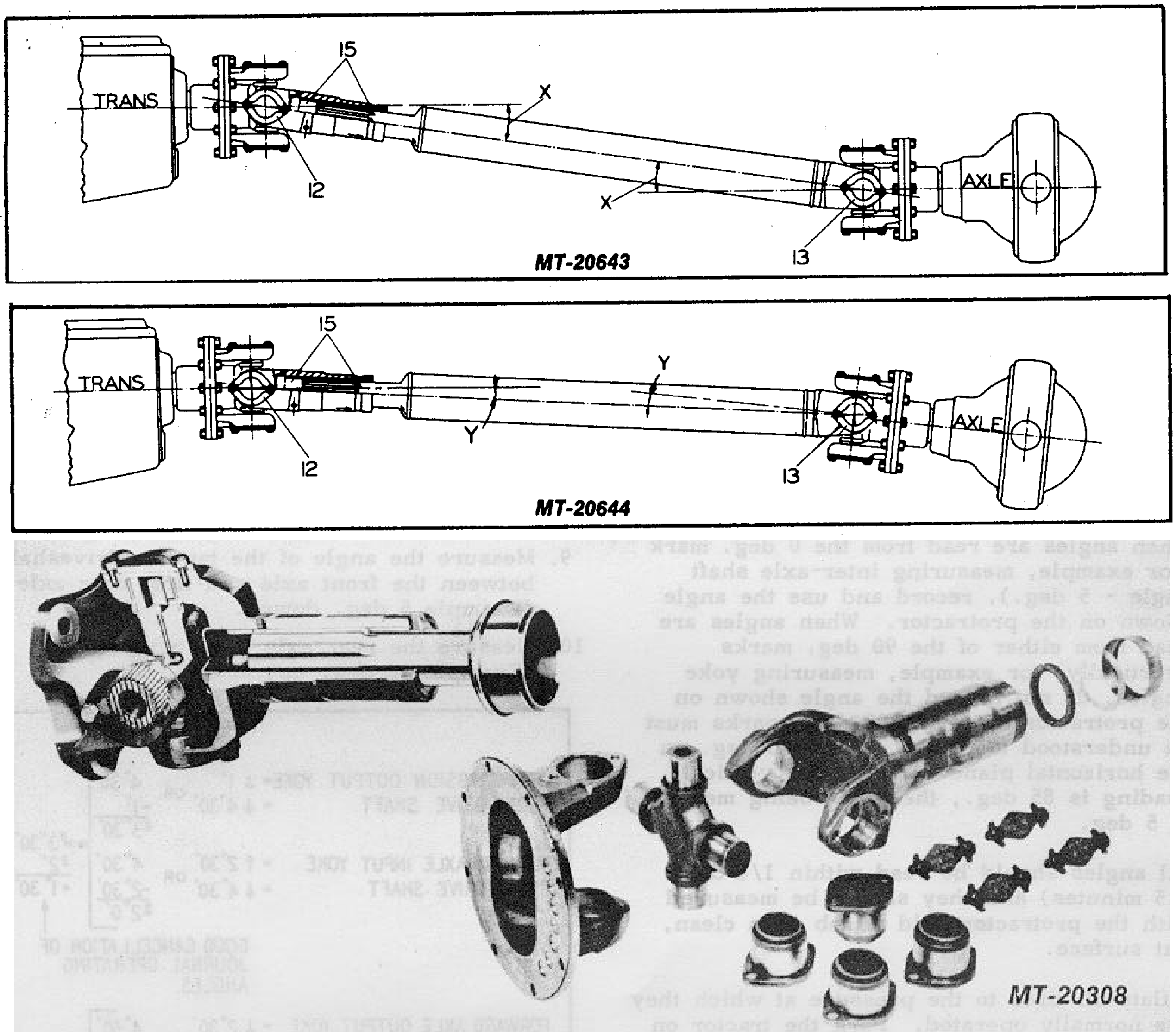


Fig. 42

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 run-out if not previously done during assembly. The run-out on the tube should not be more than .38 mm (.015") indicator reading, and on the neck of the slip stub shaft the run-out 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).

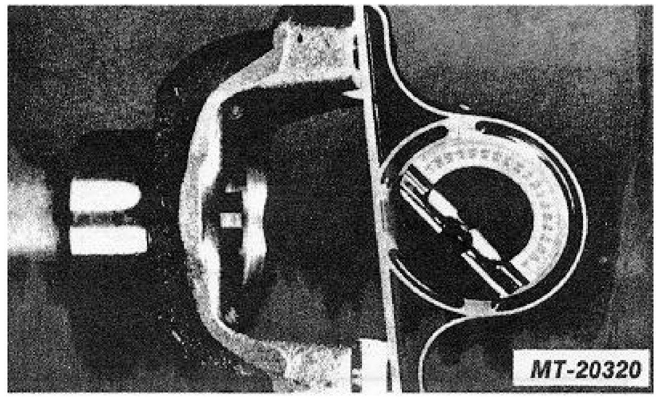


Fig. 43

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).

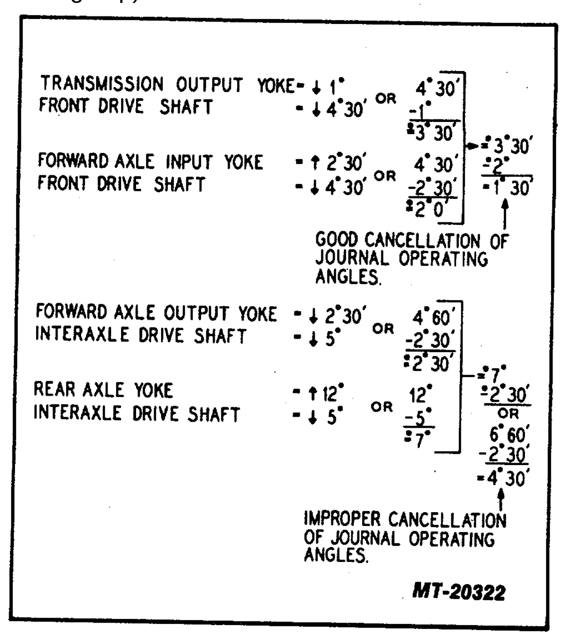


Fig. 44

INSTALLATION

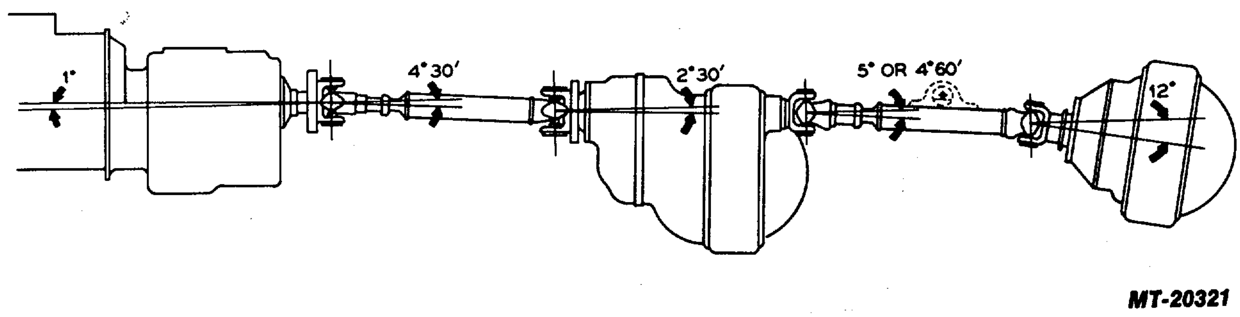


Fig. 45

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 possiseizure 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

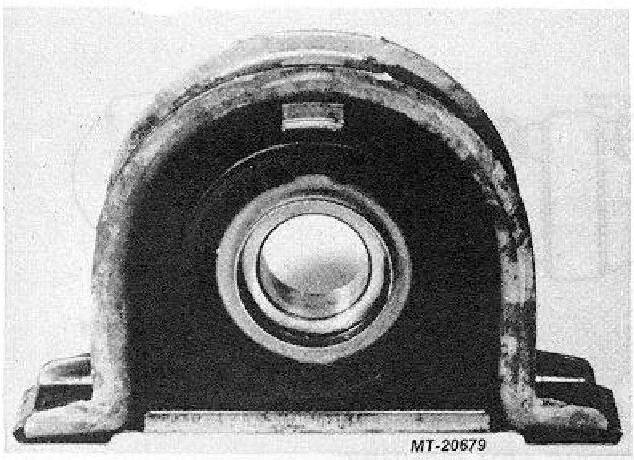


Fig. 46

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.

SPRINGS

CHAPTER I

SPRINGS, SHOCK ABSORBERS, SWAY BAR

CONTENTS

PRINTED IN UNITED STATES OF AMERICA

SPRING ASSEMBLIES

DESCRIPTION

Constant Rate

Constant rate springs are leaf-type spring assemblies that have a constant rate of deflection. For example, if 227 Kg (500 lbs.) deflect the spring assembly 2.54 cm (1 in.), then 454 Kg (1000 lbs.) would deflect the same spring assembly 5.08 cm (2 in.). 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 a stationary bracket while the rear end of the spring is mounted to a spring shackle. The shackle allows for variations in spring length during compression and rebound of the spring.

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

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

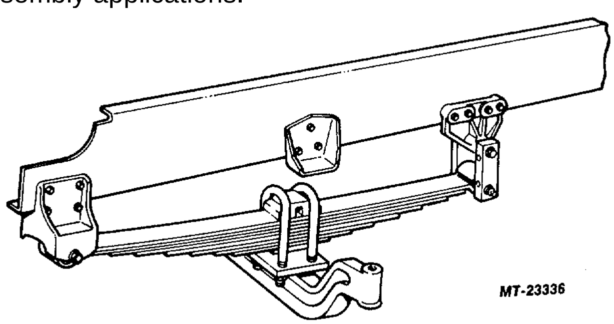


Fig. 1 Front Axle Application (Constant Rate)

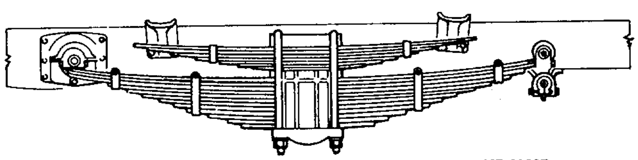


Fig. 2 Rear Axle Application (Constant Rate)

Taper Leaf

Taper leaf springs are leaf type spring assemblies that have spring leafs which are thicker in the center than the ends. This design results in a fewer number of leafs which provides lighter weight and softer ride due to lower inner leaf friction.

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 while the rear end of the spring is mounted to a spring shackle. The shackle allows for variations in spring length during compression and rebound of the spring.

Taper leaf spring assemblies are used on front axles only. Figure 3 illustrates a Taper leaf assembly.

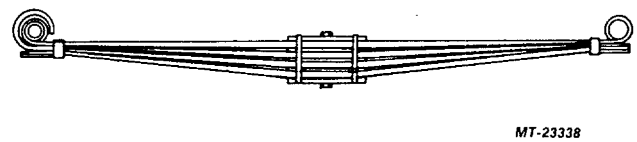


Fig. 3 Taper Leaf Spring Assembly

Auxiliary Springs

Auxiliary springs are leaf-type spring assemblies usually mounted on top of the vehicle rear spring assemblies. Auxiliary springs are only used 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.

Fig. 4 illustrates an auxiliary spring assembly.

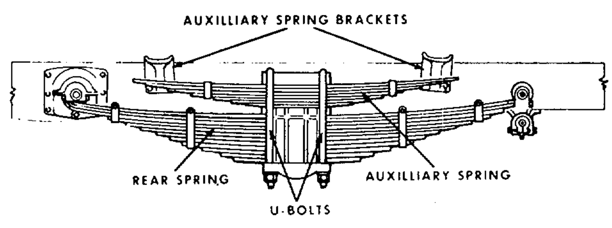


Fig.4 Auxiliary Spring Assembly

Progressive (Vari-Rate)

Progressive (Vari-rate) springs are leaftype 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 come in contact providing increased capacity and stiffness.

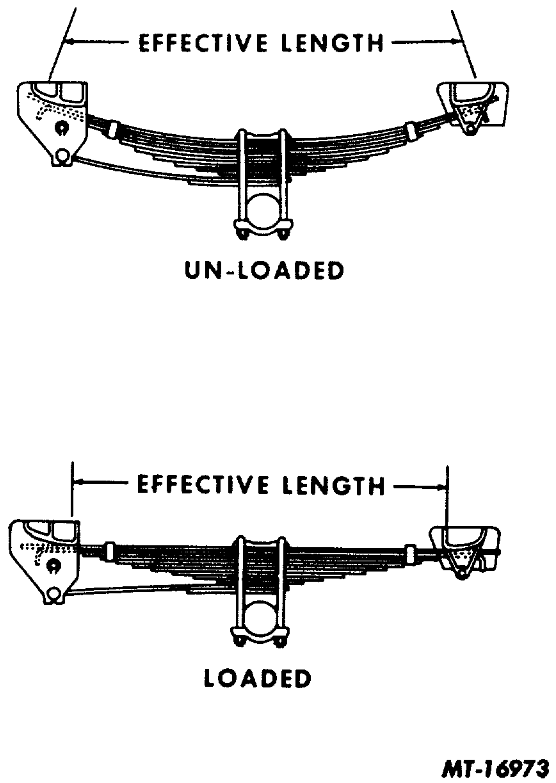


Fig. 5 Progressive Spring Assembly

MAINTENANCE

Lubrication

For lubrication intervals, refer to Operator's Manual. For types of lubricants recommended, refer to LUBRICATION, Section CTS-2412.

SERVICING

Although the exact servicing procedures are different for each type of spring assembly and spring assembly 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. Remover U-bolts, spring bumper and retainer or U-bolt 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.
7. If spring is rubber bushed, bushing halves may be removed from each side of spring and shackle eye.

Installation

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

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 TORQUE CHART for U-bolt torque specifications. Spring failures may occur at the center bolt hole if U-bolts become loosened. These bolts must be kept tight and checked frequently. Spring pins should also be checked periodically.

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 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. 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.

CAUTION

When assembling spring leaves, be careful to prevent physical injury to 1 personnel. The use of special holding fixtures or "C" clamps for holding spring leaves in place during assembly is strongly recommended.

4. 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.

SHOCK ABSORBERS

Shock absorbers are provided to control body sway and 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 (Fig. 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) however, to 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.

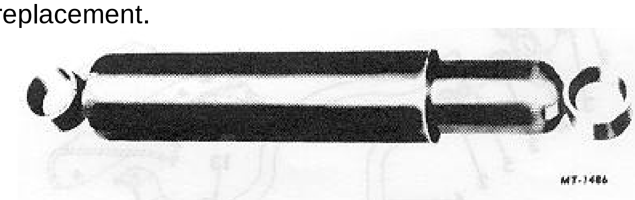


Fig. 6 Direct Acting Shock Absorber

MOUNTING AND LINKAGE

Loose, bent or broken shock absorber mountings or linkage should always be checked for and corrected 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 indicate excessive wear.

SWAY BAR

Some body styles applicable to light or. medium duty delivery trucks require a stabilizing device in the suspension system. This unit, known as a sway bar, supplements the spring by adding greater stability to the truck.

A sway bar is a U-shaped cross bar mounted transversely with the chassis frame.

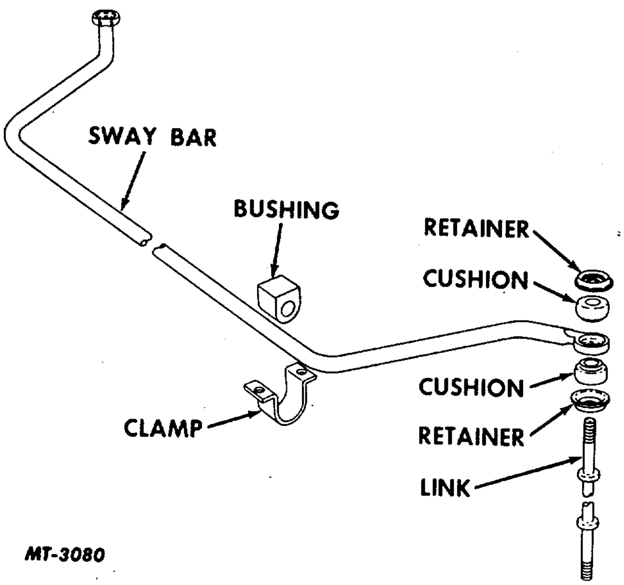


Fig. 7 Front Sway Bar

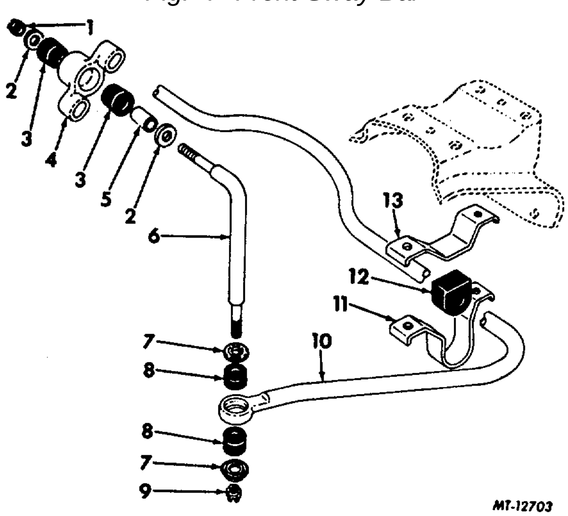


Fig. 8. Rear Sway Bar

Legend for Fig. 8

Key	Description
1	NUT
2	WASHER
3	BUSHING
4	BRACKET
5	SPACER
6	LINK, Sway Bar
7	RETAINER, Cushion
8	CUSHION
9	NUT
10	SWAY BAR
11	BRACKET
12	BUSHING
13	BRACKET

Sway bars are available for both front (Fig. 7) and rear (Fig. 8) suspension applications.

Simple in construction, these bars perform their stabilizing effect by twisting when spring height at opposite wheels becomes unequal. For example, if the wheel on one side drops into a chuck hole, the spring on that same side expands. At the same time the sway bar tends to expand the opposite spring and lift the truck. Failing to do this, the bar twists and lessens the shock of the wheel dropping.

In like manner, if the wheel on one side hits an obstacle, the spring on that side compresses. The sway bar tends to compress the opposite spring and hold the truck down. Failing to do this, the sway bar twists and lessens the shock. This resistance to twisting in the sway bar is particularly useful in limiting sway or roll when the truck is rounding a curve or when it suddenly encounters a strong cross wind.

No service is necessary on the sway bar other than a periodic inspection to see that mounting parts remain secure. Rubber bushings should be replaced when they become deteriorated or permit metal to metal contact. Keep mounting bolts tight.

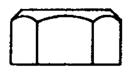
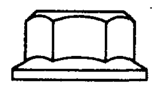
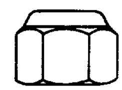
TROUBLE SHOOTING

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 trouble shooting. For additional information on these related items of trouble shooting, see AXLE-FRONT: CTS-2052.

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. Too much lubricant on spring leaves. c. Broken spring leaves. d. Defective shock absorbers. e. 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. Loose center bolt. d. Defective shock absorbers. e. Improper adjustment on spring pin. f. Tight spring shackle. g. Too much lubricant on spring leaves.
5. Noisy springs.	a. Loose U-bolts. b. Loose center bolt. c. Loose rebound clips. d. Loose shackles. e. Worn shackle bushings. f. Loose, bent or broken spring brackets. g. Worn spring pins.
6. Erratic steering when braking.	a. Loose U-bolts. b. Loose center bolt.

U-BOLT NUT RETORQUE

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)						
	N.m	Ft Lbs	N.m	Ft Lbs	N.m	Ft Lbs
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						
	N.m	Ft Lbs	N.m	Ft Lbs	N.m	Ft Lbs
1/2" - 20	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

Whenever U-Bolt nuts are loosened or removed when servicing a suspension, the U-Bolt nuts must be retorqued at the intervals and under the conditions described below.

1. After the chassis has been operating under load for 1000 miles, or six months whichever comes first, the U-Bolt nuts must be retorqued.
2. The U-Bolt nuts thereafter should then be retorqued every 36,000 miles.
3. The U-Bolt (joint) should be in a new or as new condition.

IMPORTANT

In instances 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 RETORQUE TO ORIGINAL SPECIFICATIONS. Rusty joints must be disassembled, cleaned and lubricated to assure a like-new condition prior to retorque.

SPECIAL TOOLS

SE-2050 Torque Indicator Wrench (0-600 ft. lbs.)

SE-2059 Torque Indicator Wrench (0-150 ft. lbs.)

For additional information, refer to Service,. Tool Manual CTS-1147.

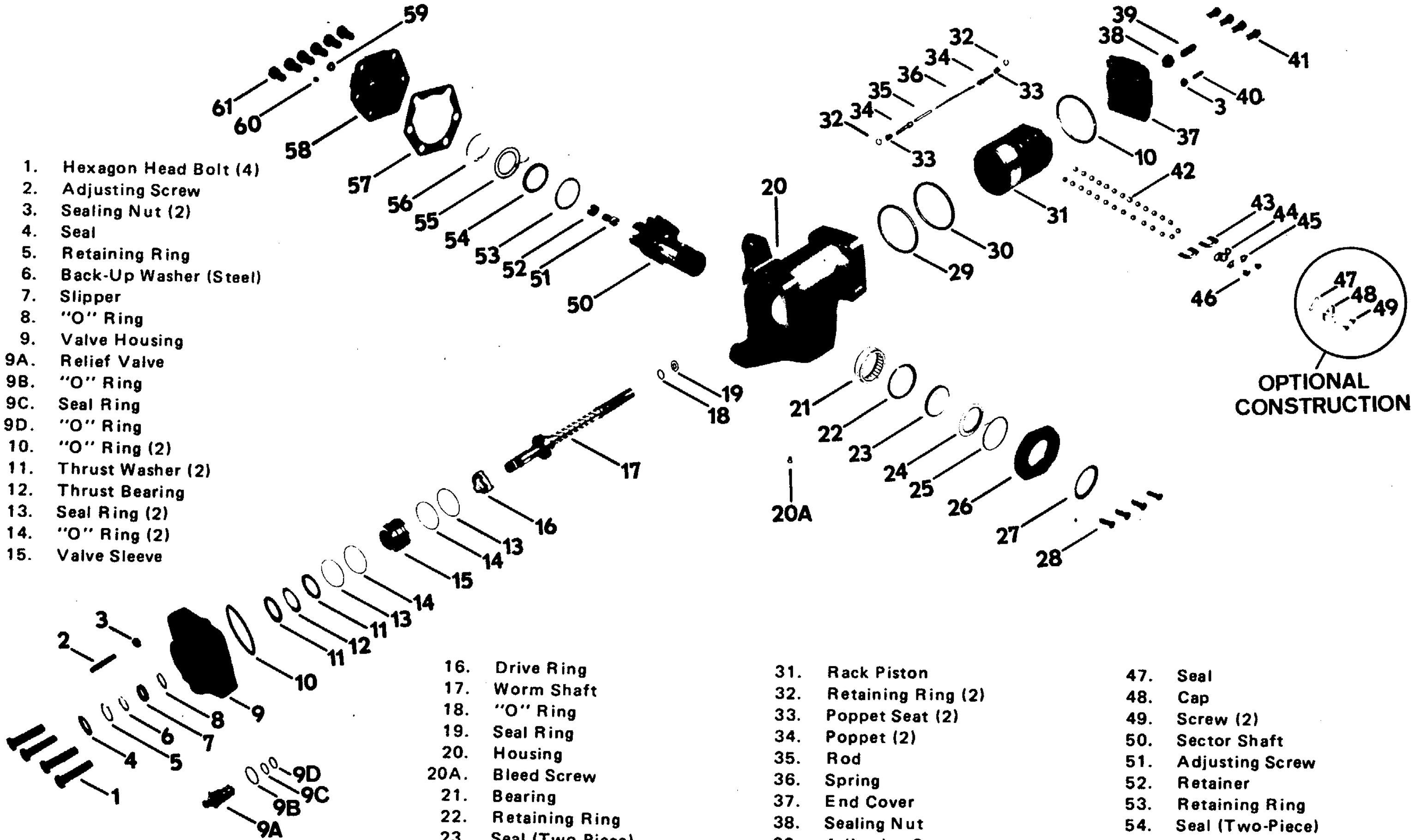
STEERING GEAR

(ROSS)

IH MODEL	IH CODE
S-335	05335
S-336	05336
S-337	05337
S-338	05338

INDEX

1. Hexagon Head Bolt (4)
2. Adjusting Screw
3. Sealing Nut (2)
4. Seal
5. Retaining Ring
6. Back-Up Washer (Steel)
7. Slipper
8. "O" Ring
9. Valve Housing
9A. Relief Valve
9B. "O" Ring
9C. Seal Ring
9D. "O" Ring
10. "O" Ring (2)
11. Thrust Washer (2)
12. Thrust Bearing
13. Seal Ring (2)
14. "O" Ring (2)
15. Valve Sleeve



MT-20827

16. Drive Ring
17. Worm Shaft
18. "O" Ring
19. Seal Ring
20. Housing
20A. Bleed Screw
21. Bearing
22. Retaining Ring
23. Seal (Two-Piece)
24. Back-Up Washer
25. Seal
26. Trunnion Cover
27. Seal
28. Screw (4)
29. Seal Ring
30. "O" Ring
31. Rack Piston
32. Retaining Ring (2)
33. Poppet Seat (2)
34. Poppet (2)
35. Rod
36. Spring
37. End Cover
38. Sealing Nut
39. Adjusting Screw
40. Adjusting Screw
41. Hexagon Head Bolt (4)
42. Ball (27)
43. Ball Return Guide (2)
44. Clip
45. Lock Washer
46. Screw (2)
47. Seal
48. Cap
49. Screw (2)
50. Sector Shaft
51. Adjusting Screw
52. Retainer
53. Retaining Ring
54. Seal (Two-Piece)
55. Back-Up Washer (Plastic)
56. Washer
57. Side Cover Gasket
58. Side Cover
59. Nut
60. Vent Plug
61. Special Bolt (6)

FIG. 1

DESCRIPTION

This steering gear (Fig. 1) is a fully integral power steering unit incorporating a hydraulic control valve, a hydraulic power cylinder and a manual steering mechanism into a single compact package. The control valve is a rotary design which combines simplicity of construction with desirable performance characteristics. Flow of oil from an engine driven pump is directed to the power cylinder by the control valve.

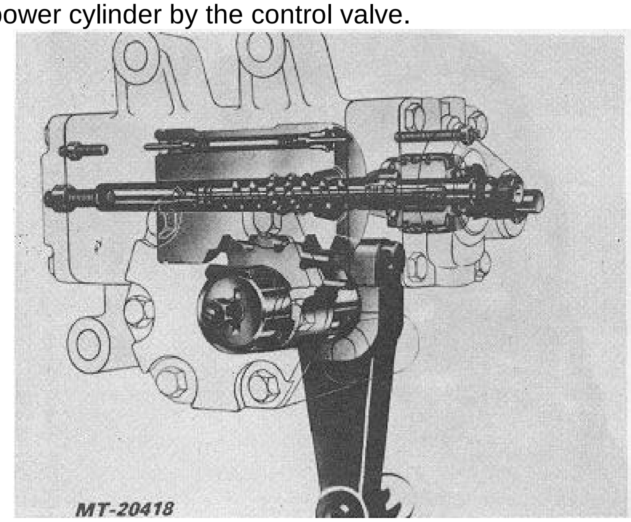


Fig. 2

DISASSEMBLY (For callouts, refer to Fig. 1)

Thoroughly clean off all outside dirt before disconnecting hoses. (Port holes should be plugged immediately after disconnecting hoses and before removing from the vehicle.)

All parts should be cleaned in clear, clean solvent and blown dry with air. Keep each part separate to avoid nicks and burrs.

IMPORTANT

Avoid wiping valve parts with cloth, as lint may actually cause binding and sticking of the closely fitted parts. Never steam clean or high pressure wash hydraulic steering gear assemblies. Do not force or abuse closely fitted parts, as damage may result.

1. Position steering gear in a vise with worm shaft (17) in a horizontal position. Check timing mark located on end of sector shaft (50), position this mark in vertical direction with steering gear in center of steering gear travel.

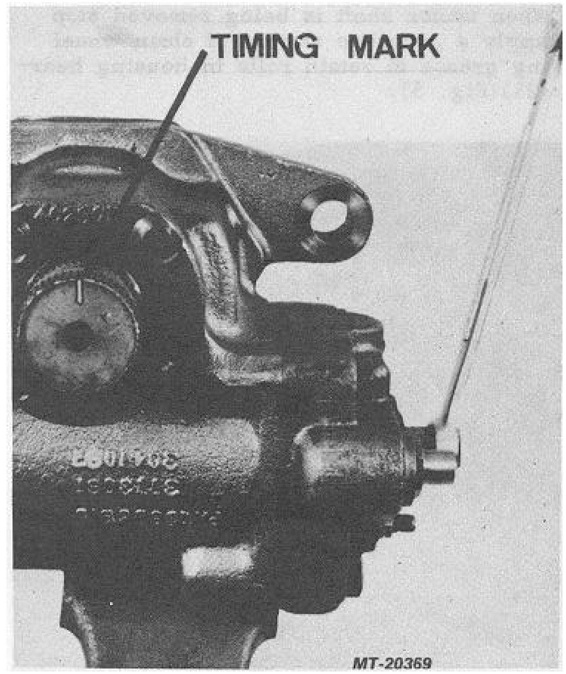


Fig. 3

2. Remove any paint or corrosion from serrated end of sector shaft (50) and loosen jam nut (59) on sector shaft adjusting screw (51).

3. To drain steering gear fluid remove six "special ring head" bolts (61) from side cover (58). These bolts have a special ring located on bolt head for sealing purposes, if these bolts are replaced, they must be replaced with same "special" type and length of bolt.

4. Remove side cover (58) and sector shaft (50). A soft hammer or wooden handle may be used to remove sector shaft (Fig. 4).

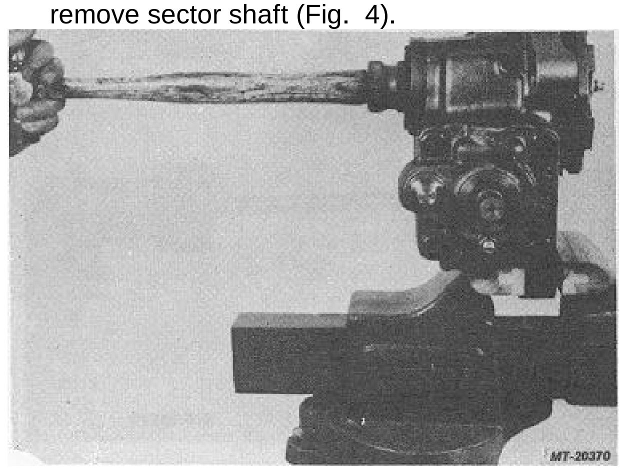


Fig. 4

When sector shaft is being removed stop and apply a generous amount of clean wheel bearing grease to retain rolls in housing bearing (21)(Fig. 5).

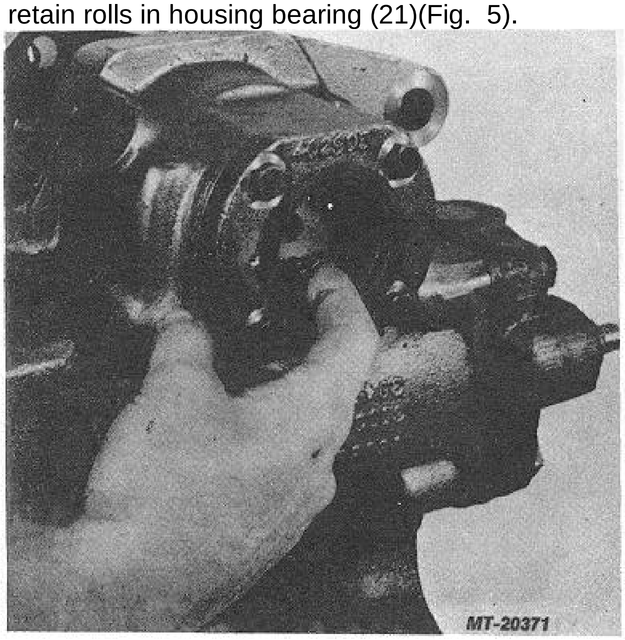


Fig. 5

5. Check to make sure all bearing (21) rolls are in place after sector shaft (50) is removed.

6. Remove sector shaft adjusting screw nut (59).

7. Screw sector shaft adjusting screw (51) thru side cover (58) with a screwdriver and remove shaft (50)(Fig. 6).

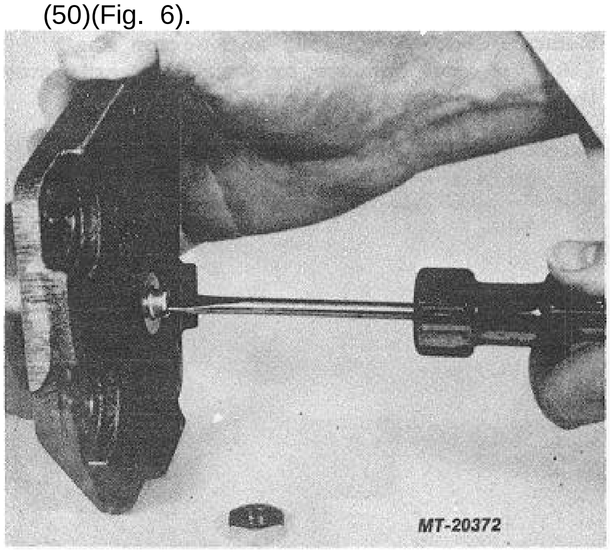


Fig. 6

8. Inspect sector shaft (50) bearing areas and tooth surfaces for wear marks, pitting or brinelling. If any of these conditions exist, replace sectorshaft (Fig. 7).

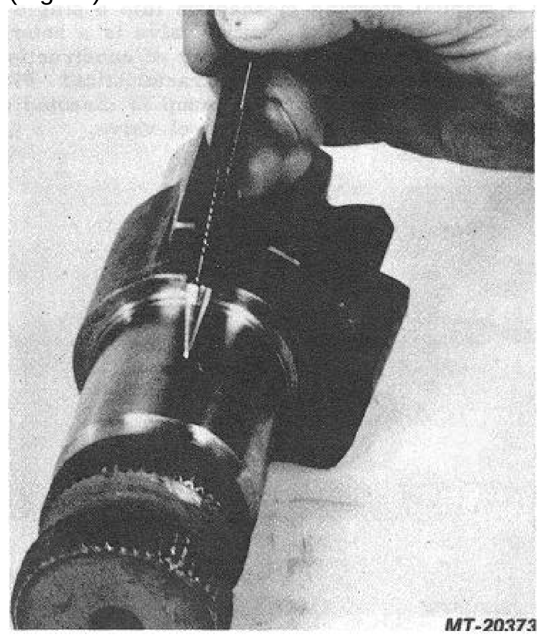


Fig. 7

9. Remove retaining ring (52), two-piece sea] (54), (plastic) back-up washer (55) and (steel) back-up washer (56) from side cover (58).

10. Remove bearing rolls from side cover (58), inspect for wear marks; replace bearing if required. Bearing and bearing rolls cannot be replaced without replacing side cover (Fig. 8).

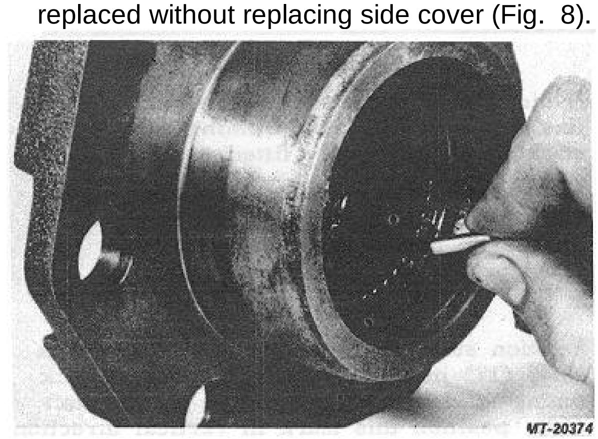


Fig. 8

11. Remove seal (27) from trunnion cover (26) with a screwdriver and remove four screws (28) from trunnion cover and remove trunnion cover (Fig. 9).

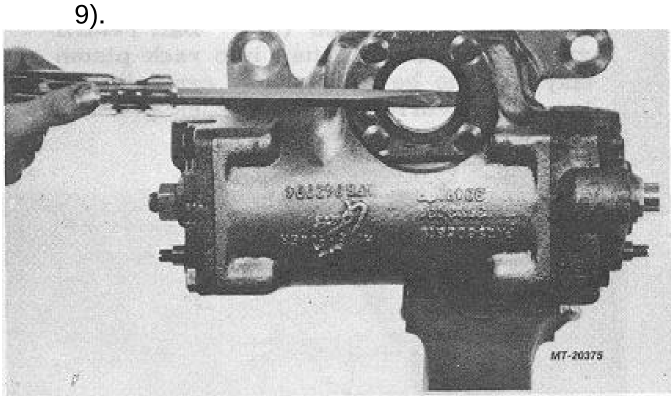


Fig. 9

12. Remove seal (25), two-piece seal (23) and back-up washer (24) from trunnion cover (26).

13. Loosen adjusting screw sealing nut (38) and adjusting screw (39) approximately two turns with a screwdriver and socket.

14. Remove four bolts (41) and remove end cover (37)(Fig. 10). Loosen nut (3) and adjusting screw (40) approximately two turns.

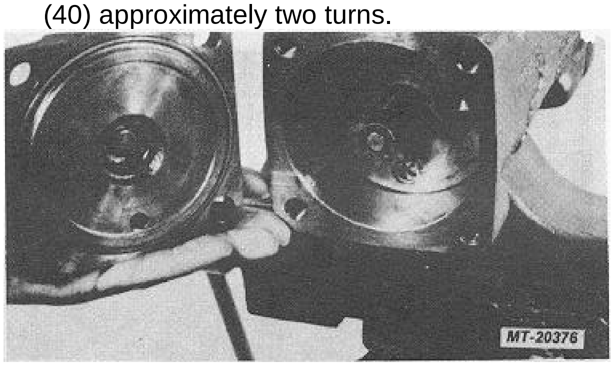


Fig. 10

15. Remove "O" ring (10) from end cover (37).

16. Remove relief valve (9A) from valve housing (9). Remove "O" rings (9B) and (9D) and seal ring (9C) from relief valve.

17. Remove four bolts (1) from valve housing (9) and remove valve housing.

IMPORTANT

Proper valve function depends on valve sleeve (15) and wormshaft (17) being reassembled in their original assembled position. Timing marks have been added to these parts so they can be reassembled in their original position (Fig. 11).

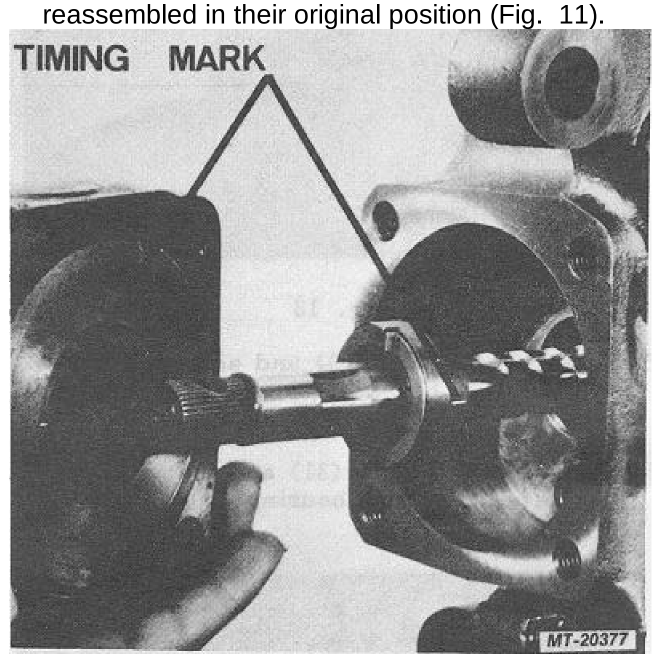


Fig. 11

18. Do not remove drive ring (16) from worm shaft (17) or attempt to unbend tangs which hold drive ring in place on worm shaft.

19. Remove valve sleeve (15) from valve housing (9).

20. Remove thrust washers (11) and thrust bearing (12) from valve housing (9).

21. Remove "O" ring (10) from valve housing (9).

22. Remove seal (4), retaining ring (5), back-up washer (6), slipper (7) and "O" ring (8) from valve housing (9).

23. Inspect thrust bearing (12) and thrust washers (11) for wear marks or brinelling, replace if damaged (Fig. 12).

24. Remove seal rings (13) and "O" rings (14) from valve sleeve (15).

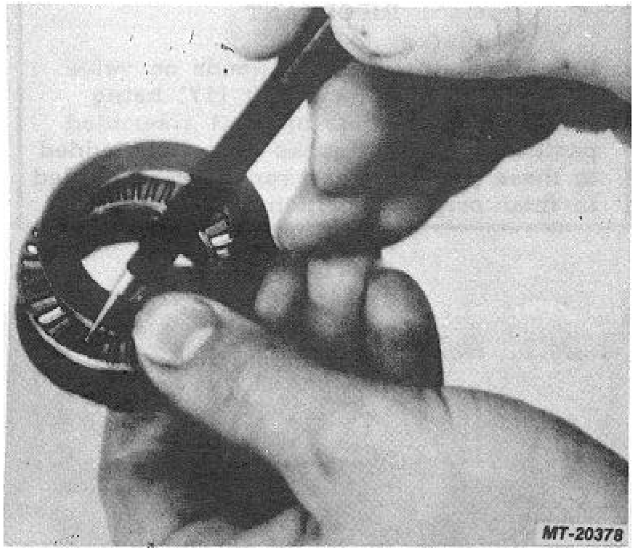


Fig. 12

25. Loosen sealing nut (3) and adjusting screw (2) in valve housing (9) approximately two turns.

26. Remove rack piston (31) and worm shaft (17) assembly from housing (20) (Fig. 13).

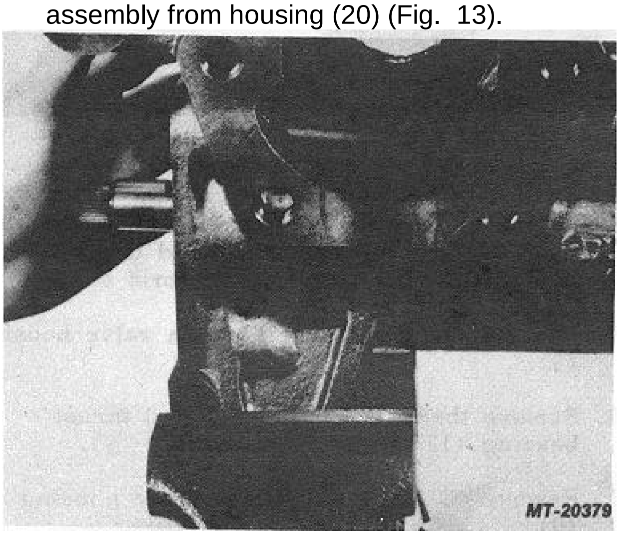


Fig. 13

27. Lay rack piston (31) and worm shaft (17) assembly on a clean rag to keep from rolling and to catch balls (42) as they come out. Bend locking tabs down on lockwashers (45), if applicable, some models of steering gears will not have lockwashers.

28. Remove two screws (46) or (49), if applicable.

29. Remove clip (44) or cap (48), if applicable.

30. Remove seal (47) from cap (48), if applicable.

31. Remove ball return guides (43) and balls (42) from rack piston (31). Ball return guides are closely fitted into rack piston and may have to be removed by carefully inserting a screwdriver between rack piston and ball return guides' (Fig. 14).

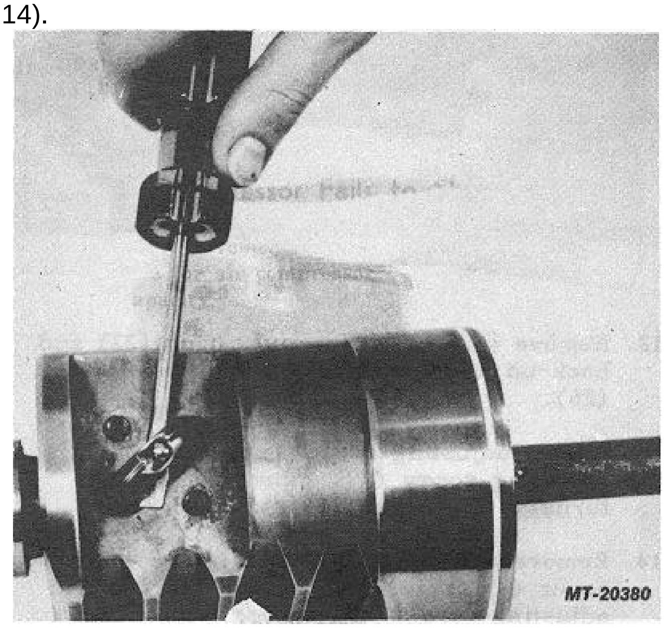


Fig. . 14

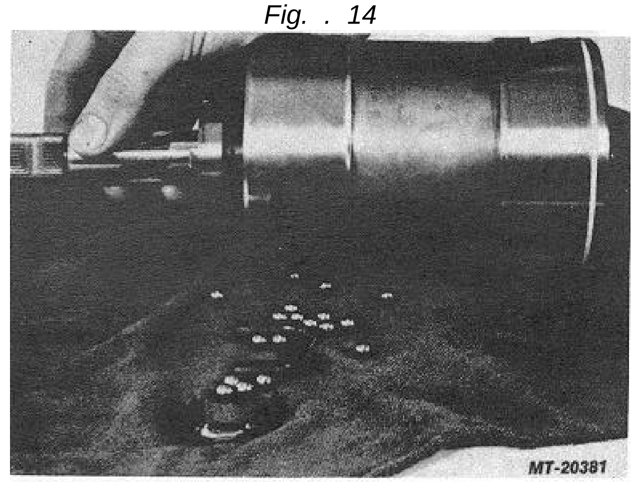


Fig. 15

32. To remove balls, turn rack piston over so balls can roll out as worm shaft is rotated in each direction by small amounts. Assembly contains a set of twenty-seven matched balls,

special care must be exercised to not lose them. A complete new matched set of balls will be required if any balls are lost (Fig. 15),.

33. Remove worm shaft (17) from rack piston (31).

34. Clamp rack piston (31) in a vise to remove retaining rings (32), poppet seats (33), poppets (34), rods (35) and spring (36). Do not remove these parts unless there is evidence of damage (Fig. 16).

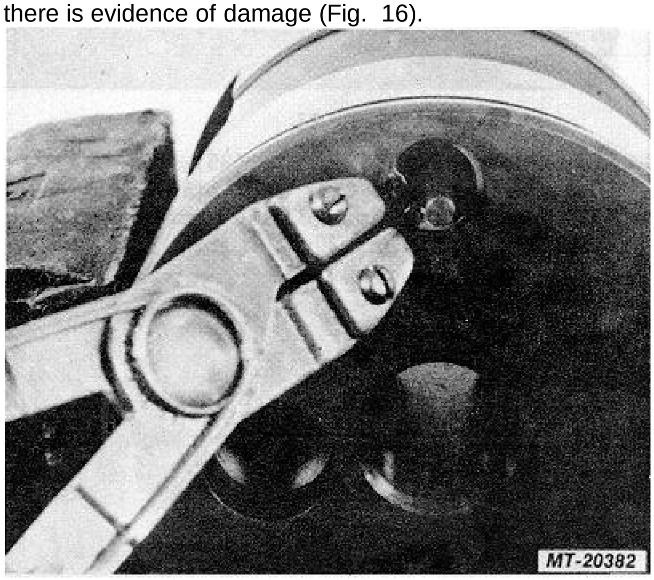


Fig. 16

35. Inspect rack piston (31) teeth and worm groove for excessive wear marks (Figs. 17 and 18).

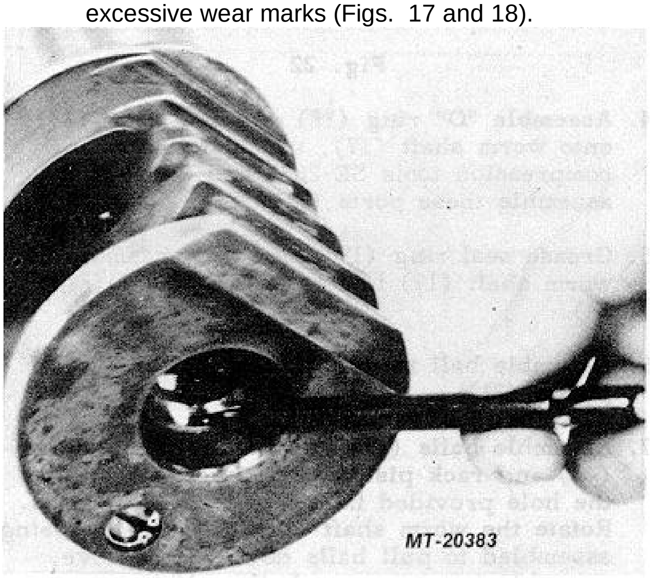


Fig. 17

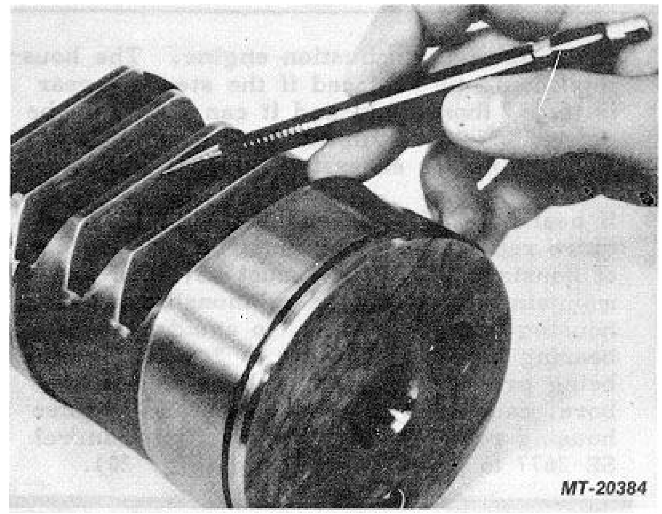


Fig. 18

36. Remove seal ring (29) and "O" ring (30) from rack piston (31). 37. Inspect worm shaft (17) helical groove for brinelling (Fig. 19). If this condition is visible the rack piston (31), valve sleeve (15) and worm shaft must be replaced. Remove seal ring (19) and "O" ring (18) from worm shaft.

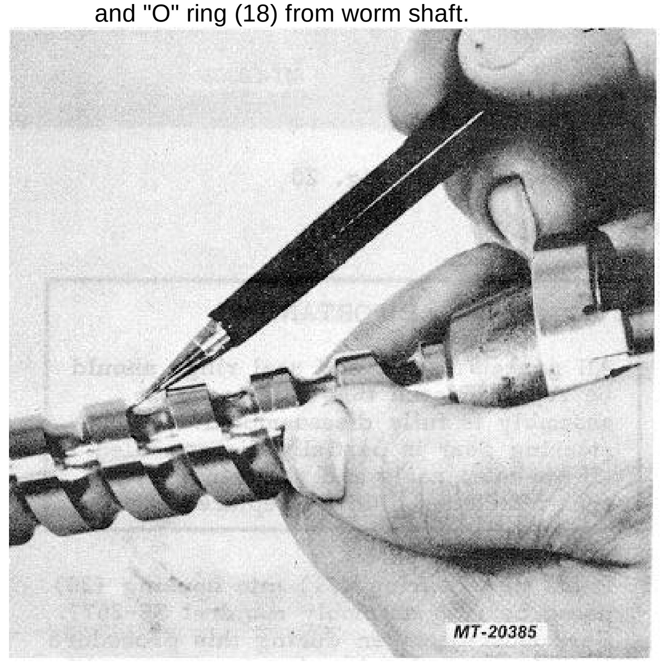


Fig. 19

38. Inspect housing (20) for abnormal wear, scoring or damage. The housing should not be replaced simply because the cylinder bore may exhibit considerable scoring, this scoring should not be rated in any manner relative to the type scoring which is critical

to an internal combustion engine. The housing should be replaced if the steering gear is tested thoroughly and it can definitely be determined that cylinder bore scoring is responsible for excessive internal leakage.

39. If bearing (21) and retaining ring (22) require replacement they must be pressed out of housing (20). Care must be taken to maintain a good square relationship between housing and press base, to avoid damaging bearing bore. If bearing is "cocked" while being pressed out, it may burnish housing bore, causing it to be oversize and require housing replacement. Use bearing mandrel SE-2677 to press bearing out (Fig. 20).

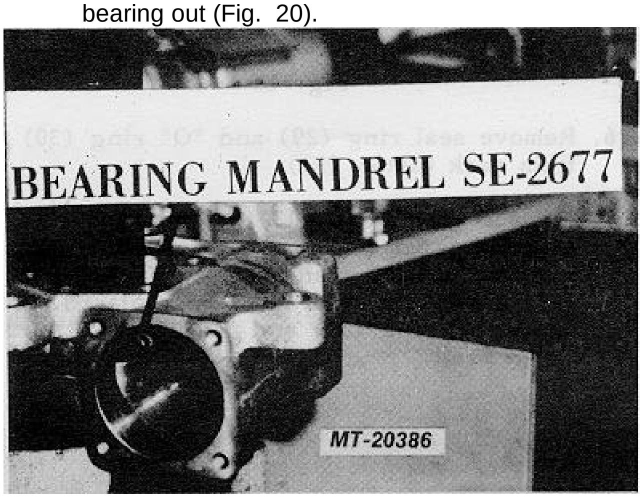


Fig. 20

REASSEMBLY

IMPORTANT

All gaskets, seals and seal rings should be replaced each time steering gear assembly is fully disassembled. If steering gear is partially disassembled all gaskets, seals and seal rings in area effected should be replaced.

1. Press new bearing (21) into housing (20) using bearing assembly mandrel SE-2677. Care must be taken during this procedure to make sure that housing is square with press base and that bearing is not in a "cocked" position. Apply a generous amount of clean wheel bearing grease to bearing race to retain bearing rolls; assemble forty four bearing rolls, grease must retain rolls (Fig. 21).
2. Assemble "O" ring (30) and seal ring (29) onto rack piston (31).

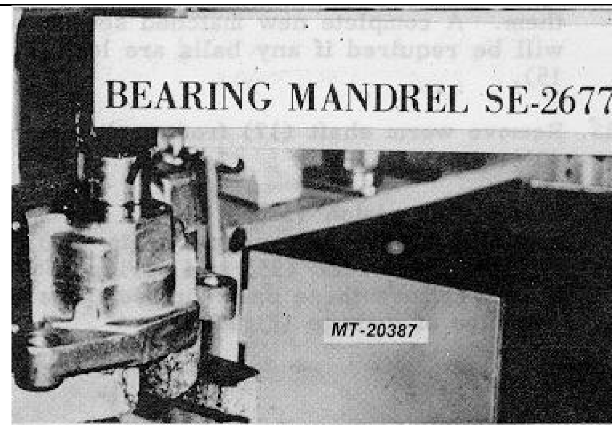


Fig. 21

3. Assemble spring (36), rod (35), poppets (34), poppet seals (33) and retaining ring (32) into rack piston (31). Torque poppet seats to 27-34 N•m (20-25 ft.lbs.)(Fig. 22).

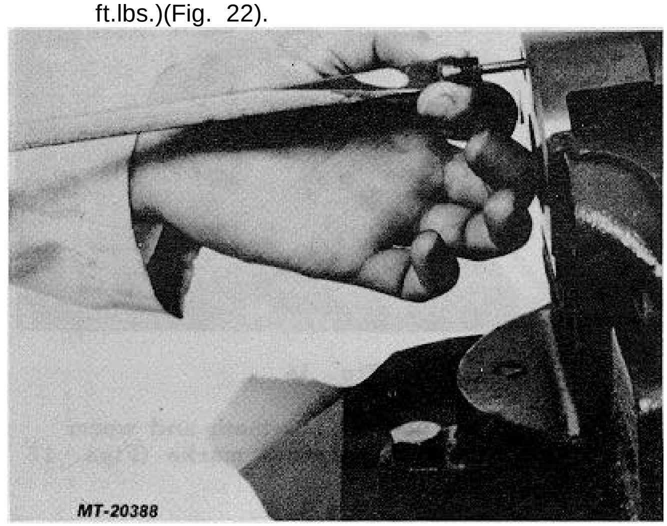


Fig. 22

4. Assemble "O" ring (18) and seal ring (19) onto worm shaft (17), use installation and compression tools SE-2673 and SE-2674 to assemble these ports (Fig. 23).
5. Grease seal ring (19) area and assemble worm shaft (17) into rack piston (31)(Fig. 24).
6. Assemble ball return guides (43) into rack piston (31).
7. Assemble balls (42) into ball return guides (43) and rack piston (31); drop balls thru the hole provided in the ball return guides. Rotate the worm shaft (17) as balls are being assembled to pull balls down into groove, assemble twenty-seven balls. Make sure ball return guides stay down in place in rack piston while assembling balls (Fig. 25).

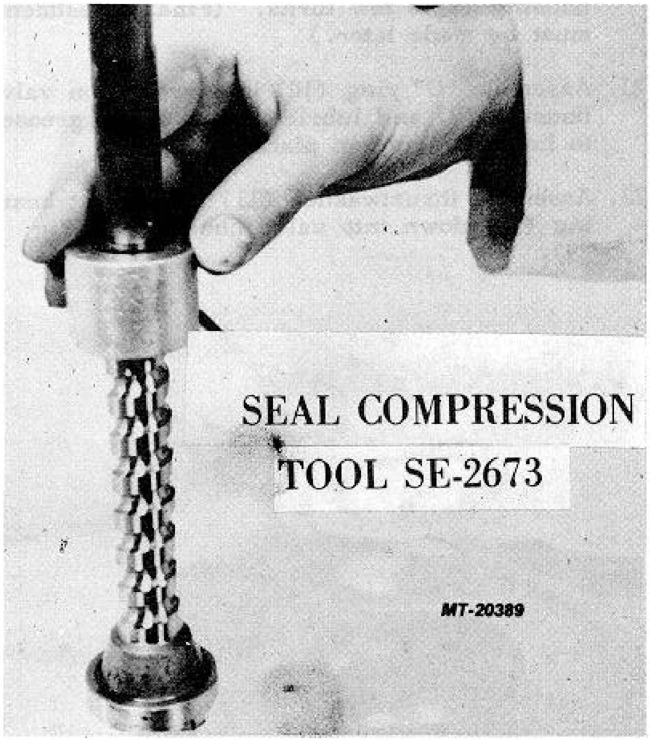


Fig. 23

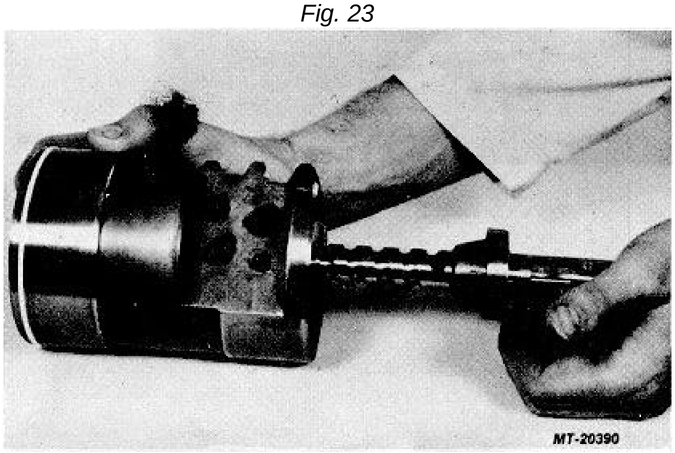


Fig. 24

8. Assemble clip (44) or seal (47) and cap (48) onto rack piston (31).

9. Assemble two lockwashers (45), if applicable.

10. Assemble two screws (46) or (49). Torque screws (46) to 15-20 N•m (11-15 ft.lbs.), torque screws (49) to 20-26 N•m (15-19 ft. lbs.). Screws (49) have a locking feature and lockwashers (45) are not required.

11. Bend tabs on two lockwashers (45) up against flat on screws (46) (Fig. 26).

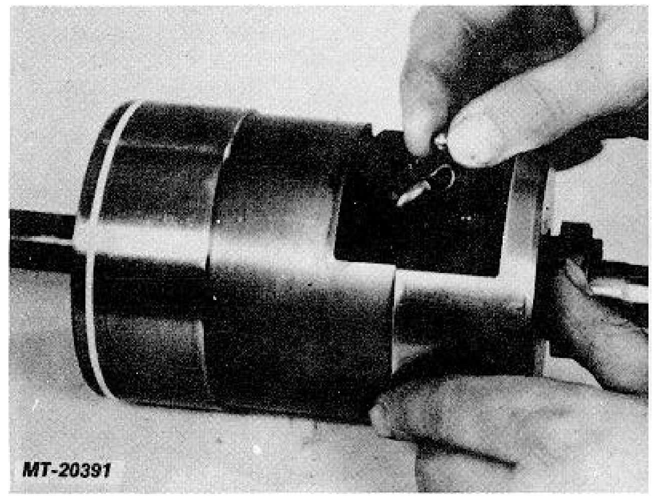


Fig. 25

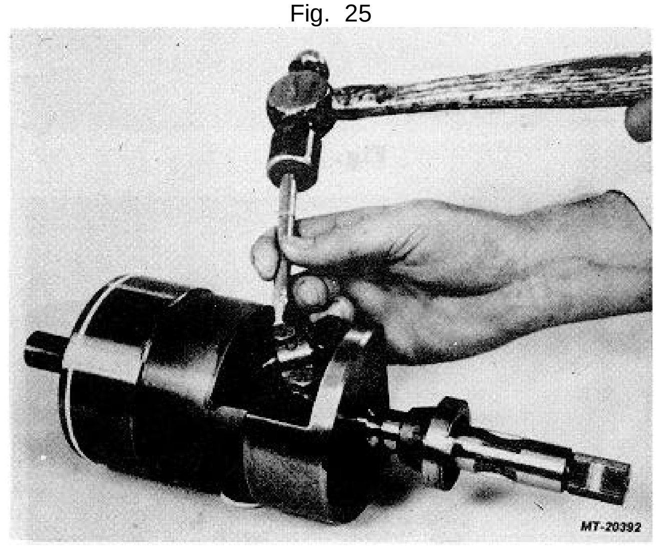


Fig. 26

12. Apply a generous amount of clean grease to seal ring (29) area of rack piston (31) and assemble rack piston and worm shaft assembly into housing (20)(Fig. 27).

13. Assemble sealing nut (38) onto adjusting screw (39) with sealing side to be against end cover (37)(Fig. 28).
14. Assemble adjusting screw (39) into end cover (37) a few turns. (Final adjustment must be made later.)
15. Assemble sealing nut (3) onto adjusting screw (40) with sealing side to be against end cover (37).
16. Assemble adjusting screw (40) into end cover (37) a few turns. (Final adjustment must be made later.)

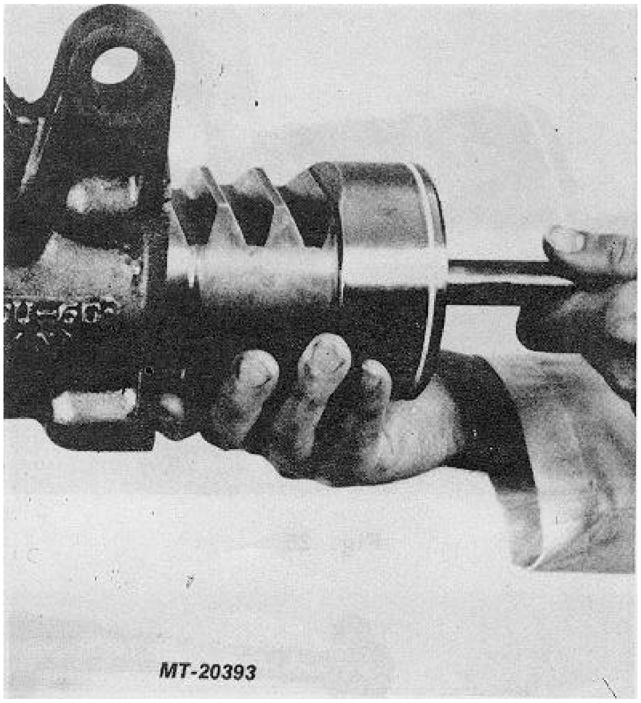


Fig. 27

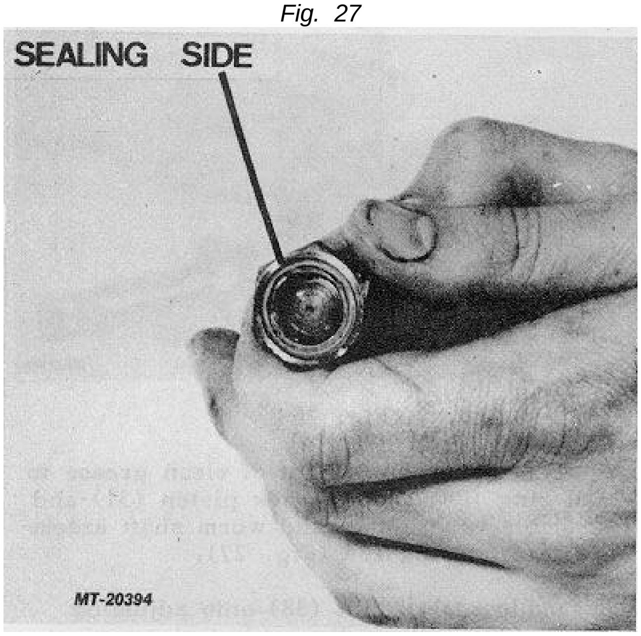


Fig. 28

17. Assemble "O" ring (10) into groove on end cover (37) and lubricate with clean grease to hold "O" ring in place.
18. Assemble end cover (37) onto housing (20) with four bolts (41). Torque bolts to 142-156 N•m (105-115 ft.lbs.).

19. Assemble sealing nut (3) onto adjusting screw (2) with sealing side to be against valve housing (9).
20. Assemble adjusting screw (2) into valve housing (9) a few turns. (Final adjustment must be made later.)
21. Assemble "O" ring (10) into groove on valve housing (9) and lubricate with clean grease to hold "O" ring in place.
22. Assemble thrustwasher (11) and thrust bearing (12) down into valve housing (9)(Fig. 29).

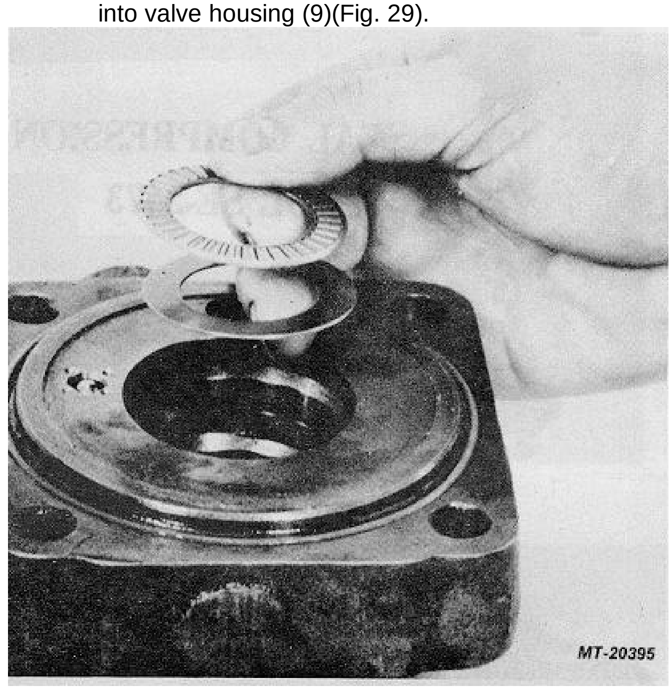


Fig. 29

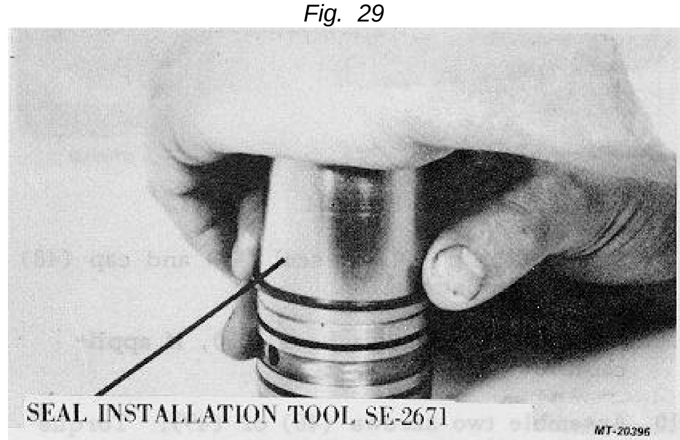


Fig. 30

23. Assemble "O" rings (14) and seal rings (13) onto valve sleeve (15), use installation and compression tools SE-2671 and SE-2672 (Figs. 30 and 31).

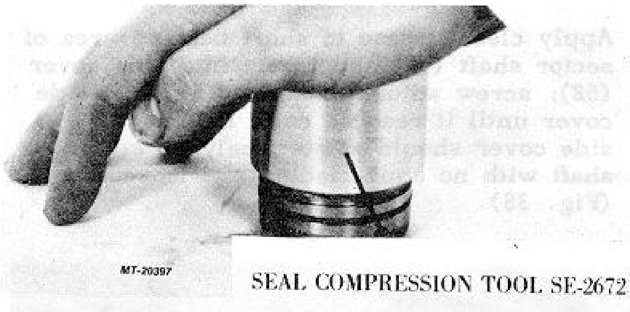


Fig. 31

24. Apply, clean grease to seal ring (13) areas of valve sleeve (15).
25. Apply clean grease to end of valve sleeve (15) and assemble thrust washer (11) onto end of valve sleeve, grease must hold thrust washer in place (Fig. 32).

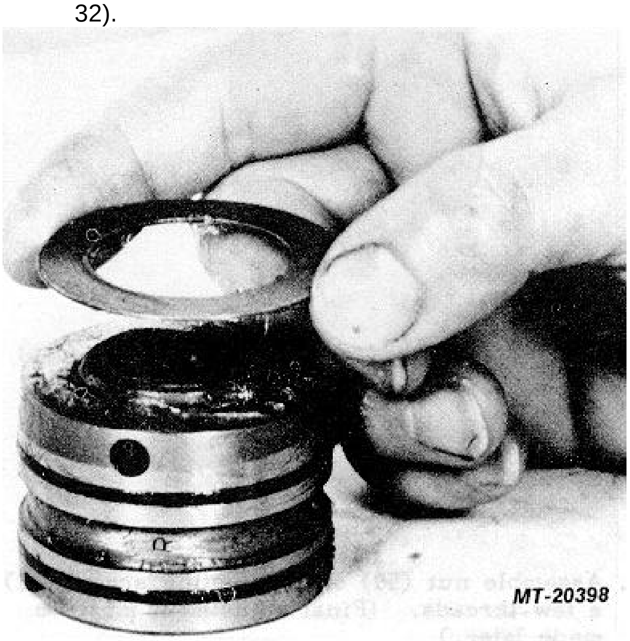


Fig. 32

26. Assemble valve sleeve (15) with thrust washer attached down into valve housing (9). When valve sleeve is down into place in valve housing, it should measure approximately 10.2 mm (.4 in.) from face of valve housing to face of valve sleeve (Fig. 33).
27. Align timing marks on valve sleeve (15) and worm shaft (17) and assemble valve housing (9) onto worm shaft. Make sure drive ring (16) teeth engage notches in valve sleeve (15). Use a box end wrench to rotate worm shaft to pull valve housing (9) down against housing (20)(Fig. 34).

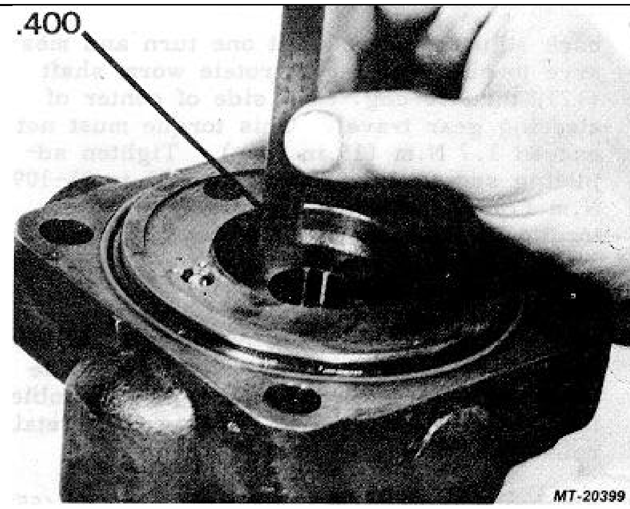


Fig. 33

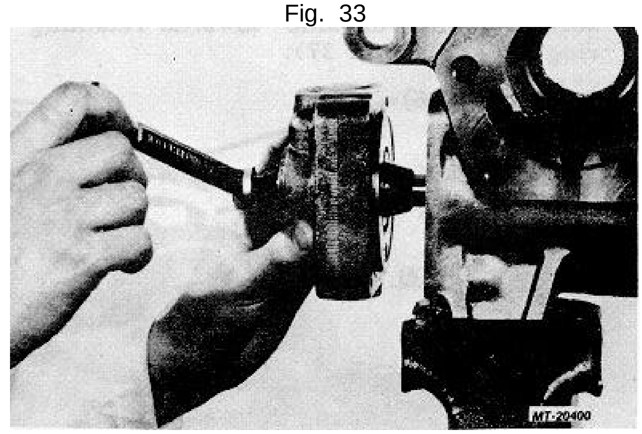


Fig. 34

28. Assemble four bolts (1) into housing (20) and torque to 142-156 N•m (105-115 ft.lbs.).

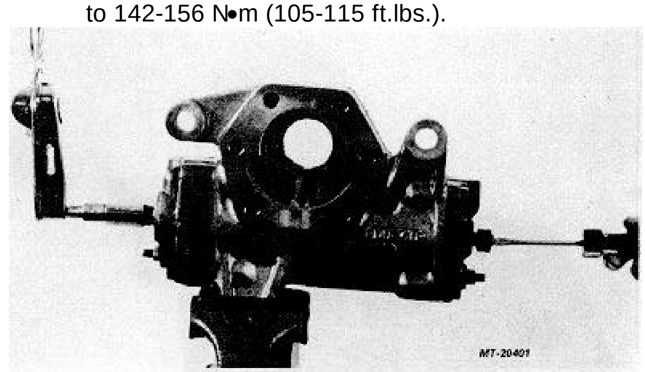


Fig. 35

29. With rack piston (31) near center of steering gear travel, screw adjusting screw (39) into solid height. 14 N•m (10 ft.lbs.) maximum

back adjusting screw out one turn and measure torque required to rotate worm shaft (17), thru 90 deg. each side of center of steering gear travel. This torque must not exceed 1.7 N•m (15 in.lbs.). Tighten adjusting screw and torque nut (38) to 95-109 N•m (70-80 ft.lbs.), after tightening nut torque to rotate worm shaft must rise .45-.79 N•m (4-7 in.lbs.) above torque checked previously (Fig. 35).

30. Apply a generous amount of clean wheel bearing grease to bearing race inside side cover (58) to retain bearing rolls; assemble forty-four bearing rolls. Grease must retain rolls.

31. Assemble washer (56), back-up washer (55), two-piece seal (54) and retaining ring (53) into side cover (58). Assemble two-piece seal (54) with "oil side" towards retaining ring (Figs. 36 and 37).

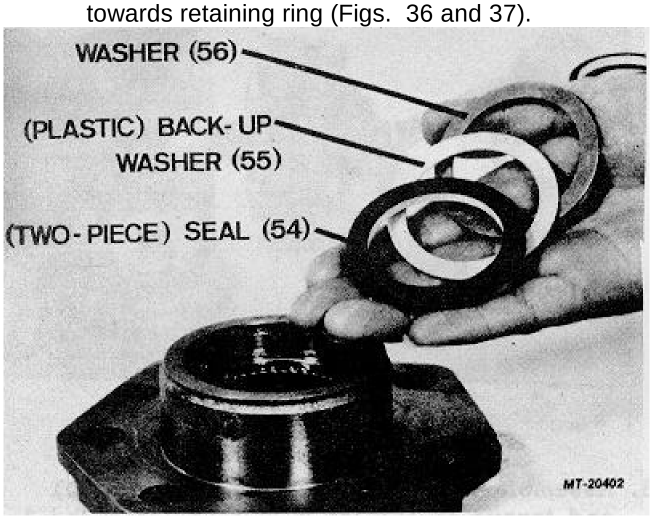


Fig. 37

38. Apply clean grease to short bearing area of sector shaft (50) and insert into side cover (58); screw adjusting screw (51) into side cover until it reaches solid height. The side cover should rotate freely on sector shaft with no appreciable axial movement (Fig. 38).

Fig. 38

33. Assemble nut (59) onto adjusting screw (51) a few threads. (Final adjustment must be made later.)

34. Assemble vent plug (60) in hole provided in side cover (58), press vent plug in flush with side cover.

35. Apply clean grease to side cover gasket (57) and assemble onto side cover (58). Grease must hold side cover gasket in place.

36. Rotate worm shaft (17) to position rack piston (31) in center of steering gear travel. Align center tooth on sector shaft (50) with third notch from seal ring (29) end on rack piston and assemble sector shaft with side cover attached into housing (20); care must be taken to not pinch side cover gasket and to be certain that sector shaft goes thru housing bearing (21) without knocking out bearing rolls (Figs. 39 and 40).

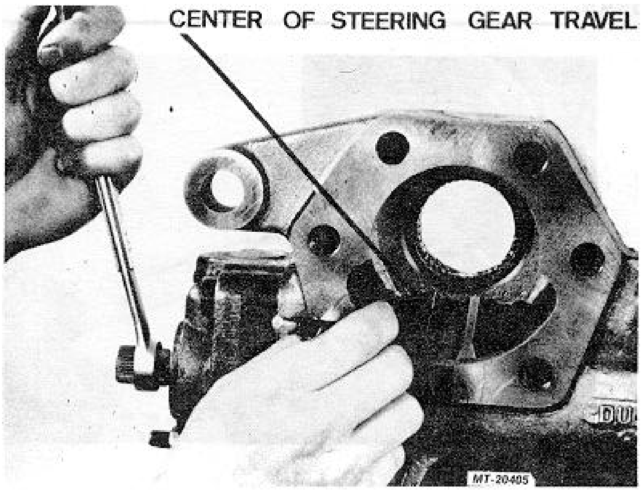


Fig. 39

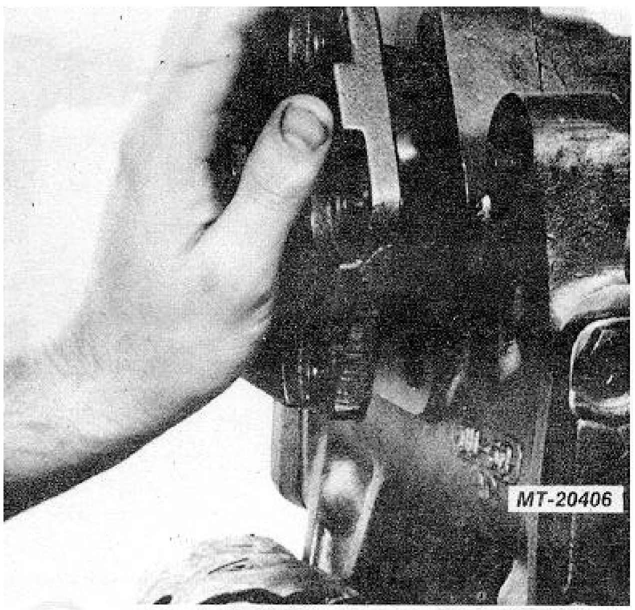


Fig. 40

37. Assemble six special bolts (61) and torque to 298-325 N•m (220-240 ft.lbs.).

38. Adjust side cover adjusting screw (51) to provide a 2.6-3.2 N•m (23-28 in.lbs.) torque at worm shaft (17) as steering gear is moved 90 deg. each side of center. Back out the adjusting screw one turn and note torque required to move thru 90 deg. each side of center. Move adjusting screw in to provide a rise in torque of .23-.45 N•m (2-4 in.lbs.) at a point within 45 deg. each side of center. After tightening nut (59) to 54-61 N•m (40-45 ft.lbs.) torque to rotate worm shaft must not exceed 2.9 N•m (26 in.lbs.) at any point in steering gear travel (Fig. 41).

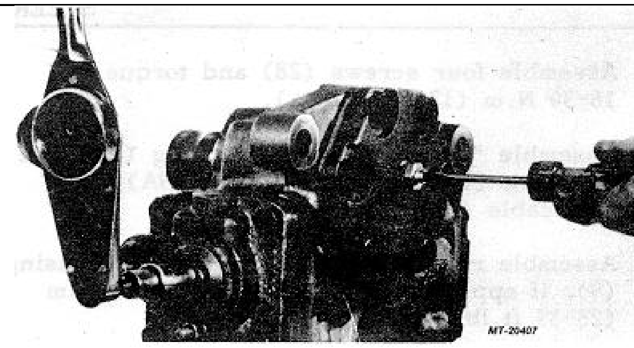


Fig. 41

39. Assemble back-up washer (24), two-piece seal (23) and seal (25) into trunnion cover (26). Assemble two-piece seal (23) with "oil side" towards housing (20).

40. Cover serrations on sector shaft (50) with tape and assemble trunnion cover (26) (Fig. 42).

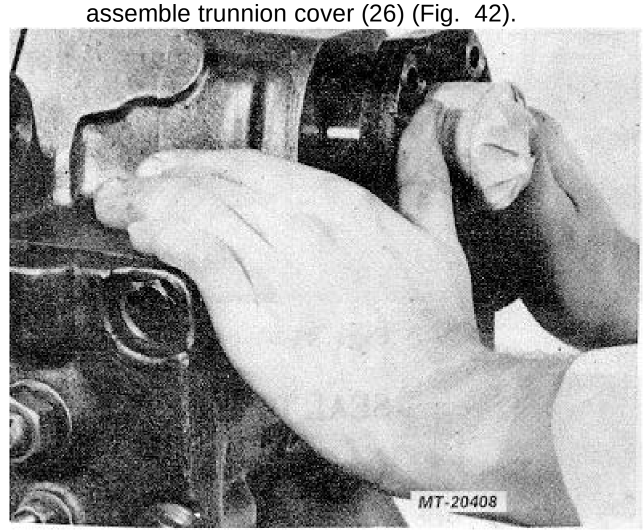


Fig. 42

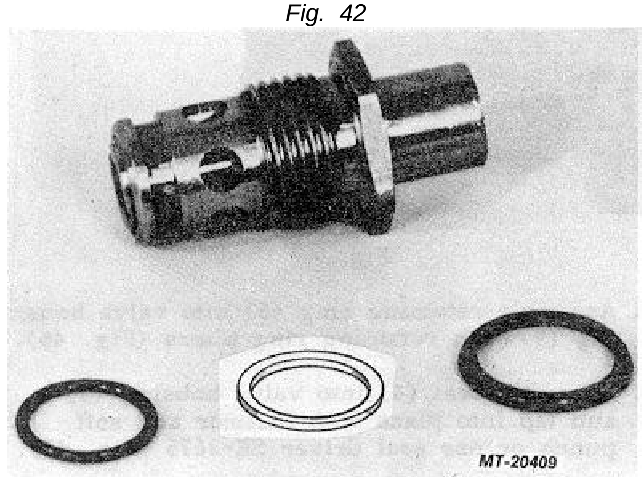


Fig. 43

41. Assemble four screws (28) and torque to 16-30 N•m (12-22 ft.lbs.).

42. Assemble "O". ring (9B), seal ring (9C) and "O" ring (9D) onto relief valve (9A), if applicable (Fig. 43).

43. Assemble relief valve (9A) into valve housing (9), if applicable and torque to 34-48 N•m (25-35 ft.lbs.).

44. Assemble "O" ring (8) onto slipper (7) and assemble both parts (with flat side of slipper out) into valve housing (9). Assemble (steel) back-up washer (6) into valve housing (9), use seal driver to push parts into valve housing SE-2676 (Figs. 44 and 45).

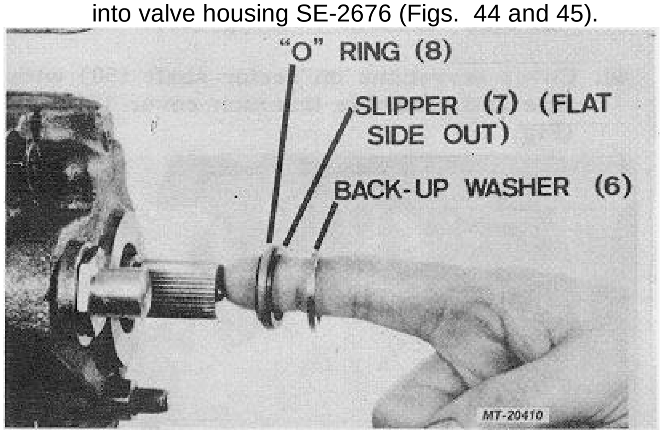


Fig. 44

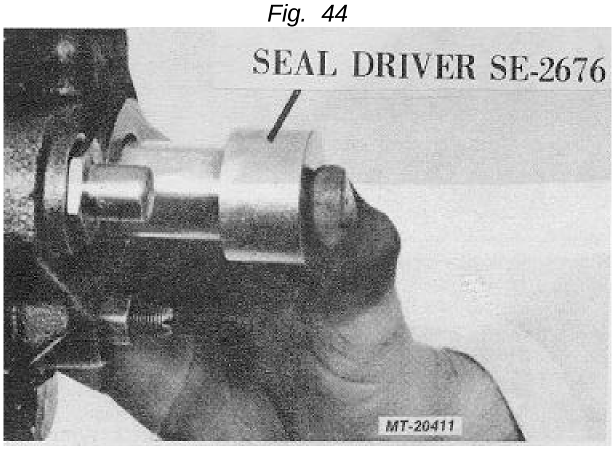


Fig. 45

45. Assemble retaining ring (5) into valve housing (9) with retaining ring pliers (Fig. 46).

46. Assemble seal (4) into valve housing (9) and tap into place with hammer and soft punch or use seal driver SE-2675 (Fig. 47).

47. Assemble seal (27) into trunnion cover (26) and tap into place with hammer and soft punch (Fig. 48).

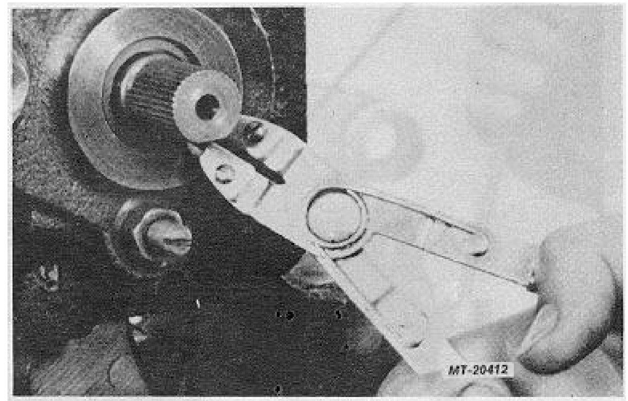


Fig. 46

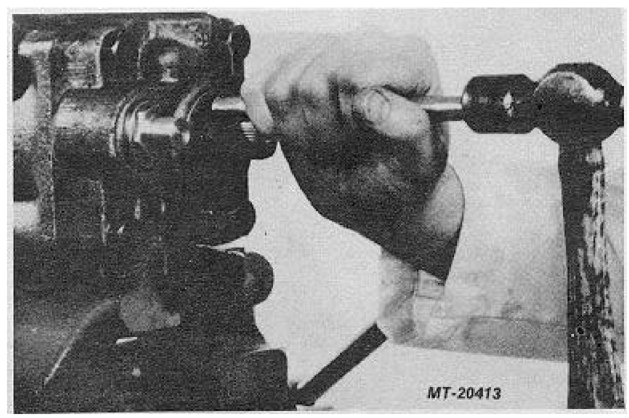


Fig. 47

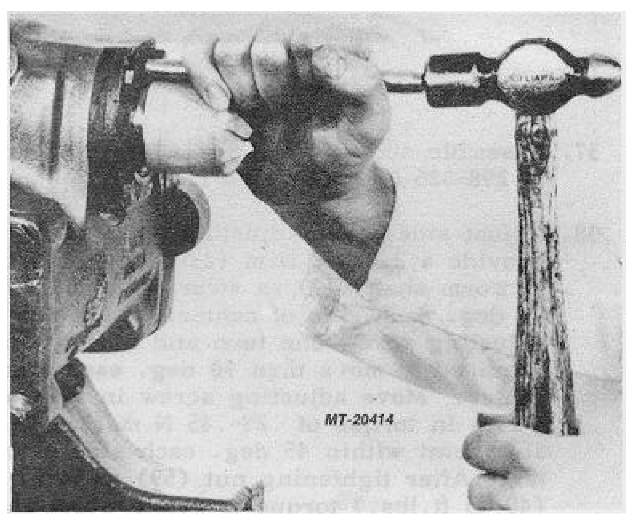


Fig. 48

48. Assemble bleed screw (20A) into housing (31), if applicable and torque to 3.0-3.7 N•m (27-33 in.lbs.).

ADJUSTMENT OF POPPET ADJUSTING SCREWS (WITH STEERING GEAR INSTALLED ON VEHICLE)

1. Install a suitable pressure gage in the line between the pump and steering valve pressure port.

2. Actuate steering to provide full travel to wheel stops and note pressure on gage. Adjust adjusting screw (40) in a clockwise direction to provide a pressure at least 2757 kPa (400 psi) below pressure noted above. During this adjustment the oil temperature should be approximately 54.4 deg. C (130 deg. F).

   Care must be exercised to not hold pressure for longer than 15 seconds while this adjustment is being made, or damage to pump, from head, may result.

3. Repeat above procedure for other direction of steering. During the above procedure, observe for any tendency of the gear to self steer or motorize. If self steering does occur, check steering column, slip joint(s) and universal joint(s) for binding or excessive friction. If no problem is found in these areas, the gear should be checked as follows:

   A. Is upper thrust bearing package (items 11 (2 pcs) and 12) properly installed? If the gear has been assembled with these components out of position they probably will be damaged and should be replaced.
   B. Is valve sleeve (15) "sticky" on worm shaft (17)? These two parts are fitted very closely and a nick or burr on either part can cause the valve assembly to be sticky. Minor damage can be corrected by polishing with crocus cloth. If major damage is evident, the valve sleeve (15), drive ring (16) and worm shaft (17) should be replaced.
   C. If (A) and (B) above do not stop the tendency to self steer, the worm shaft (17) and valve assembly should be replaced.

ADJUSTMENTS & REPAIRS WITH STEERING GEAR ON VEHICLE

Removal of the steering gear from most vehicles is difficult and time consuming. It is suggested that after becoming proficient in servicing the gear on a bench as described in this manual, consideration be given to performing adjustment and minor repairs without removing the gear from the chassis. On some vehicles access to the gear may be so restricted that it must be removed for service.

1. Adjustments: Remove input coupling and pitman arm or drag link. Leave plumbing connected in normal manner. Engine should be running while adjustments are being made.
   A. Adjust sector shaft.
   B. Worm Preload Adjustment. Loosen jam nut (38), tighten adjusting screw (39) to 2.8-3.4 N•m (25-30 in.lbs.) and retighten the jam nut to 95-109 N•m (70-80 ft.lbs.) while holding the adjusting screw so that it does not rotate when the jam nut is tightened. Purpose of this adjustment is to put a light preload on the worm thrust bearing package items (11 and 12). After the adjustment has been made, there should be no perceptible in and out movement of the input shaft when it is oscilated from right turn to left turn and back. The input shaft should rotate smoothly and without binding thru full travel of the gear with a maximum torque of 3.7 N•m (33 in.lbs.).
2. Repairs
   A. On many installations the trunnion cover (26) can be removed from the gear allowing service of the output shaft seal package (23 and 24) and the trunnion cover seal (25). Remove the pitman arm and clean gear in area of trunnion cover so dirt will not get into gear while trunnion cover is removed. Remove dirt seal (27), clean dirt and paint from shaft. Remove trunnion cover and shaft seal package. Clean portion of shaft now exposed using fine emery paper if necessary.
      Cover shaft serrations with cellophane tape and reassemble using new shaft seal package (23 and 24), seal (25) and dirt seal (27). Add fluid to reservoir and bleed system if necessary.
   B. If the input shaft area is accessible, the input shaft seal assembly, items (7) and (8) can be replaced with a minimum of effort by the following procedure. Remove the input coupling and clean the area of the gear around the input shaft. Remove supply and return hoses from gear and plug hoses. Remove fittings

from gear and plug lower most port to minimize loss of fluid. Install special fitting (or combination of fittings) in other port to allow connection to shop air. Remove dirt seal (4) and retaining ring (5). Clean dirt and paint from input shaft using fine emergy paper if necessary. Place a shop rag over input shaft area of gear and connect shop air to special fitting. Air pressure should cause seal assembly items (7) and (8), back-up washer (6) and some fluid to come out of gear. Be sure shop rag is in place and be prepared to disconnect air as soon as the seal assembly is out of the cavity.

Apply clean grease to O.D. and I.D. of seal and to input shaft. Install seal assembly (items 7 and 8) and back-up washer with flat side of seal assembly out. Press against back-up washer with soft (brass) probe until back-up washer is just inside retaining ring groove. Install retaining ring taking care that it is properly seated in groove. Pack cavity above retaining ring with grease and install dirt seal. Add fluid to reservoir and bleed system if necessary.

C. Other parts of the gear which may be serviceable on the vehicle are the end cover (37) and the valve housing (9) areas. Familiarity with the gear should be gained by bench disassembly and reassembly before attempting to service these areas. The portion of the gear to be disassembled should always be cleaned so that dirt is not introduced into the gear. Also, whenever the end cover or valve housing is removed for service, care must be taken to position the worm thrust bearing package (items 11, 12 and 11) properly upon reassembly. Anytime the end cover is removed, the worm adjusting screw should be backed out to avoid jamming of components when end cover is reassembled.

Always check fluid level in the reservoir after servicing the gear. If a significant amount of fluid is added, the system should be bled.

FILLING AND AIR BLEEDING THE SYSTEM

1. Fill reservoir nearly full. Be ready to add oil when engine is started. Do not let oil drop below outlet to power pump, to insure that power pump will not suck air into system.

2. Start engine, and let idle. Immediately add oil to reservoir as needed to keep reservoir full.

3. Steer vehicle from full right turn to full left turn several times. Poppets (34) must be adjusted so they relieve pressure at full right and full left turns in order to remove air from system. This procedure should remove all air from system unless steering gear is invert mounted.

4. To remove air from inverted mounted steering gears, see steps 1, 2 and 3, then determine which direction of steering wheel rotation is required to pressurize bleed screw (20A). Turn steering wheel slowly in this direction and loosen bleed screw a few turns. When all air is removed from system, tighten bleed screw 3.4 + .33 N•m (30 + 3 in.lbs.).

   If bleed screw (20A) is not tight when steering gear is rotated in opposite direction, air will be sucked into system.

LUBRICANT

For type of lubricant refer to LUBRICATION CTS-2412.

NORMAL NOISE

1. A "hissing" noise may be heard from the control valve when it is actuated during a steering maneuver.
2. Fluid being bypassed thru the poppets at full turn may cause noise.
3. Noise may be heard from the system relief valve when it is required to actuate.
4. Pump "growl" may be heard from some types of power steering pumps.

ABNORMAL NOISE

1. If the power steering pump is belt driven, a "squealing" noise during steering may indicate that the belt(s) should be tightened or replaced.
2. A "clicking" noise heard when initiating a steering maneuver or when changing directions of turn may indicate that some component is loose and is shifting under load.
3. A change in the normal noise from the power steering pump may indicate that an excessive amount of air has been trapped in the fluid or that the fluid level is low. Also check for dirt, sludge, or other foreign material-trapped in filter, screen, or other passages in the hydraulic system.
4. Excessive noise from the power steering pump may indicate that it is worn or defective. See "Pump Pressure Test" and Pump Flow Test.

ROAD WANDER

1. Components in steering linkage such as ball sockets on drag link or axle arm loose or worn.
2. Tire pressure incorrect or unequal left to right.
3. Wheel bearings improperly adjusted or worn.
4. Steering gear mounting bolts loose on frame.
5. Front end alignment out of specification.
6. Steering gear center adjustment improperly adjusted. (See adjustment procedure)
7. Dry fifth wheel or poor finish on fifth wheel or trailer plate.
8. Steering geometry incorrect (pitman arm and/or axle arm ball position).
9. Worm preload improperly adjusted. (See adjustment procedure).

NO RECOVERY

1. Front end alignment incorrect.
2. Ball sockets or other linkage connections too tight or not lubricated.
3. Pump Flow insufficient.
4. Tire pressure low.
5. Fifth wheel dry.
6. Control valve spool or sleeve sticking.
7. Tight front axle spindles.
8. Steering column binding.
9. Sector shaft adjustment too tight. (See adjustment procedure).
10. Worm preload too tight.

SHIMMY

1. Front end alignment incorrect.
2. Air in hydraulic system.
3. Wheels out of balance.
4. Components in steering linkage such as ball sockets on drag link or axle arm loose or worn.
5. Badly worn or unevenly worn tires.
6. Wheel bearings improperly adjusted or worn.

EXTERNAL OIL LEAKAGE

1. No external leakage is acceptable at steering gear.
2. Rubber relief plug (60) leaking at side cover indicates failure of sector shaft oiloseal (54) in side cover.
3. Finding location of leak may be difficult since oil may "run" away from leak and drip from a low point on the gear or chassis.

DARTING OR TENDENCY TO OVERCORRECT 1

1. Front end components binding.
2. Sector shaft adjustment too tight (see adjustment procedure).
3. Control valve spool or sleeve sticking.
4. Steering geometry incorrect (pitman arm and/or axle arm ball position).
5. Steering column binding.

HIGH STEERING EFFORT

1. Vehicle overloaded.
2. Inadequate flow (See Pump Flow Test)
3. Inadequate pressure (See Pump Pressure Test).
4. Excessive internal leakage in steering gear (see Steering Gear Internal Leakage Test).
5. Low hydraulic fluid level.
6. Low tire pressure.
7. Restriction in supply line or supply line too small.
8. High back pressure caused by restriction in return line or clogged filter. .
9. Binding or lack of lubrication in linkage components or in steering column.
10. Poppet adjustment improper (if high effort occurs near end of travel in one or both directions of turn

LOST MOTION AT STEERING WHEEL

1. Loose ball socket connections or other linkage connections.
2. Loose steering gear adjustment Side cover adjustment and/or worm adjustment.
3. Steering wheel loose on shaft.
4. Pitman arm loose on output shaft.
5. Steering gear loose on frame.
6. Loose connections between steering column and steering gear.

EXCESSIVE HEAT

1. Restriction in pressure or supply line due to severe bend, kink, or clogging by dirt, sludge, or other impurities. Should be accompanied by high back pressure. 2. Undersize line, hose or fitting. 3. Vehicle overloaded causing pump relief valve to operate excessively during docking or other maneuvers. 4. Poppets not properly adjusted to relieve pressure at full turn in each direction. 5. Overheating can damage seals in both pump and steering gear.

6. Overheating may be evidenced by seals becoming hard, discoloration of internal parts of the gear and an offensive odor from the hydraulic fluid.

"TIPS" FOR MAINTENANCE OF STEERING GEAR SYSTEMS

1. Always check for wear in steering linkage and other system components first, before making adjustments to steering gear assembly.

2. Prevent internal bottoming of steering gear . . . Carefully check axle stops.

3. Make periodic checks of lube level for steering gear and components to prevent malfunction due to inadequate lubrication.

4. Make routine and/or periodic checks for proper front end alignment.

5. Maintain correctly inflated tires.

6. Always use a "puller," never use a torch or hammer to remove steering arms.

7. Always carefully examine all steering parts which have been subject to "impact" and replace any that are questionable.

8. Investigate immediately, and correct cause of any play, rattle, or shimmy in any part of the linkage or steering mechanism.

9. Remove cause of steering column misalignment, and if necessary elongate support bracket holes at dash.

10. Encourage all drivers to report any malfunction or accident that could have damaged the steering mechanism.

II. Do not attempt to weld any broken steering component. (Replace only with original equipment.)

12. Do not cold straighten, hot straighten or bend any steering system part.

13. Always use new seals and "O"-rings during repairs and overhauls.

14. Replacement of single bearing assemblies, or balls, if one or more make a "set" is not recommended.

15. Excessive heat will develop if any power steering gear is held in an extreme right or left turn longer than a few seconds. (Heat developed can damage seals and/or pump.)

16. Prevent dirt or foreign particles from entering hydraulic steering system's. (Always clean off around filler caps, before removing to check oil supply.)

17. Use care to prevent even minor hydraulic leaks to continue.

TORQUE CHART

SUBJECT	NUMBER (See Fig. 1)	NEWTON METERS	FT.LBS.
Hexagon Head Bolt	1	142-156	105-115
Sealing Nut	3	16-24	12-18
Relief Valve	9A	34-48	25-35
Bleed Screw	20A	37-45	27-33
Auxiliary Cylinder Fitting		34-48	25-35
Screw	28	16-30	12-22
Poppet Seat	33	27-34	20-25
Nut	38	95-109	70-80
Hexagon Head Bolt	41	142-156	105-115
Screw	46	15-20	11-15
Screw	49	20-26	15-19
Nut	59	54-61	40-45
Special Bolt	61	298-325	220-240
Bolt (Pitman Arm Clamp)	Lubricated or Plated	406-434	300-320

POWER STEERING PUMP
SAGINAW 125 SERIES (LIGHT DUTY) AND
235 SERIES (MEDIUM AND HEAVY DUTY) HYDRAULIC
VANE-TYPE PUMPS

CONTENTS

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CHAPTER 1
POWER STEERING PUMP INFORMATION
CONTENTS

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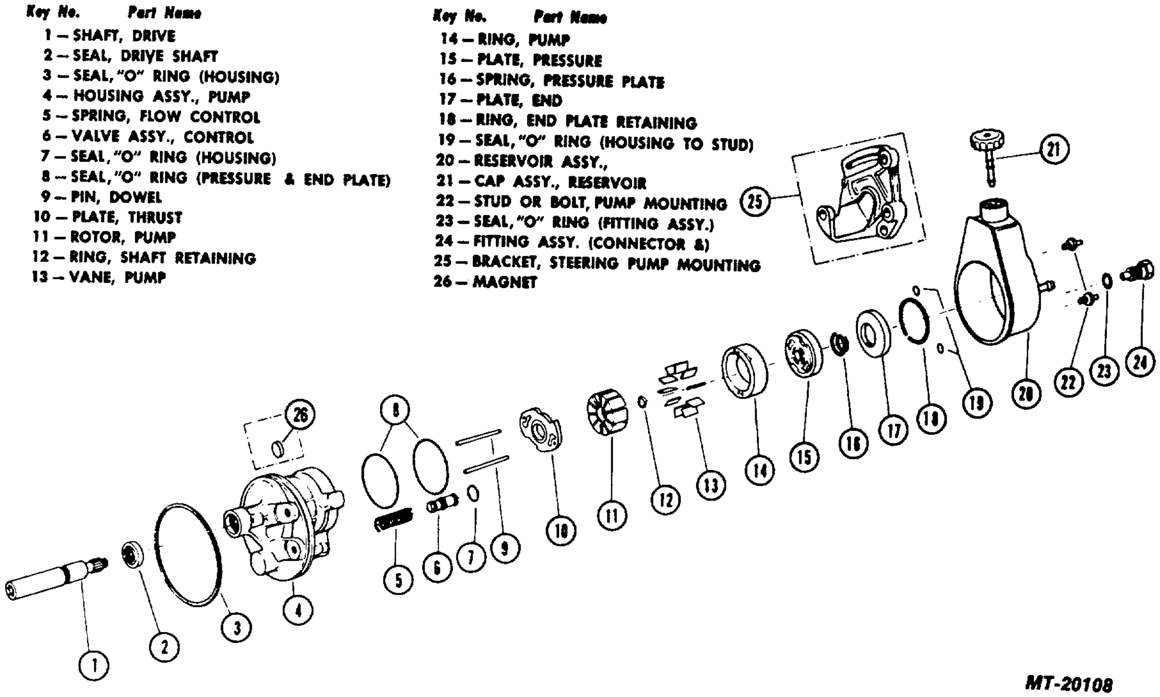

Fig. 1 125 Series Hydraulic Pump Assembly

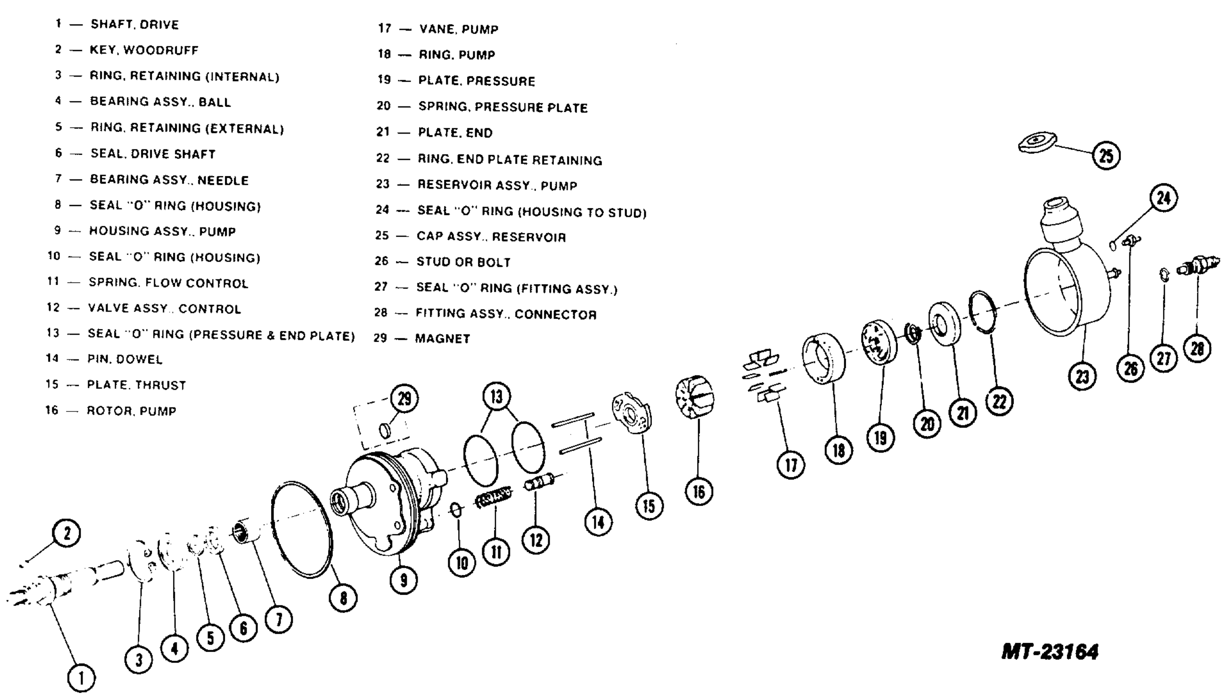

Fig. 2 235 Series Hydraulic Pump Assembly

DESCRIPTION

The housing and internal parts of the pump are 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 the shaft hub exposed. The reservoir has a filler neck fitted with a cap. On the 125 series pump, a shaft bushing and seal are pressed into the housing from the front. The drive shaft is inserted through this seal and bushing. On the 235 series pump, the shaft is supported in the front with a ball bearing and in the back with a needle bearing. The drive shaft seal is pressed into the housing and located behind the ball bearing. A large hole in the rear of the housing contains the functional parts; namely ring, rotor, vanes and plates. A smaller hole contains the control valve assembly and spring.

The thrust plate (Figs. 1 & 2) is located on the inner face of the housing by two dowel pins. This plate has four central blind cavities for undervane oil pressure. The two outer blind cavities direct discharge oil through the two cross-over holes in the pump ring (Fig. 3), through the pressure place and into cavity 1 (Fig. 4). The two outside indentations in the thrust plate are for intake of the oil from the suction part of the pump.

The pump ring (Fig. 3) is a plate having the mating surfaces ground flat and parallel. The center hole is a two-lobed cam in which the rotor and vanes operate. The ring is placed next to the thrust plate and located with the same dowel pins.

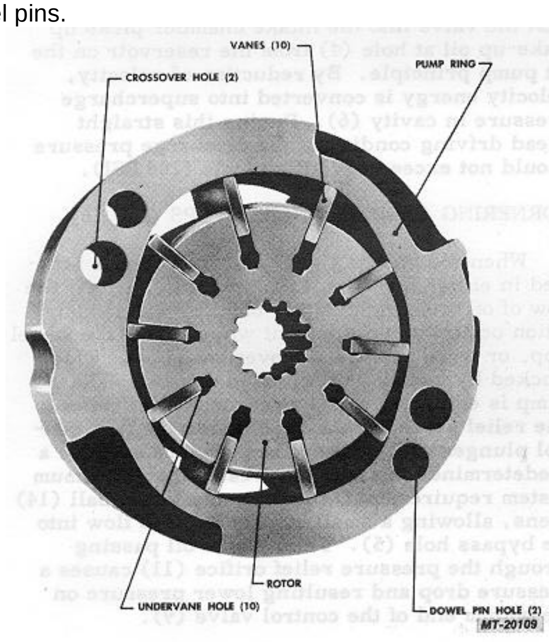

Fig. 3 Pump Ring and Rotor

The pressure plate is fitted against the ring and located with the same two dowel pins. This plate has six through ports. The four central through ports connect from cavity 1 (Fig. 4) to supply undervane oil pressure. The two outer ports pass oil under discharge pressure to cavity 1. The two indentations are for oil intake from the suction part of the pump, cavity 6 (Fig. 5) into the rotor.

The reservoir is for oil storage. It receives and directs the return oil back to the make-up passage of the pump.

The drive shaft is fitted with a pulley and is belt driven from the crankshaft. The rotor is loosely splined to the drive shaft and secured with a retaining ring. It is located centrally within the ring and between the thrust and pressure plates. The ten vanes are mounted in radial slots in the rotor (Fig. 3).

OPERATION

The mode of operation of the power steering pump is based upon the demand of the power steering system. The various major modes of operation are: slow cornering, moderate to high speed straight ahead driving, and cornering against the wheel stop. The pump is designed to recognize these conditions as required by the steering gear valve and compensate for them internally.

As the drive shaft turns the rotor, the vane tips follow the inner cam surface of the pump ring, moving outward and inward twice during each revolution. This results in a complete pumping cycle every 180 degrees of rotation (Fig. 3). Oil is moved in the spaces between the vanes. As the vane tips move outward, oil is sucked into the inter-vane spaces through four suction ports in the pressure and thrust plates. The pressure of the oil is raised, and the oil is discharged from the pump ring, as the vane tips move inward. High pressure oil discharges into cavity 1, (Fig. 4), through two open ports in the pressure plate, and through two blind ports in the thrust plate, which are connected to cavity 1 by the cross-over holes in the ring. A portion of this oil is circulated through the central port system in the pressure plate, forcing the vanes to follow the cam surface of the ring. The ring-rotor leakage oil 12 (Fig. 4) is used for bushing lubrication and then bled to the reservoir.

SLOW CORNERING (FIG. 4)

During slow cornering maneuvers, the oil pressure required will usually not exceed 2760 kilopascals (400 PSI) RPM of the pump is not high enough to require internal bypassing of oil; therefore, the pump bypass port to (5) remains closed.

The high pressure discharge oil (7) is slightly lower in pressure than the internal high pressure oil (1). The drop in pressure occurs as oil flows through the flow control orifice (2). This reduces the pressure at the bottom end of the pump control valve (9) because the orifice (11) is connected by passage (8) to (9) resulting in a pressure unbalance on the valve. The flow control valve moves away from the discharge fitting, but due to the force of the flow control spring (10) the valve remains closed to the bypass hole (5). The oil pressure does not build up high enough to cause the pressure relief valve to actuate, because the oil pumped through the steering gear is allowed to recirculate through the entire system.

Fig. 4 Slow Cornering

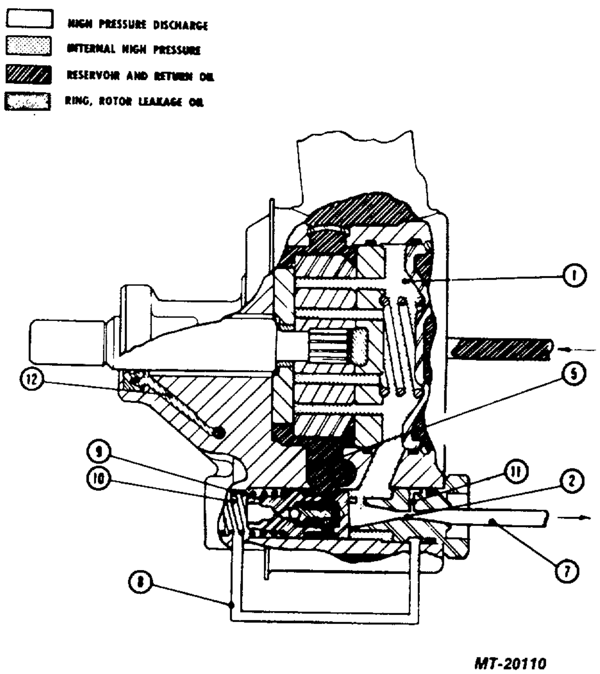

Fig. 4 Slow Cornering

MODERATE TO HIGH SPEED OPERATION (FIG. 5)

When operating at moderate to high speed, it is desirable to limit the temperature rise of the oil. This is done by flow controlling. The control valve in the steering gear is an open center rotary valve. When this valve is in the straight ahead position, oil flows from the pump through the open center valve and back to the pump reservoir without traveling through the power steering gear. When this flow exceeds the predetermined system requirements, oil is bypassed within the pump. This is accomplished by the pressure drop which occurs across the flow control orifice (2). The pressure is reduced at the bottom of the flow control valve (9) because the orifice (11) is connected by (8) to the bottom of valve (9).

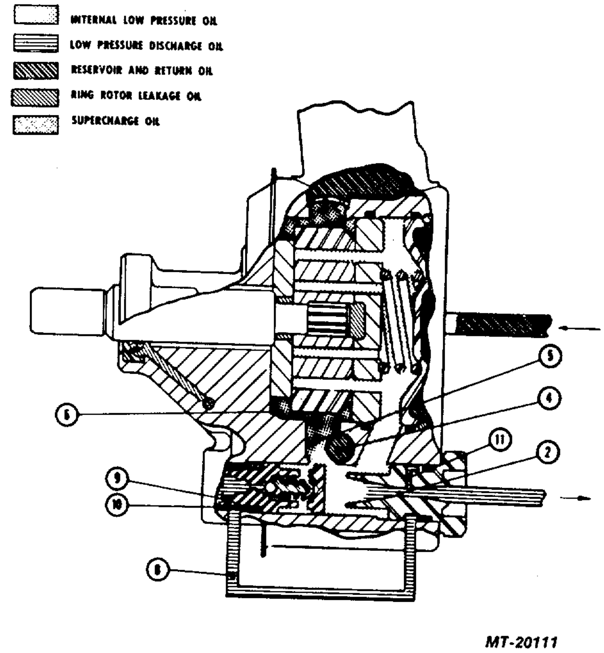

Fig. 5 Flow Controlling

The pressure unbalance of the valve is sufficient to overcome the force of the spring (10), allowing the valve to open the bypass hole (5), and diverting oil into the intake chamber (6). Supercharging of the intake chamber occurs under these conditions. Oil at high velocity discharging past the valve into the intake chamber picks up make-up oil at hole (4) from the reservoir on the jet pump principle. By reduction of velocity, velocity energy is converted into supercharge pressure in cavity (6). During this straight ahead driving condition, the discharge pressure should not exceed 690 kilopascals (100 PSI).

CORNERING AGAINST WHEEL STOPS (FIG. 6)

When the steering gear control valve is actuated in either direction to the point of cut-off, the flow of oil from the pump is blocked. This condition occurs when the front wheels meet the wheel stop, or when the wheel movement is otherwise blocked by a curb or deep sand or mud. The pump is equipped with a pressure relief valve. The relief valve is contained inside the flow control plunger (13). When the pressure exceeds a predetermined pressure, (greater than maximum system requirements) the pressure relief ball (14) opens, allowing a small amount of oil to flow into the bypass hole (5). This flow of oil passing through the pressure relief orifice (11) causes a pressure drop and resulting lower pressure on the bottom end of the control valve (9).

The pressure unbalance then causes the valve to compress the spring (10) allowing the major portion of the oil to bypass into the intake chamber (from 3 to 6) in the same manner as is accomplished by flow controlling. Relief pressures are usually between 5170 and 9995 kilopascals (750 and 1450 PSI) depending on the vehicle requirements.

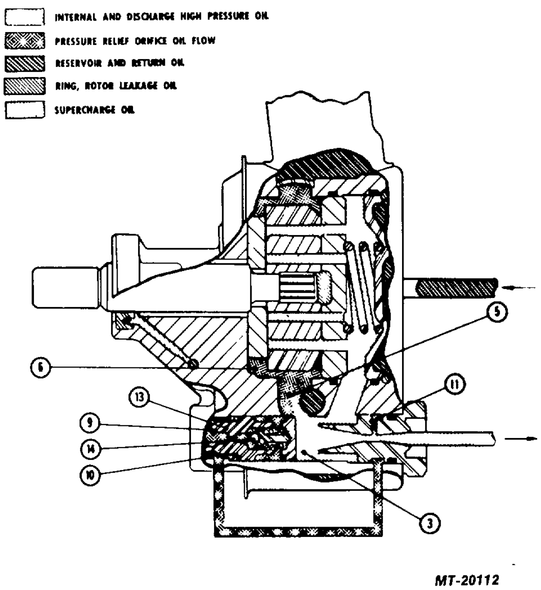

Fig. 6 Pressure Relief

MAINTENANCE

FLUID LEVEL

1. Run engine until power steering fluid reaches normal operating temperature, approximately 80°C (170°F), then shut engine off. Remove reservoir filler cap and check oil level.
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-2412.
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 reservoir.

   b. Start engine, and running at fast idle, recheck fluid level. Add fluid if necessary.

   c. Bleed system by turning wheels from side to side without hitting stops. Maintain fluid level just above internal pump casting. 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 problem.

DIAGNOSTIC CHARTS

Use the following diagnostic charts to determine cause and correction of problem. Refer to the appropriate chapter for the gear being serviced for detailed repair procedures.

CONDITION	POSSIBLE CAUSE	CORRECTION
Chirp noise in steering pump.	1. Loose belt.	1. Adjust belt tension to specification.
Belt squeal (Particularly noticeable 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, thrust plate or rotor. 2. Extreme wear of cam ring and vanes.	1. Replace parts and flush system. 2. Replace parts.
Groan noise in steering pump.	1. Low oil level. 2. Air in tne 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.
Rattle noise in steering pump.	1. Vanes not installed properly.	1. Install properly. 2. Free up by removing burrs, varnish or dirt.
Momentary increase in effort when turning wheel fast to right or left.	1. Low oil level in pump. 2. Pump belt slipping 3. High internal leakage. Valve or cylinder assembly.	1. Add power steering fluid as required. 2. Tighten or replace belt. 3. Check pump pressure.

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CONDITION	POSSIBLE CAUSE	CORRECTION
Steering wheel surges or jerks when turning with engine running especially during parking.	1. Low oil level. 2. Loose pump belt. 3. Insufficient pump pressure. 4. Sticky flow control valve.	1. Fill as required. 2. Adjust tension to specification. 3. Check pump pressure. (See pump pressure test. Replace relief valve if defective. 4. inspect for varnish or damage, replace if necessary.
Hard steering or lack of assist especially in parking.	1. Loose pump belt. 2. Low oil level in reservoir. 3. Steering gear to column misalignment. 4. Lower coupling flange rubbing against steering gear adjuster plug. 5. Tires not properly inflated.	1. Adjust belt tension to specification. 2. Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage. Tighten loose connectors. 3. Align steering column. 4. Loosen pinch bolt and assemble properly. 5. Inflate to recommended pressure.
Note: If checks 1 through 5 do not reveal cause of hard steering, follow the procedure below to determine fault.	Further possible causes could be: 6. Sticky flow control valve. 7. Insufficient pump pressure output. 8. Excessive internal pump leakage. 9. Excessive internal system leakage.	In order to diagnose conditions such as listed in 6, 7, 8, & 9, a test of the entire power steering system is required.

CONDITION	CORRECTION
POWER STEERING SYSTEM TEST PROCEDURE	1. Disconnect pressure hose at union of pump, use a small container to catch any fluid which might leak. 2. Install SE-2780 power steering analyzer, between union and pressure hose (See Figure 7). 3. Open hand valve on analyzer. 4. Start engine, allow system to reach operating temperatures, and check fluid level - adding any fluid if required. When engine is at normal operating temperature, the initial pressure read on the gauge (valve open) should be in the 550-860 kilopascals (80-125 PSI) range. Should this pressure be in excess of 1035 kilopascals (150 PSI) - check the hoses for restrictions and for proper routing. 5. Close valve fully 3 times. Record the highest pressures attained each time. (Note: Do not leave valve fully closed for more than 5 seconds as the pump could be damaged internally.) (a) If the pressures recorded are within the listed specifications and the range of readings are within 345 kilopascals (50 PSI) the pump is functioning within specifications. Example: Specifications 6205-6895 kilopascals (900-1000 PSI) - readings 6375-6720-6620 kilopascals (925-975-960 PSI). (b) If the pressures recorded are high, but do not repeat within 345 kilopascals (50 PSI), the flow-controlling valve is sticking. Remove the valve, clean it and remove any burrs using crocus cloth or fine hone. If the system contains some dirt, flush it. If it is exceptionally dirty, both the pump and accompanying system must be completely disassembled, cleaned, and reassembled before further usage. (c) If the pressures recorded are constant, but more than 690 kilopascals (100 PSI) below the low listed specification, replace the flow-control valve and recheck. If the pressures are still low, replace the rotating group in the pump. 6. Shut off engine, remove analyzer, reconnect pressure hose and check fluid level or make needed repairs.

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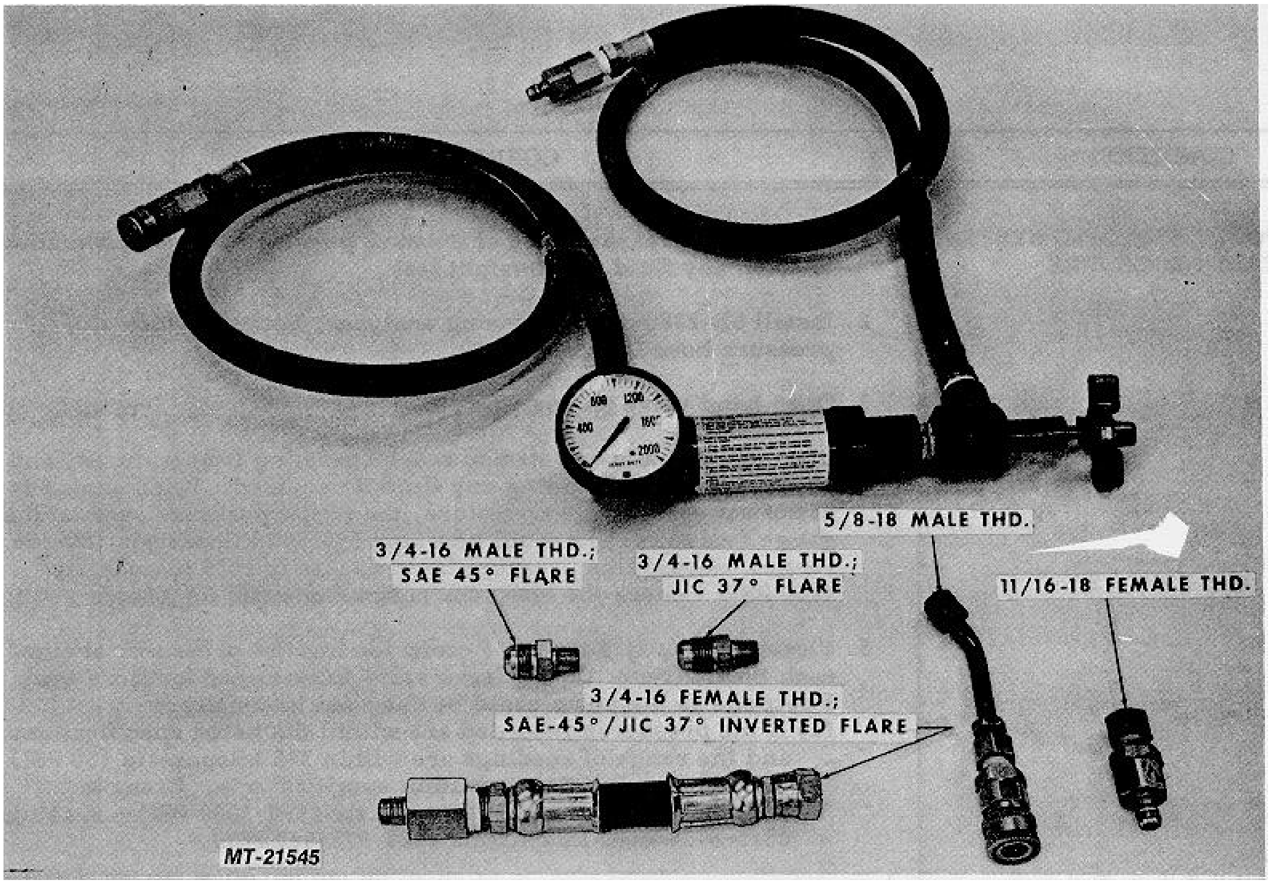

Fig. 7 SE-2780 Power Steering Analyzer

CONDITION	POSSIBLE CAUSE	CORRECTION
Foaming milky power steering fluid, low fluid level and possible low pressure	1. Air in the fluid, and loss of fluid due to internal pump leakage causing overflow.	1. Check for leak and correct. Bleed system. Extremely cold temperatures will cause system aeration should oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from housing. Check welsh plug and housing for cracks. If plug is loose or housing is cracked, replace housing.
Low pressure to steering pump	1. Flow-control valve stuck or 2. Pressure plate not flat against cam ring	1. Remove burrs or dirt, reinoperative place. 2. Correct. .

CONDITION	POSSIBLE CAUSE	CORRECTION
	3. Extreme wear of cam ring and vanes.	3. Replace parts. Flush system.
	4. Scored pressure plate, thrust plate or rotor.	4. Replace parts. (If rotor replace with rotating group kit.). Flush system.
	5. Vanes not installed properly.	5. Install properly.
	6. Vanes sticking in rotor slots.	6. Free-up by removing burrs, varnish or dirt.
	7. Cracked or broken thrust or pressure plate.	7. Replace part.

EXTERNAL LEAKAGE DIAGNOSIS

The following diagrams have been prepared to show the potential areas of leakage. If leakage occurs in the areas shown, perform the operation described. Refer to the appropriate chapter for the pump being serviced for detailed repair procedures.

EXTERNAL LEAKAGE 125 SERIES PUMP

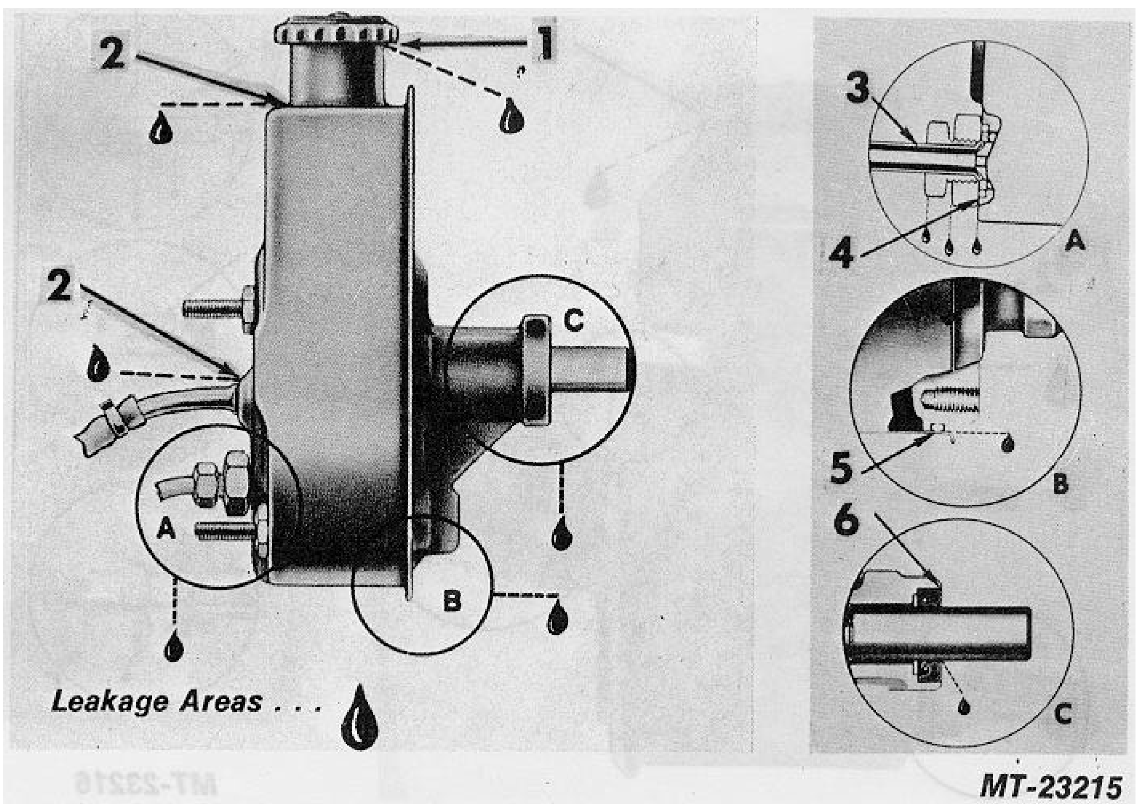

Fig. 8 Suspected Leakage Areas

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 normal 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 the fluid level to rise, especially after system repair. Bleed the system as described in the MAINTENANCE section of this chapter.

2. Replace reservoir.
3. If leakage persists upon tightening the fitting nut to specified torque:
   a. Loosen the nut and rotate tubing to reseat with brass connector. Tighten nut again and recheck. If leakage still persists, proceed to 3b.
   b. Remove the hose and check the sealing .face for cracks. If a cracked flare is found, replace the hose. If no cracks are observed, proceed to 3c.
   c. Replace the brass connector and reface the tube flare. Also, check the threads in the pump housing and on the fitting nut. If nut threads are damaged, replace the nut. If pump housing threads are damaged, replace both the housing and the nut. If either the return hose or the pressure hose leaks, other than at the nut connections, replace the hose.
4. Tighten fitting to specified torque. If leakage persists, replace both "O" ring seals.
5. Replace reservoir "O" ring.
6. Replace drive shaft seal after inspecting and thoroughly cleaning the sealing surface. Replace drive shaft if severe pitting is found. If the corrosion in the lip seal contact zone is slight, clean the surface of the shaft with crocus cloth first. Always replace the seal if the shaft is replaced.

EXTERNAL LEAKAGE 235 SERIES PUMP

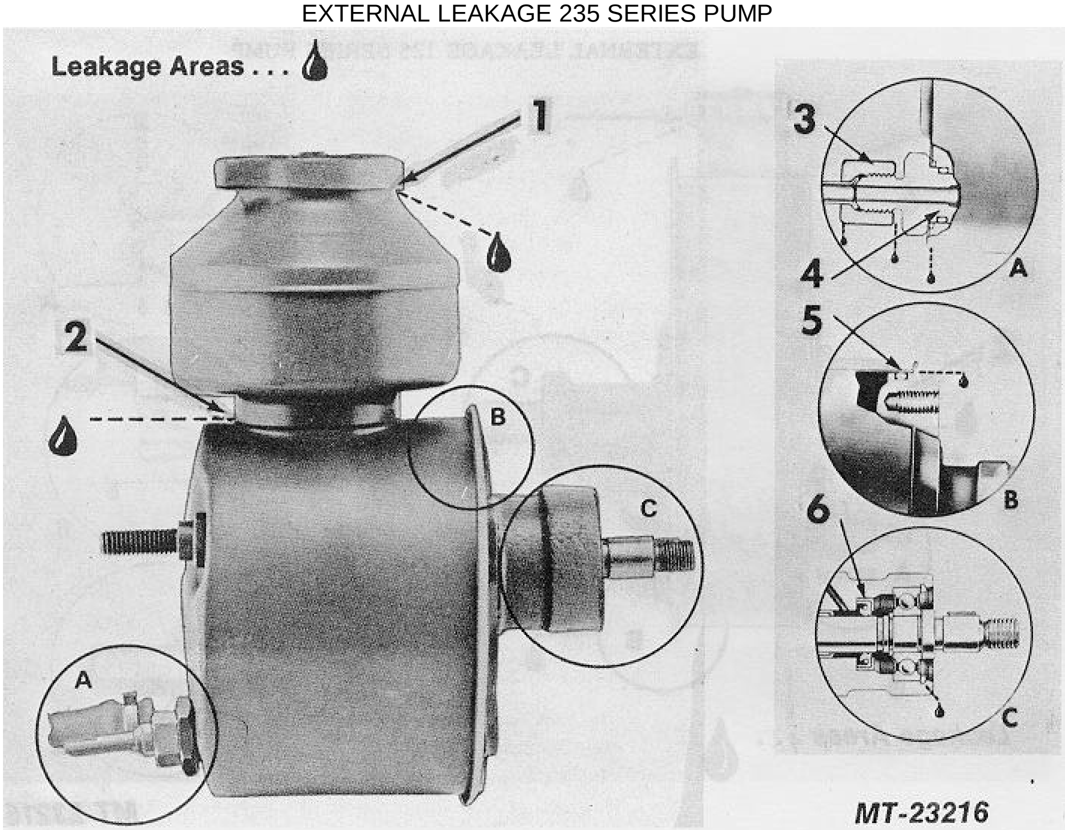

Fig. 9 Suspected Leakage Areas

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 normal 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. Tighten hose fitting nut to specified torque. If leakage persists, replace discharge fitting and reface hose tube flare or replace hose as required.

   If either the return hose or the pressure hose leaks, other than at the nut connections, replace the hose.

4. Tighten fitting to specified torque. If leakage persists, replace both "O" ring seals.

5. Replace reservoir "O" ring seal.

6. Replace drive shaft seal after inspecting and thoroughly cleaning the sealing surface. Replace drive shaft if severe pitting is found. 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.

TRUCK SERVICE MANUAL
STEERING

CHAPTER 3

235 SERIES PUMP SERVICE INFORMATION

CONTENTS

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INSTALLATION AND REMOVAL

INSTALLATION

1. Position pump assembly on mounting bracket with holes lined up and install bolts loosely.
2. Slide pulley on shaft over key.

IMPORTANT

Do not hammer pulley on as this will damage internal pump parts.

3. Install pulley nut finger tight against pulley. (Always use a new nut.)
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. Move pump until belt is tight; then tighten mounting screws. See BELT TENSION and BELT ADJUSTMENT sections of Chapter 1.
8. Tighten pulley nut to specified torque.
9. Bleed system per FLUID LEVEL section, Chapter 1.

REMOVAL

1. Disconnect both hoses at pump. When both hoses are disconnected, secure ends in raised position to prevent drainage of oil.
2. Install caps at both pump fittings to prevent drainage of oil from pump.
3. Remove attaching nut on pump drive pulley.
4. Loosen necessary bolts to loosen belt tension.
5. Remove pump belt.
6. Slide pulley from shaft using pulley puller SE-2578.

IMPORTANT

Do not hammer pulley off shaft as this will damage internal pump parts.

7. Remove bracket-to-pump bolts or bracket to engine bolts and remove pump.

SERVICE

DISASSEMBLY

Before disassembly of pump, remove reservoir filler cap (when used) and drain oil from reservoir by inverting the pump so oil may drain out the filler hole.

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.

1. Clamp front hub of pump in vise so that the extending portion of shaft is directed downward, being careful not to clamp vise too tight as this may distort the bearings. Use soft jaws in vise if available.

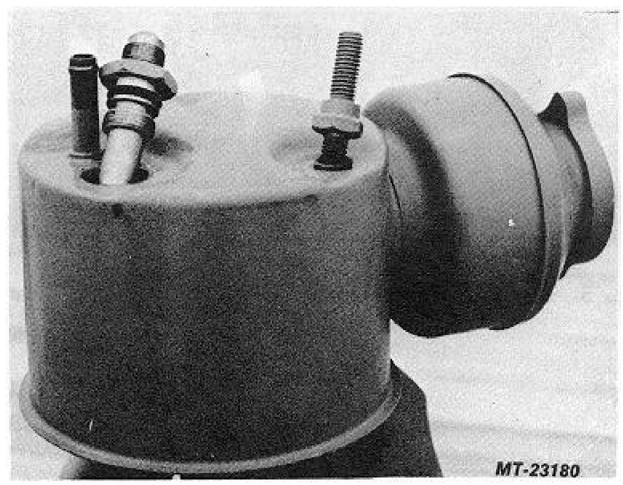

Fig. 1 Remove Stud and Union

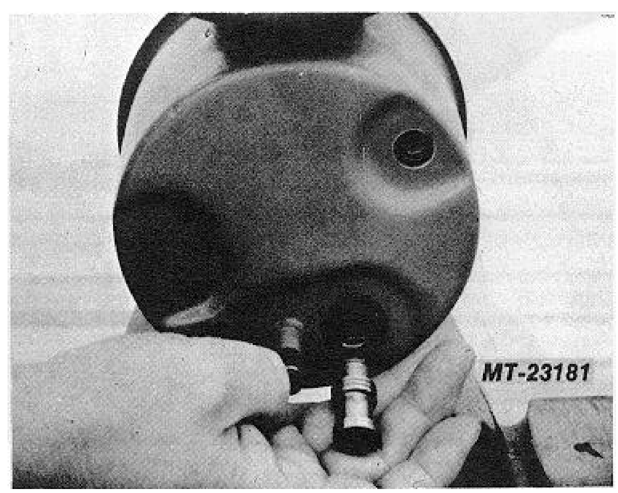

Fig. 2 Remove Flow Control Valve and Spring

2. Remove stud and union 11/16 box (stud) and l--inch deep well socket (union), (Fig. 1). Tip pump to remove flow-control valve and spring. (Fig. 2)

3. Remove reservoir. Reservoir may be removed from ,housing by rocking it back and forth to unseat the "O" ring (Fig. 3). Remove housing and union "0'" rings and discard (Fig. 4).

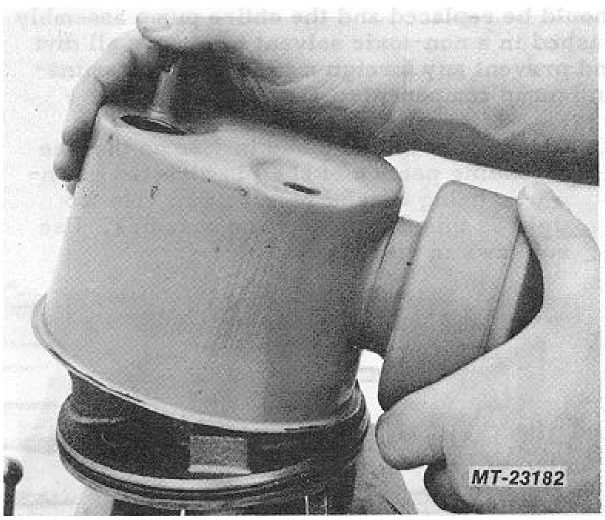

Fig. 3 Remove Reservoir

Fig. 4 Remove Housing and Union "O" Rings

4. Remove magnet from housing and clean with solvent (Fig. 5).

Fig. 5 Remove Magnet

5. Rotate retaining ring with blunt-nosed punch until the ring opening is approximately 6 mm (1/4 in.) from knock-out hole in pump housing (Fig. 6).

6. Insert needle-nosed punch into knock-out hole and tap with hammer until ring is forced away from housing. Insert screwdriver beneath retaining ring and pry away the full diameter until the ring is free (Fig. 7).

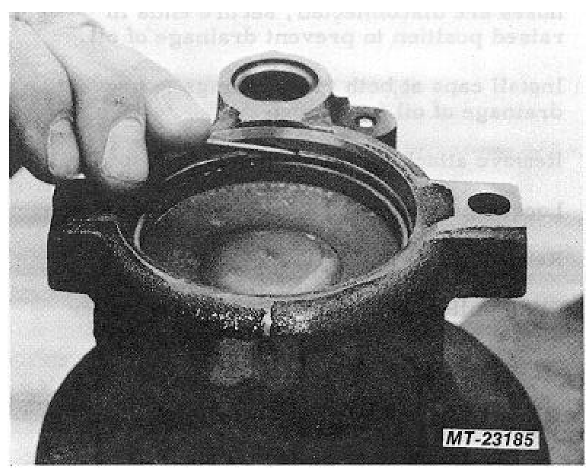

Fig. 6 Rotate Retaining Ring

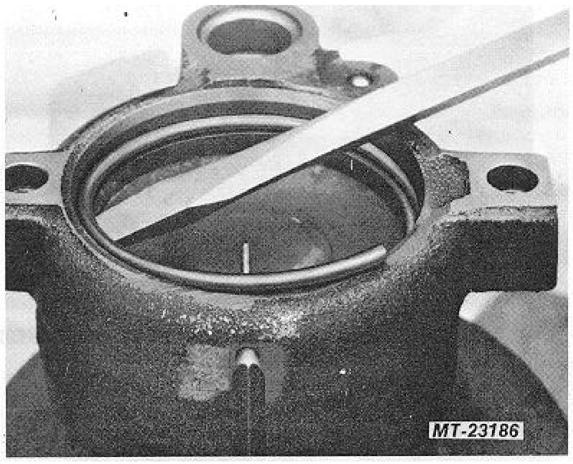

Fig. 7   Remove Retaining Ring

7. Remove end plate and end plate "0" ring. End plate is spring loaded and will generally sit above the housing level for ease of removal. If sticking should occur, a slight rocking of the end plate should be used to free it (Fig. 8).

Fig. 8   Remove End Plate

8. Remove pressure plate spring and end plate "O" rings (Figs. 9 and 10).

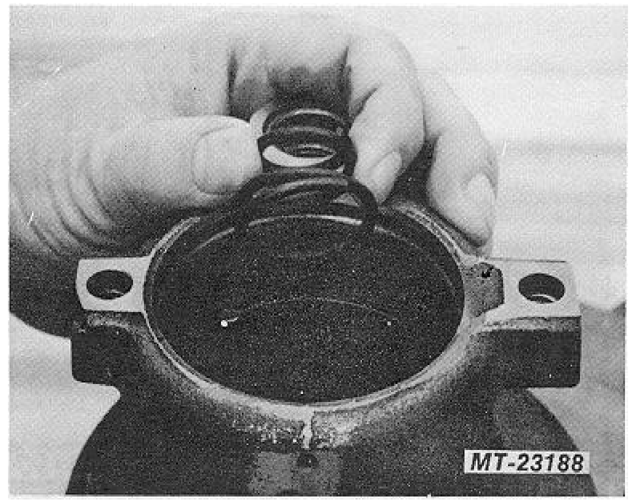

Fig. 9   Remove Spring

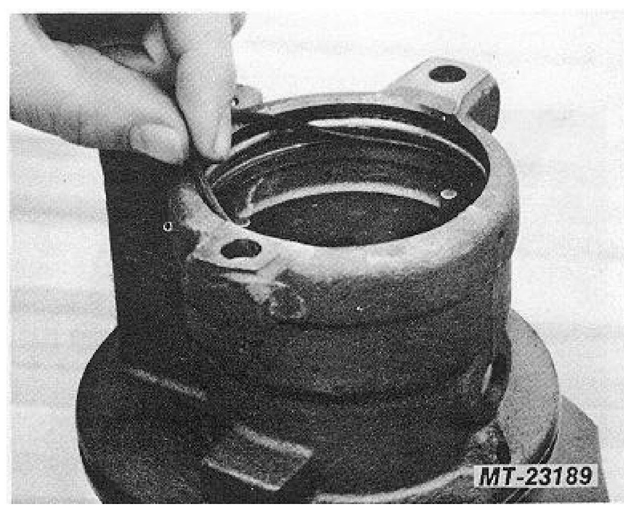

Fig. 10   Remove End Plate "O" Ring

9. Release pump housing from vise. Invert housing and bump bench sharply (Fig. 11). (Use clean shop towel to catch parts.) The impact should free the entire rotating group. If it does not, bump again.

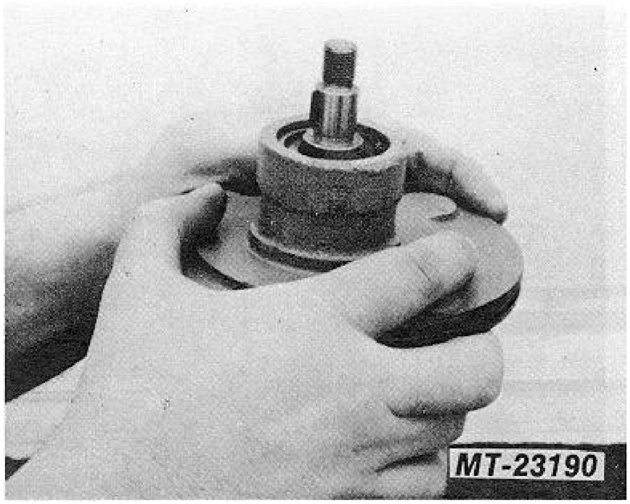

Fig. 11 Separate Rotating Group From Housing

10. Remove and discard pressure plate "O" ring (Fig. 12).

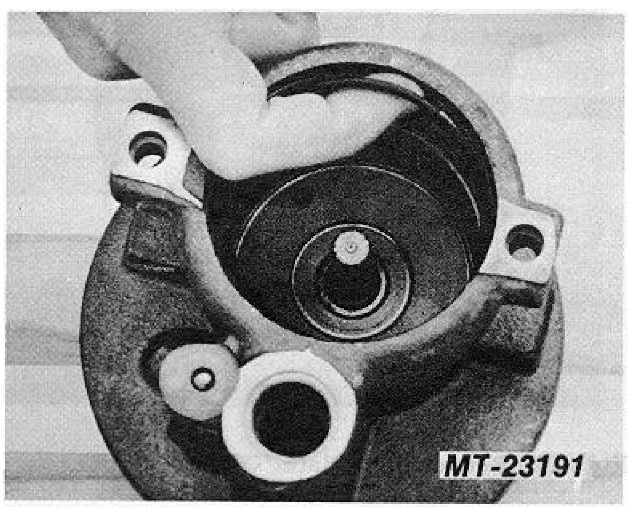

Fig. 12 Remove Pressure Plate "O" Ring

11. Disassemble pump rotating group as shown in Figure 13 through Figure 16.

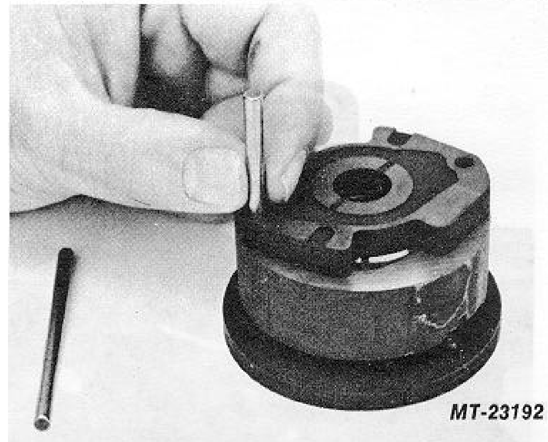

Fig. 13 Remove Dowel Pins

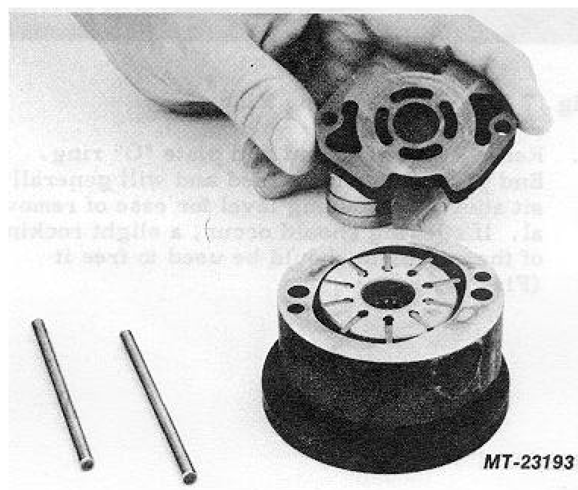

Fig. 14. Remove Thrust Plate

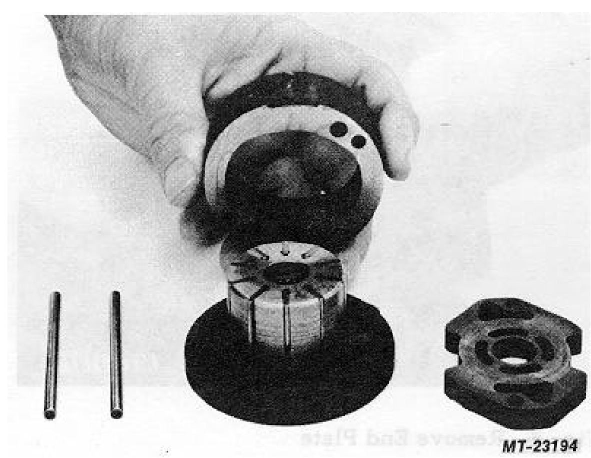

Fig. 15 Removing Pump Ring

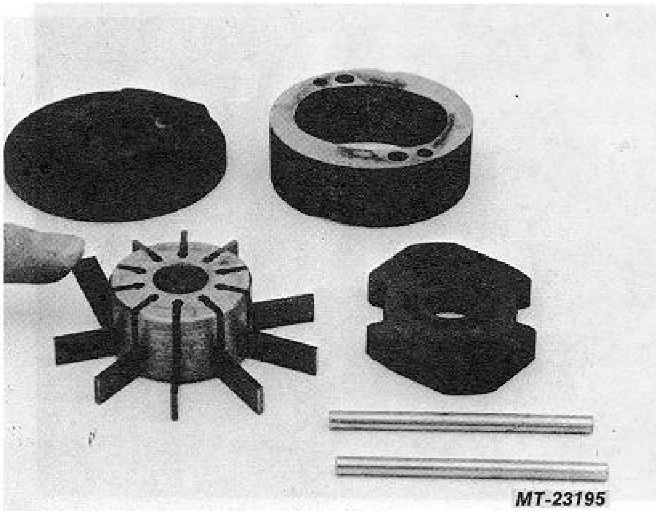

Fig. 16 Remove Vanes From Rotor

12. Remove retaining ring and shaft assembly (Fig. 17). The shaft assembly can be removed with the hands alone (Fig. 18).

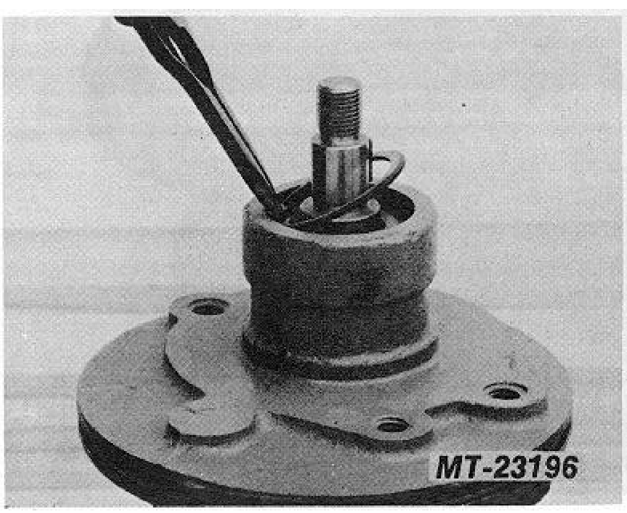

Fig. 17 Remove Retaining Ring

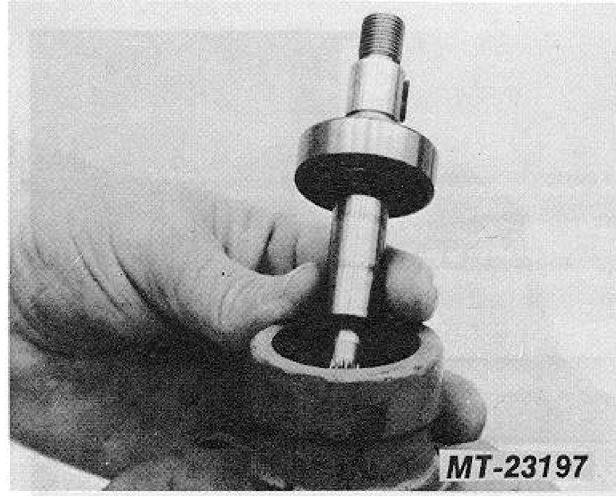

Fig. 18 Remove Shaft Assembly

CLEANING, INSPECTION AND REPAIR

Clean all metal parts in a nontoxic solvent.

1. Wash and inspect rotating group. Check ring cam, wear. surfaces of thrust and pressure plates, and vane tips for heavy or unusual wear. If heavy wear is present, the entire rotating group (pump ring, rotor, vanes, thrust and pressure plates) must be replaced.
2. Inspect the needle and seal ride areas on the pump shaft. Should fretting, or some other surface irregularities be present, the shaft and more than likely the needle bearing should be replaced.
3. If shaft or bearing is to be replaced: (a) Remove retaining ring (Fig. 19). (b) Press shaft out of bearing (Fig. 20). (c) Press new shaft into bearing (Fig. 21). (d) Replace retaining ring (Fig. 19).

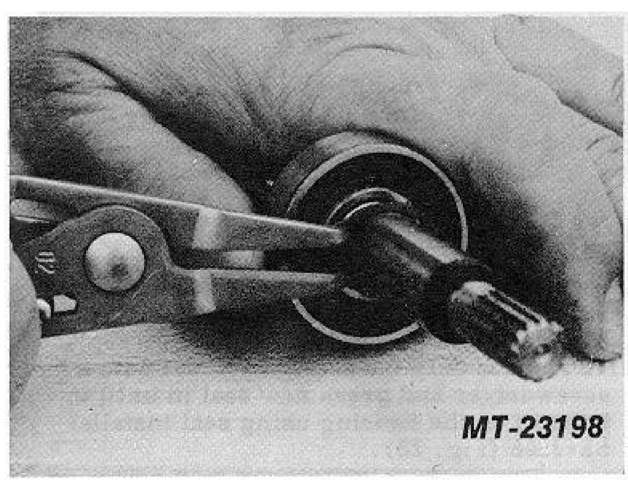

Fig. 19 Remove Bearing Retaining Ring

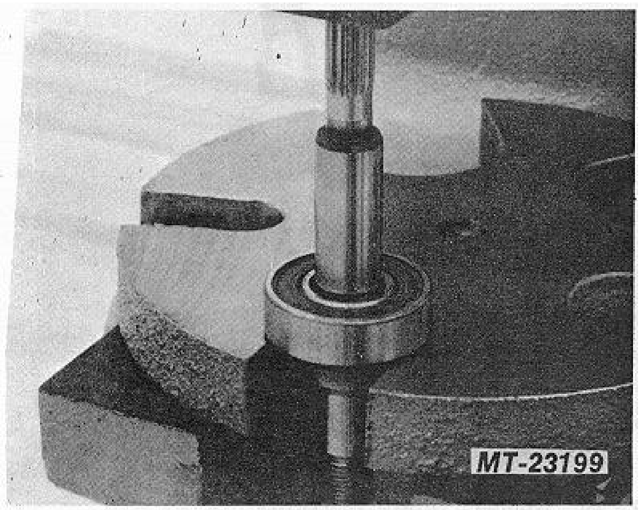

Fig. 20 Press Shaft From Bearing

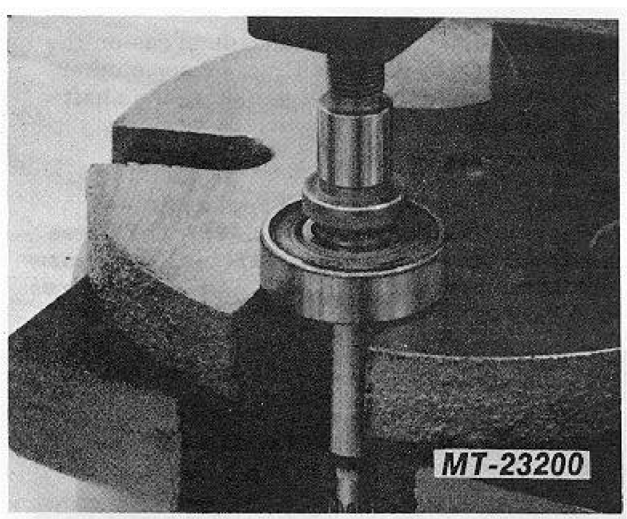

Fig. 21 Press Shaft Into Bearing

4. If seal has been leaking, the shaft has been replaced, or the pump subjected to extremely high temperature, the seal should be replaced To replace only the seal, pry it out with a screwdriver and press new seal in until it bottoms on the housing using seal installer SE-2806 (Fig. 22).

Fig. 22 Install New Pump Seal

5. If the bearing ride surface on the pump shaft is scuffed or fretted, or the needle bearing appears damaged, replace both the seal and needle bearing. Remove bearing and seal with Tool SE-2805 (Fig. 23). Press new bearing in place using Tool SE-2804 (Fig. 24). Bottom shoulder of tool on pump housing to seat bearing correctly.

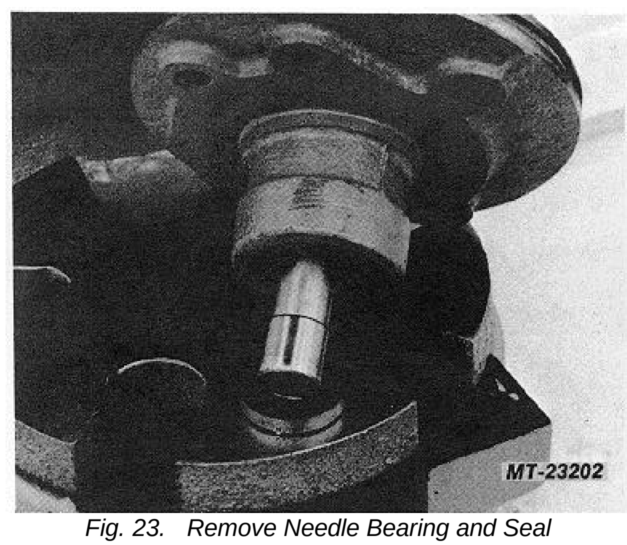

Fig. 23. Remove Needle Bearing and Seal

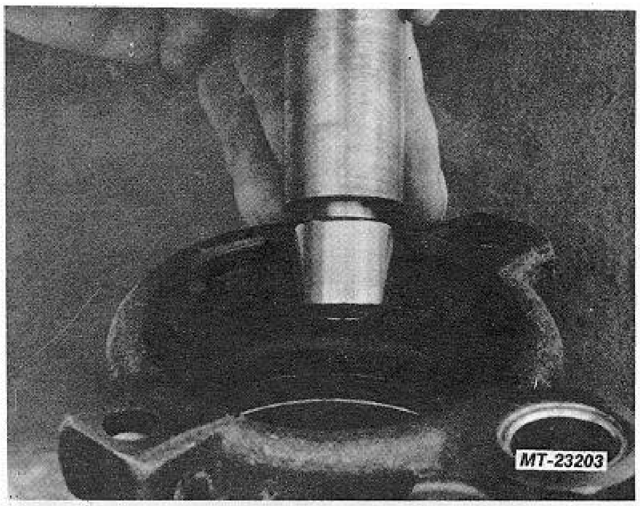

Fig. 24. Install New Needle Bearing,

ASSEMBLY

1. Install shaft and bearing assembly (Fig. 18). Secure with retaining ring (Fig. 17).
2. Lubricate the reservoir, pressure-plate, and end-plate "O" rings with power steering fluid and install into pump housing (Figs. 4, 10 and 12).
3. Insert two dowel pins into housing - press on pins to seat fully (Fig. 25).

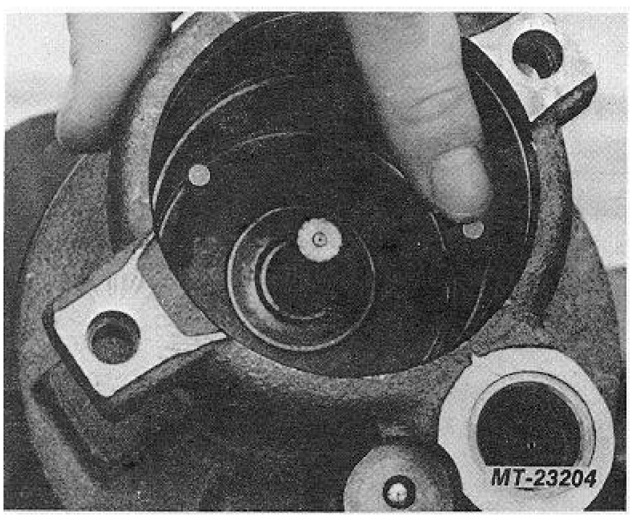

Fig. 25. Install Dowel Pins

4. Pilot thrust plate on dowel pins and push down until thrust plate bottoms on housing (Fig. 26).

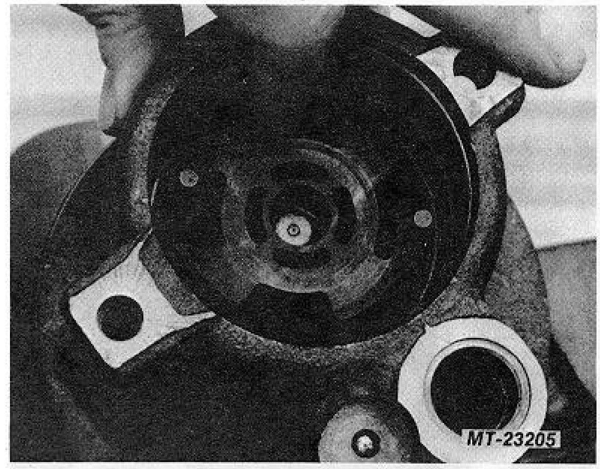

Fig. 26 Install Thrust Plate

5. Guide pump ring onto dowel pins and seat against thrust plate (Arrows on ring up) (Fig. 27).

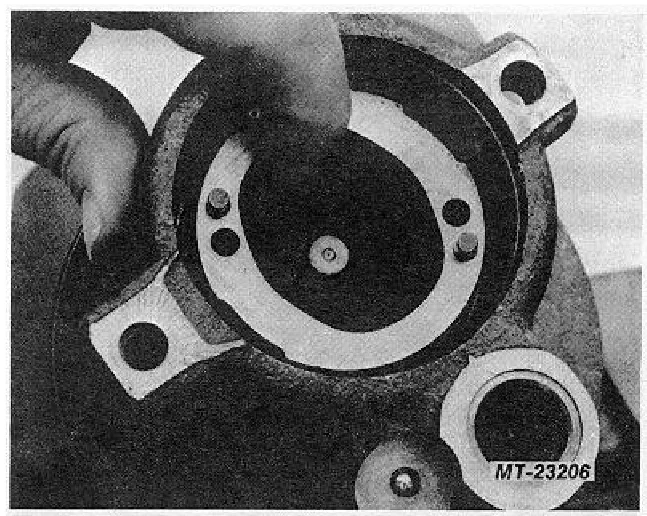

Fig. 27 Install Pump Ring

6. Slide rotor onto drive, shaft splines, then assemble ten vanes into rotor slots with rounded edges of vane out. Rounded edges must ride against ring cam (Fig. 28).

7. Squirt power steering fluid onto vanes and rotor and ring cam (Fig. 29) (Lubrication prevents internal damage at initial start).

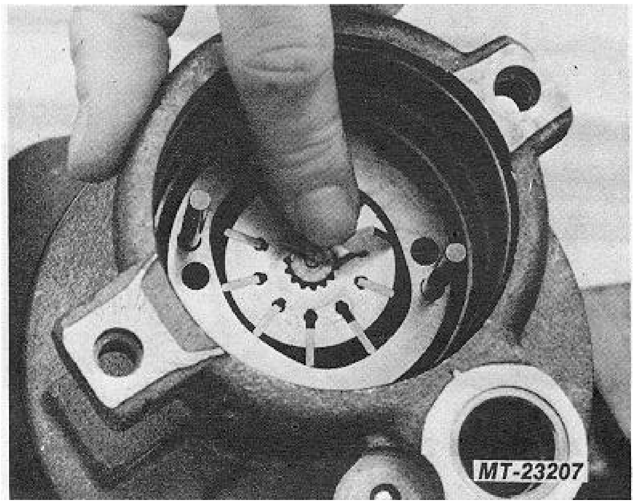

Fig. 28   Install Vanes

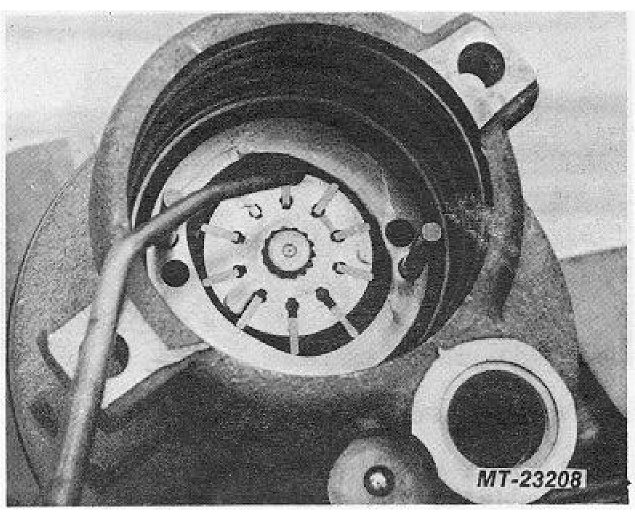

Fig. 29   Lubricate Rotating Group

8. Lubricate pressure plate with power steering fluid. Locate plate on dowel pins. Press down to force plate past pressure-plate "0" ring (Fig. 30).

Fig. 30   Seat Pressure Plate

9. Place spring in groove on pressure plate (Fig. 9).
10. Position end plate on housing. (Lip on endplate up.) Force housing down using arbor press until retaining ring groove is visible.
11. Install end-plate retaining ring (ring gap 1800 from knock-out hole in housing) and release arbor press (Fig. 31).

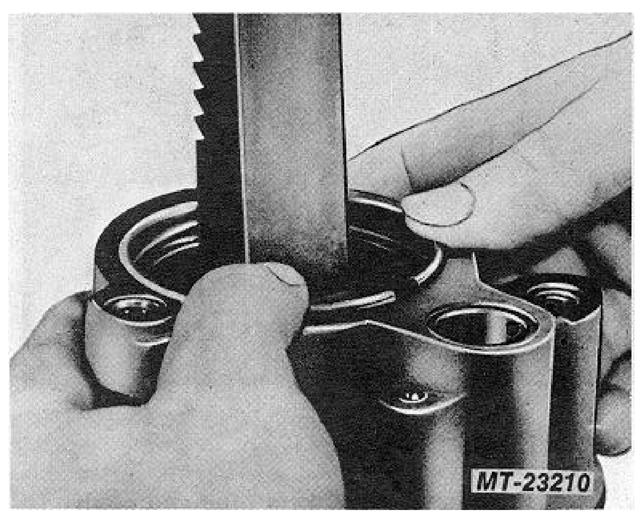

Fig. 31   Install End Plate Retaining Ring

- Replace magnet in area shown (Fig. 5).

- Place flow control valve spring into hole first and then insert flow control valve (Fig. 2).

4. Install union seal on housing (Fig. 4).

5. Lubricate inside edge of reservoir with power steering fluid and install on housing. Be careful to align union and stud holes (Fig. 3).

6. Install new "O" rings on union and stud. Insert union and stud and tighten to specifications (Fig. 1).

SPECIFICATIONS

Pump Type	Vane
Manufacturer	Saginaw
Drive	Belt
Mounting	Bracket
Reservoir	Integral
Thrust Taken By	Thrust Plate

TORQUE CHART

DESCRIPTION	NEWTON METERS	(FT. LS.)
Pulley Nut	81	60
Pump Mounting Bolt	48	35
Flow-Control Fitting Assembly	48	35
Pressure Hose	48	35

TRANSFER CASE

IH MODEL	IH CODE
TC-155	13155
TC-156	13156

CONTENTS

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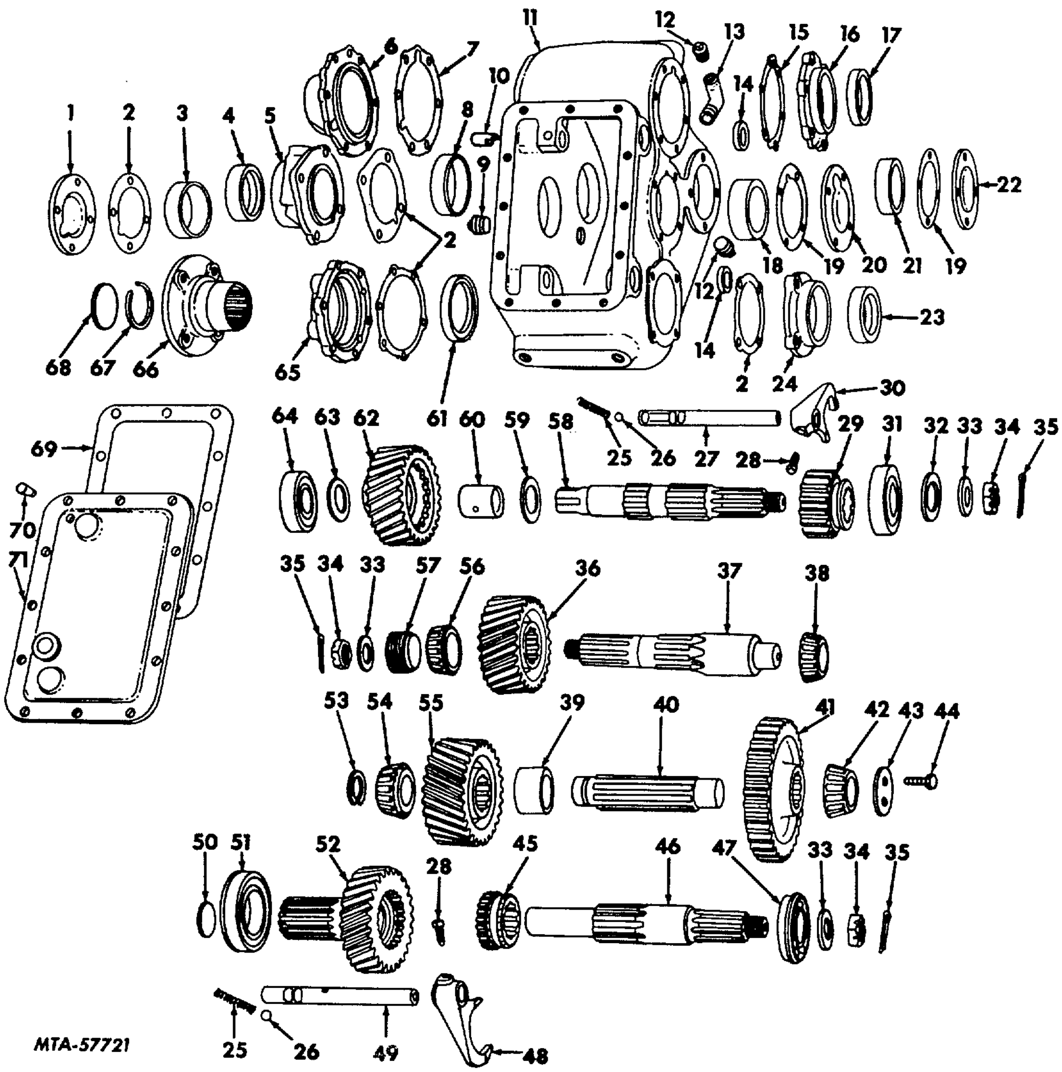

Legend for Figure 1

Key	Description	Key	Description
1	CAP, Idler Shaft Rear Bearing	15	SHIMS, .08 mm (.003") Thick .13 mm (.005") Thick .25 mm (.010") Thick
2	GASKET	16	CAP, Input Shaft Front Bearing
3	CUP, Idler Shaft Rear Bearing	17	SEAL, Oil
4	SEAL, Rear Output Shaft Oil	18	CUP, Idler Shaft Front Bearing
5	CAP, Rear Output Shaft Rear Bearing	19	SHIMS, .08 mm (.003") Thick .13 mm (.005") Thick .25 mm (.010") Thick
6	CAGE, Input Shaft Rear Bearing	20	CAP, Idler Shaft Front Bearing
7	GASKET	21	CUP, Rear Output Shaft Front Bearing
8	CUP, Rear Output Shaft Rear Bearing	22	CAP, Rear Output Shaft Front Bearing
9	PLUG, Pipe	23	SEAL, Oil
10	TUBE, Input Shaft Rear Bearing Oil Catch	24	CAP, Front Output Shaft Front Bearing
11	HOUSING, Transfer Case		
12	PLUG, Pipe, Filler/Drain		
13	ELBOW, 45 Degree		
14	SEAL, Shift Shaft Oil		

Key	Description
25	SPRING, Detent
26	BALL, Detent
27	SHAFT, Range Shift
28	SCREW, Shift Fork Set
29	GEAR, Low Speed Sliding
30	FORK, Range Shift
31	BEARING, Input Shaft Front
32	SHIM, Bearing Adjusting
33	WASHER, Companion Flange
34	NUT, Companion Flange
35	PIN, Cotter
36	GEAR, Rear Output Shaft
37	SHAFT, Rear Output
38	BEARING, Rear Output Shaft Front
39	SPACER, Idler Gear
40	SHAFT, Idler
41	GEAR, Idler Shaft Low Speed
42	BEARING, Idler Shaft Front
43	PLATE, Bearing Retainer
44	BOLT, Bearing Retainer
45	CLUTCH, Output Shaft Sliding
46	SHAFT, Front Output
47	BEARING, Front Output Shaft Front
48	FORK, Shift. Front Axle Declutch

Key	Description
49	SHAFT, Declutch Shift
50	PLUG, Expansion
51	BEARING, Front Output Shaft Rear
52	GEAR, Front Output Shaft
53	RING, Idler Shaft Snap
54	BEARING, Idler Shaft Rear
55	GEAR, Idler Shaft High Speed
56	BEARING, Rear Output Shaft Rear
57	GEAR, Speedometer Drive
58	Shaft, Input
59	WASHER, Direct Drive Gear Spacing
60	BUSHING, Direct Drive Gear
61	SEAL, Oil
62	GEAR, Direct Drive
63	SPACER, Input Shaft Rear Bearing
64	BEARING, Input Shaft Rear
65	CAP, Front Output Shaft Rear Bearing
66	HUB, Brake
67	NOT USED
68	NOT USED
69	GASKET
70	BREATHER, Oil
71	COVER, Transfer Case Housing

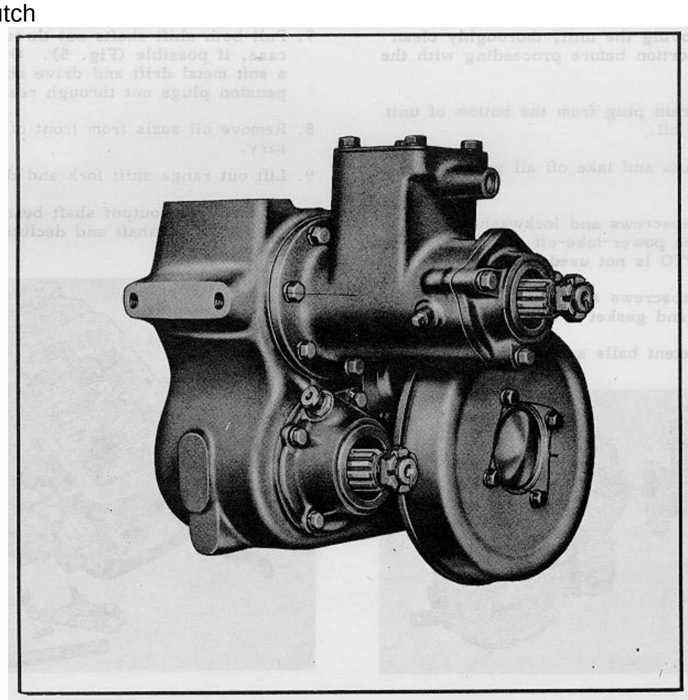

Fig. 2.

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DESCRIPTION

A transfer case is a gear box located between the main transmission and rear axle.' Its purpose is to transfer power from the transmission to the front driving axle as well as the real driving axle.

The transfer case incorporates a front axle declutch which is used to drive the front axle whenever the vehicle is used on off-road operations or operated on steep grades.

The transfer case also provides an extra gear reduction (Lo) in the vehicle power train.

The TC-155 and TC-156 transfer cases are four shaft clover-leaf type, two-speed units. The case contains constant mesh helical and spur gears with the shafts supported by roller and ball bearings.

DISASSEMBLY

Disassembly of Transfer Case

After removing the unit, thoroughly clean the exterior portion before proceeding with the disassembly.

1. Remove drain plug from the bottom of unit and drain oil.

2. Remove nuts and take off all yokes or flanges.

3. Remove capscrews and lockwashers, and pull off the power-take-off assembly, or rear cover if PTO is not used (Fig. 3).

4. Remove capscrews and lockwashers and lift off cover and gasket (Fig. 4).

5. Remove detent balls and springs.

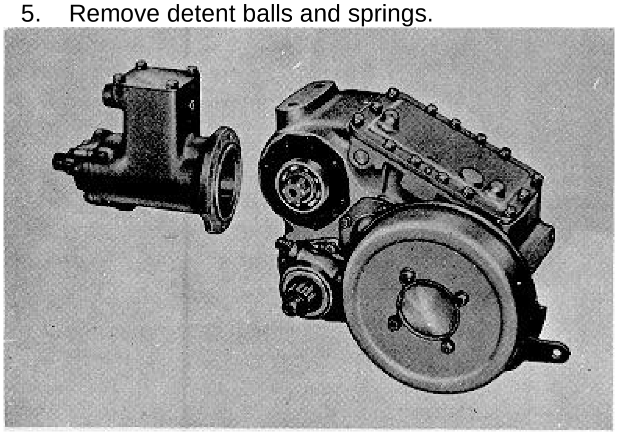


Fig. 3.

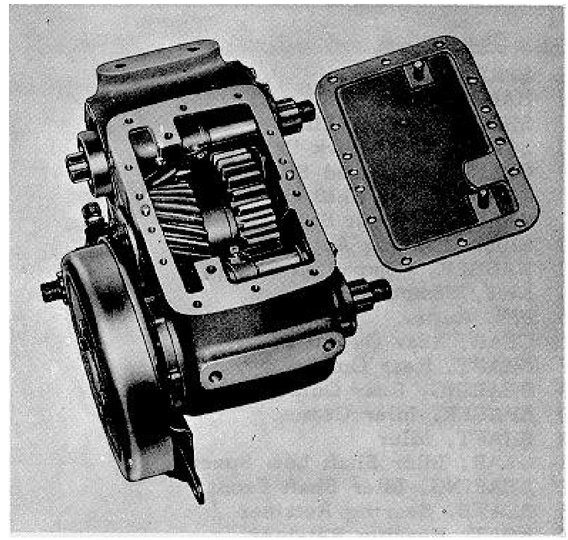


Fig. 4.

6. Cut lock wire and loosen shift fork set screws.
7. Pull both shift shafts out through front of case, if possible (Fig. 5). Otherwise, use a soft metal drift and drive shafts and expansion plugs out through rear of case.

8. Remove oil seals from front of case, if necessary.
9. Lift out range shift fork and declutch fork.

10. Remove front output shaft bearing cap and gasket. Pull shaft and declutch collar from case (Fig. 6).

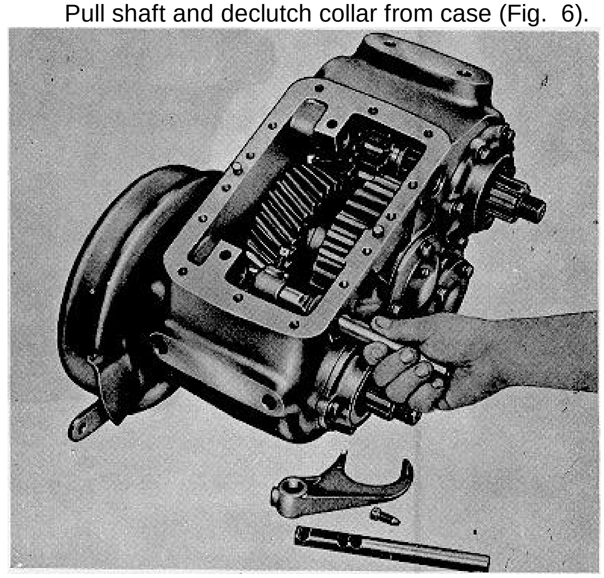


Fig. 5.

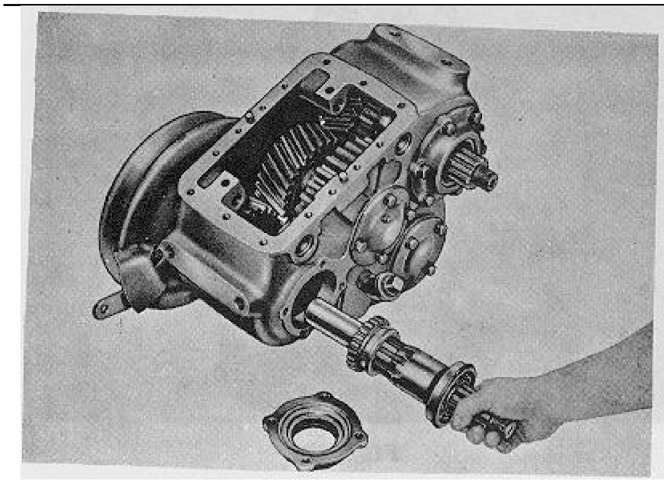


Fig. 6.

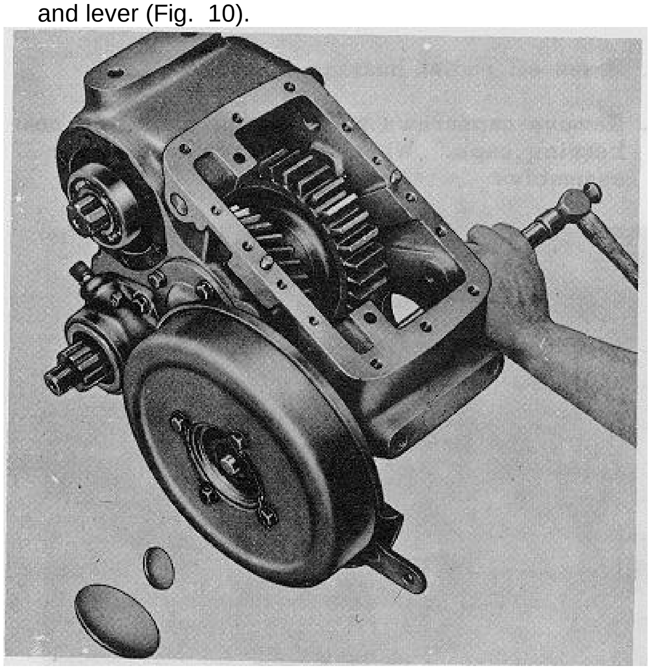
11. Slide a bar through front output shaft gear and tap out small and large expansion plugs located in brake section (Fig. 7).

12. Cut lock wire and remove capscrews from brake drum. Take off drum.

13. Remove brake hub retaining ring (Fig. 8).

14. Remove hub with a suitable puller (Fig. 9).

15. Unhook brake shoe return springs; remove brake shoes and lever (Fig. 10).



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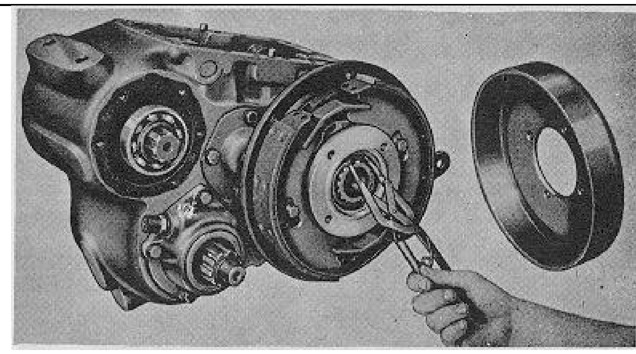
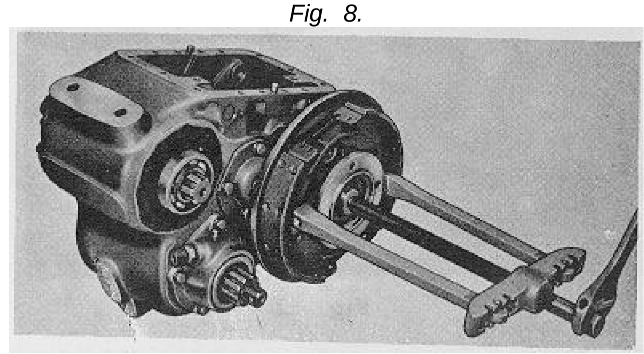


Fig. 8.



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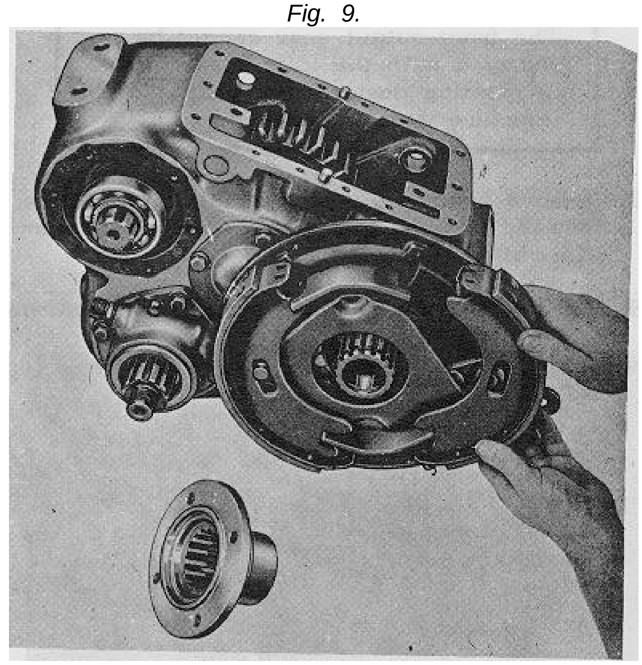

Fig. 10.

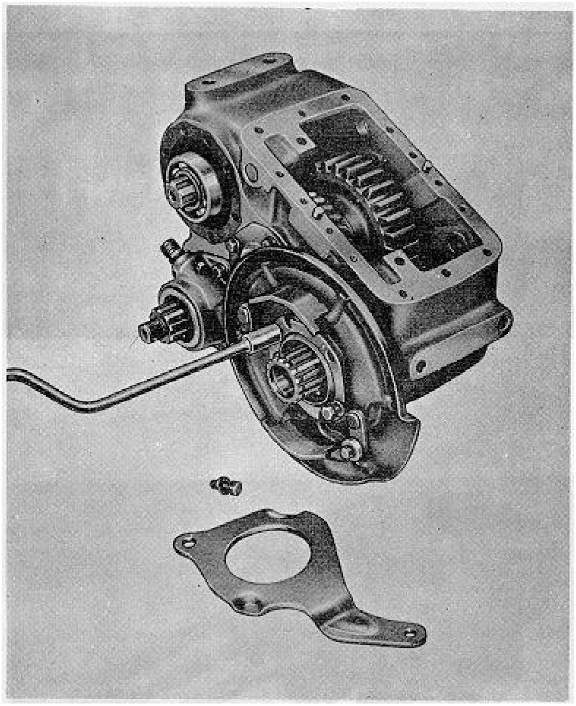

Fig. 11.

16. Remove mounting bolts and take off backing plate assembly with washer, deflector and gasket (Fig. 11).

IMPORTANT

The front output gear cannot be removed with the idler assembly in position because the gears interfere with each other.

17. Remove front and rear bearing caps. Wire forward bearing cap shims together for reassembly.

18. Remove bearing retainer plate from front end

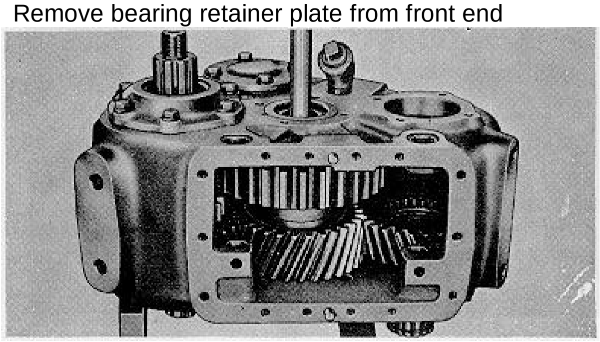

Fig. 12.

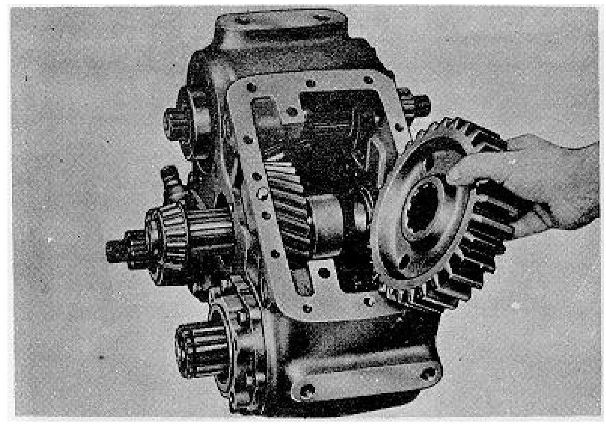

Fig. 13.

of idler shaft; then press shaft out through rear of case (Fig. 12).

19. Lift out the Lo gear, gear spacer and front bearing (Fig. 13).
20. Remove Hi gear. Tap front bearing cup from case (Fig. 14).

21. Remove snap ring and press rear bearing from idler shaft.

22. With idler assembly removed, the front output gear and bearing can be removed. Remove rear bearing cap and gasket.

23. Take off bearing snap ring and tap gear into case; reach through cover opening and lift out gear and bearing (Fig. 15).

24. Press off radial bearing.

25. Remove capscrews and take off front and rear bearing caps. Wire shims together for reassembly.

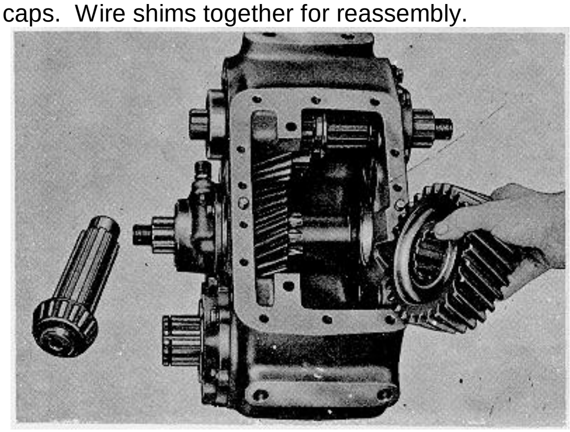

Fig. 14.

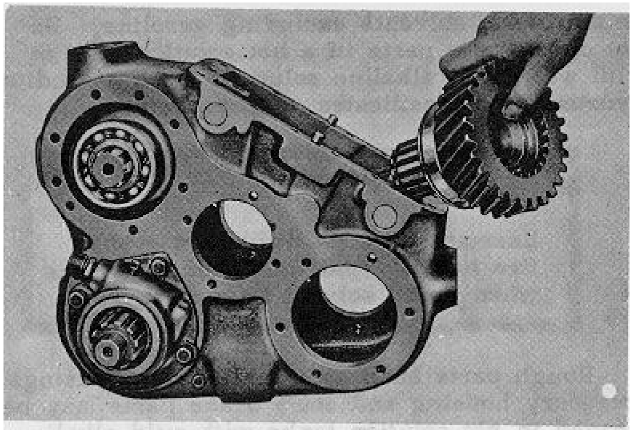

Fig. 15.

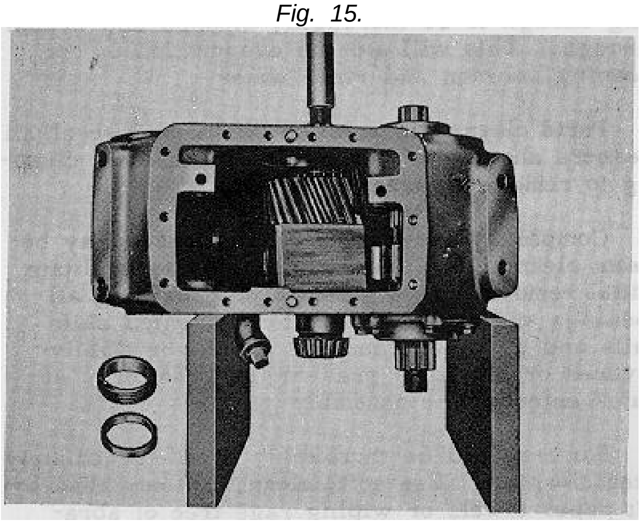

Fig. 16.

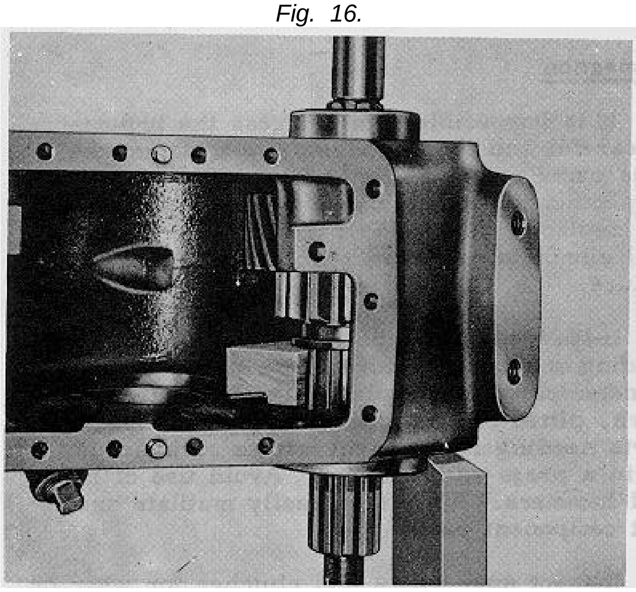

Fig. 17.

26. Remove speedometer drive gear and spacer.

27. Block gear with a piece of wood and press rear output shaft and front bearing out of the case as shown (Fig. 16). The gear and rear bearing can be lifted out through cover hole.

28. Remove input shaft front bearing cover. Wire shim pack together for reassembly.

29. Using a block of wood between sliding gear and case, press out input shaft and front bearing (Fig. 17). Do not pound on shaft if gear becomes bound.

30. Lift out sliding gear, drive gear and Spacer (Fig. 18). Remove front bearing from shaft.

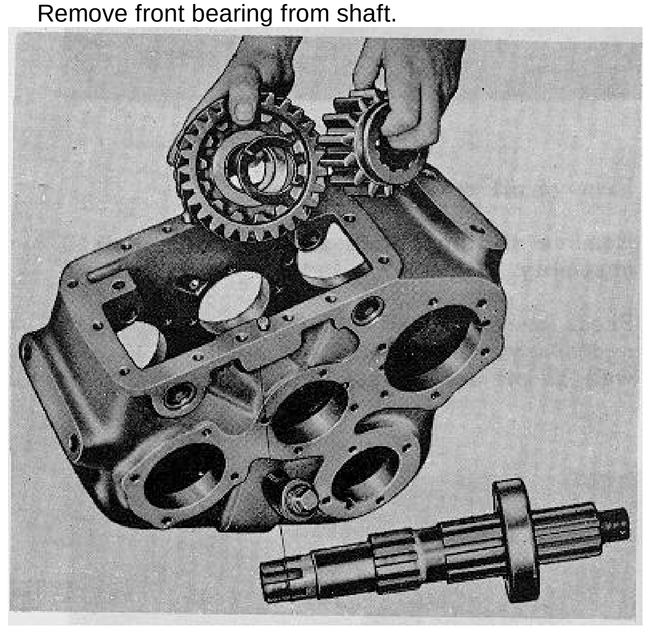

Fig. 18

Disassembly of Power-Take-Off

1. Remove capscrews and lockwashers; /lift off cover and gasket

2. Take out detent spring and ball.

3. Cut wire and loosen shift fork set screw.

4. Tap shift shaft out through rear of housing (expansion plug will fall out).

5. Remove shift shaft and shift fork (Fig. 19).

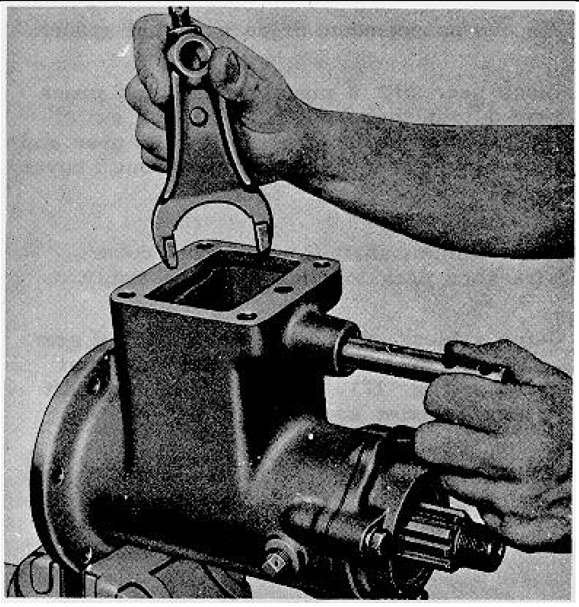

Fig. 19.

6. Remove oil seal cage.

7. Remove sliding clutch and pull out shaft assembly (Fig. 20).

8. Press bearings and wiper from shaft. If necessary, remove shift shaft oil seal as well as oil seal located inside housing.

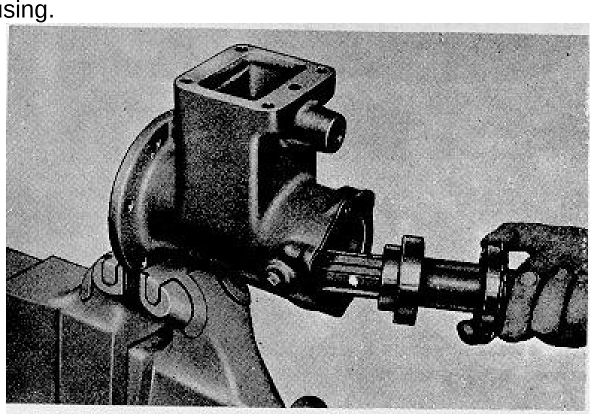

Fig. 20.

CLEANING, INSPECTION AND REPAIR

Cleaning

Clean parts having gro,ln4d and polished surfaces, such as gears, bearings and shafts, with solvent type cleaners such as emulsion cleaners or petroleum solvents excluding gasoline. Do not clean these parts in a hot solution tank or with water and alkaline solutions such as sodium hydroxide, orthosilicates or phosphates.

CAUTION
Exercise -care to avoid skin rashes, fire hazards and inhalation of vapors when using solvent type cleaners.

Rough parts such as transfer case housings, accessory housing and some brake parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts are not ground or polished. Parts should remain in the tank long enough to be thoroughly cleaned and heated through. This will aid the evaporation of the cleaning solution and rinse water.

Parts cleaned in solution tanks or with alkali cleaners should be thoroughly rinsed after cleaning to remove all traces o alkali.

Completely assembled transfer cases may be steam cleaned, on the outside only, to facilitate initial removal and disassembly, providing all openings are closed. Breathers, vented shift units and all other openings should be tightly covered or closed to prevent the possibility of water entering the assembly.

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

Inspection

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

Inspect all bearings, cups and cones, including those not removed from parts of the transfer case, and replace if rollers or cups are worn, pitted or damaged in any way. Remove parts needing replacement with a suitable puller or in a press with sleeves. Avoid use of drifts and hammers. They may easily mutilate or distort component parts.

Inspect spur gears and clutches for wear or damage. Gears which are scored, pitted, ridged or worn should be replaced.

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

Repair

Replace all worn or damaged parts. Hex nuts with rounded corners, all lockwashers, oil seals and gaskets should be replaced at the time of overhaul.

Use only genuine International replacement parts for satisfactory service. For example, using gaskets of foreign material generally leads to -mechanical trouble due to variations in thickness and the inability of certain materials to withstand compression, oil, etc.

Remove nicks, mars and burrs from machined or ground surfaces. Threads must be clean and free to obtain accurate adjustment and correct torque. A fine mill file or India stone is suitable for this purpose. Studs must be tight prior to reassembling the parts.

When assembling component parts use a press where possible.

Tighten all nuts to correct torque. :(See torque limits following service instructions.) Use soft iron locking wire to prevent possibility of wire breakage.

The burrs, caused by lockwashers, at the spot face of stud holes of cages and covers should be removed to assure easy reassembly of these parts.

ASSEMBLY

Assembly of Power-Take-Off

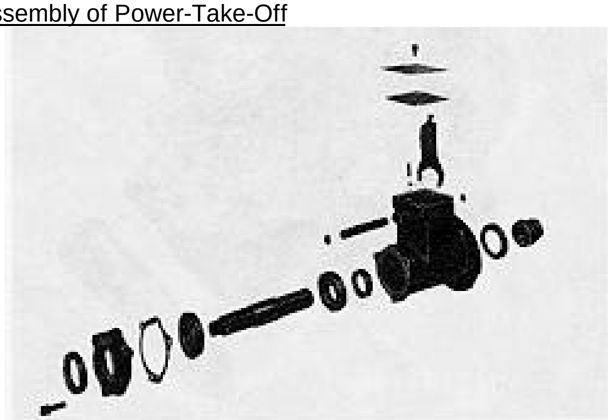

Fig. 21.

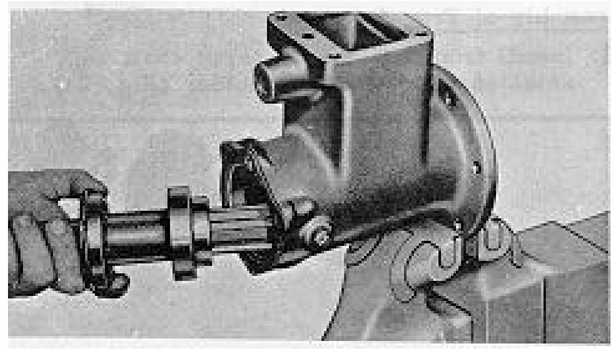

Fig. 22.

1. Install ball bearings on power-take-off shaft.
2. Position wiper against inner bearing. Install snap ring in groove of outer bearing.
3. Slide shaft assembly into housing and install sliding clutch on inner end (Fig. 22).
4. Position a new gasket and install oil seal cage assembly. Secure with capscrews and lockwashers.
5. Place shift fork in groove of sliding clutch. Slide shift shaft into bore of fork (Fig. 23).
6. Line up recess in shaft with set screw and tighten screw. Lock wire the set screw to fork.
7. Install expansion plug in shist shaft hole. If necessary, replace shift shaft oil seal located in front of housing.

Fig. 23.

Assembly of Transfer Case

1. Install front bearing on input shaft with shielded side against shoulder (Fig. 24).

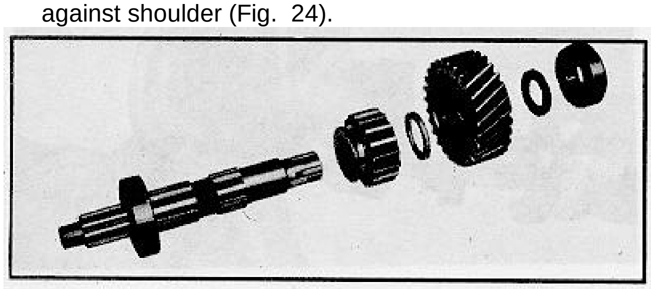

Fig. 24.

2. Start input shaft into case. Mount sliding gear, spacer and drive gear (with bushing) on shaft (Fig. 25).

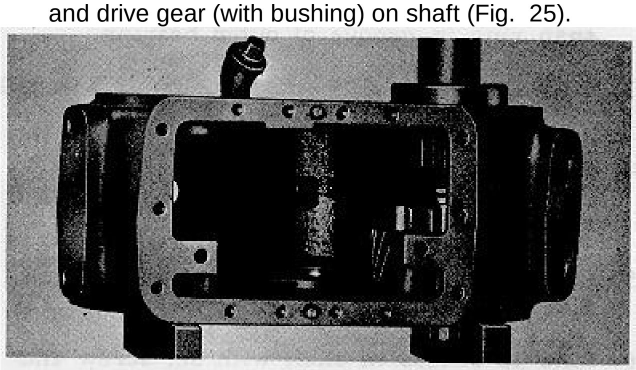

Fig. 25.

3. Tap input shaft into position using a suitable sleeve against the inner race of front bearing.
4. Position original shim pack plus .254 mm (.010") more to make sure there is end play in assembly. Install front cover and tighten capscrews.
5. Place thrust washer on shaft and install rear bearing with shielded side toward the inside.
6. Position a new gasket and attach power-takeoff (or cover, if used) to rear of case. Tighten capscrews.
7. Mount a dial indicator on the unit. Set stem against front end of input shaft and check the amount of end play in the assembly (Fig. 26). Remove enough shims from under bearing cap to arrive at an adjustment of .076 mm - .127 mm (.003" - .005") end play.
8. Reposition bearing cap, insert capscrews and tighten to specified torque. Remove power take-off for convenience in handling transfer case.
9. Press front bearing onto rear output shaft with suitable sleeve.

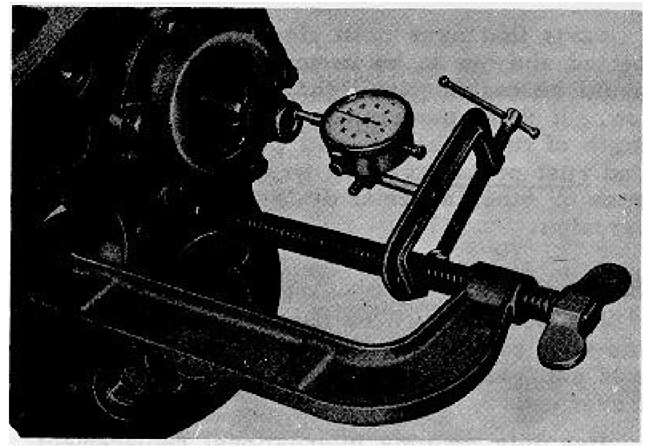

Fig. 26.

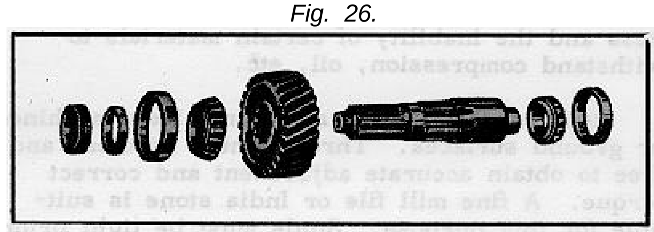

Fig. 27.

10. Hold rear output gear in position inside case and slide shaft through it (Fig. 28).
11. Install front bearing cup and original shim pack plus .254 mm (.010"). Install bearing cover, lockwasher and tighten capscrews.
12. Press rear bearing on shaft with a suitable sleeve (Fig. 29); then tap bearing cup into position.

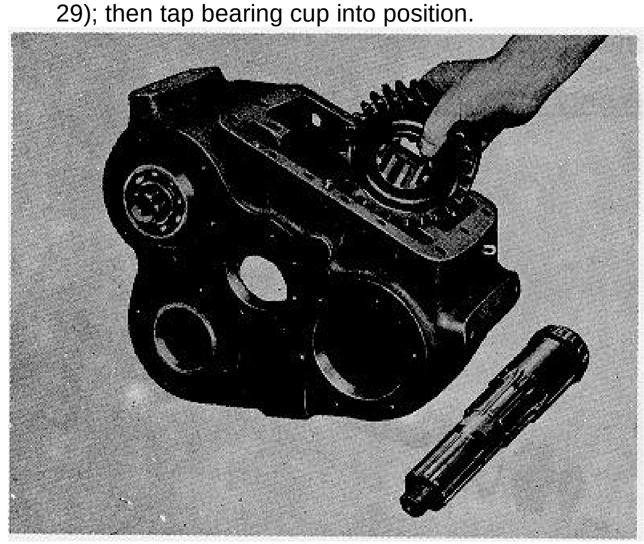

Fig. 28.

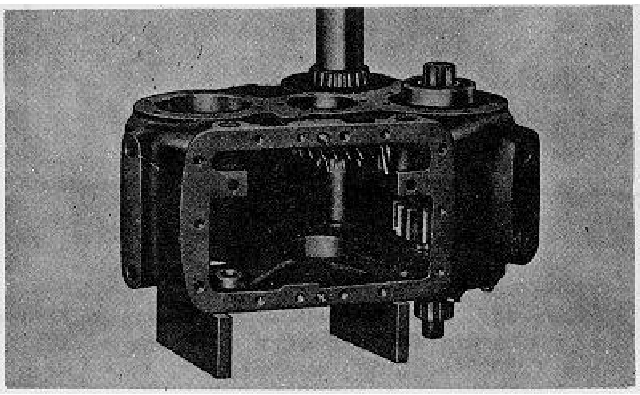

Fig. 29

13. Install spacer and speedometer drive gear over shaft.

14. Position new gasket, bearing cap (and oil seal) over shaft. Install lockwashers and capscrews and tighten to specified torque.

15. Rotate shaft to seat bearings. Mount a dial indicator against rear .,,d of shaft to check amount of end play in assembly (Fig. 30). Remove sufficient shims from under front bearing cap to arrive at an adjustment of zero end play and zero preload.

IMPORTANT

The front output gear must be installed in case before idler assembly is installed.

16. Install ball bearing on hub of gear. Position gear and bearing in case and install snap ring on bearing (Fig. 31).

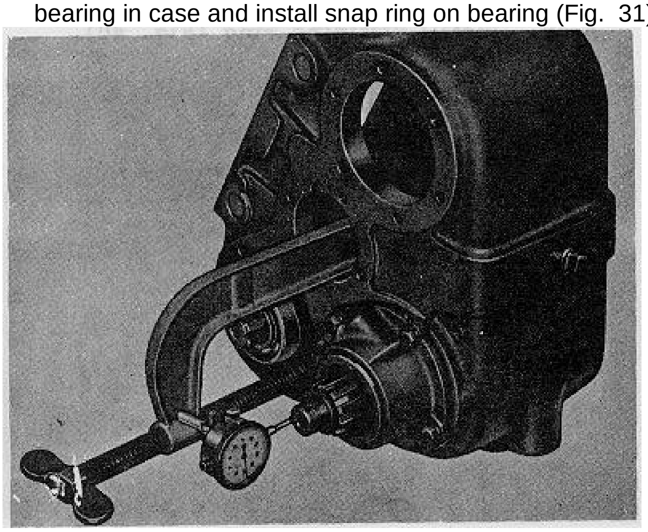

Fig. 30.

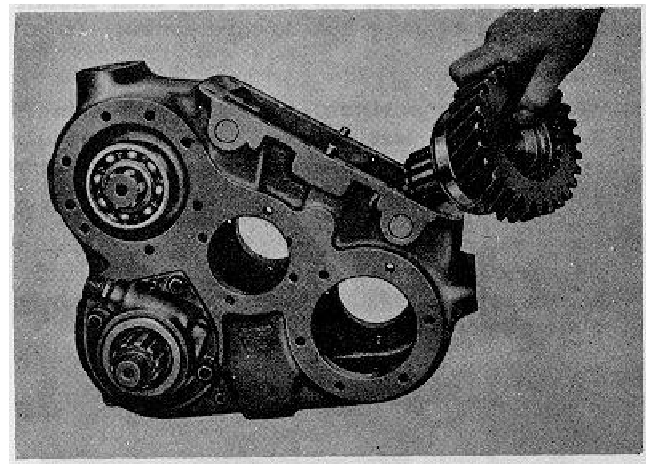

Fig. 31.

17. Install rear bearing cap over a new gasket. Insert capscrews and lockwashers and tighten to specified torque.

18. Press rear bearing on idler shaft. Install snap ring.
19. Hold Hi gear in position inside case and tap idler shaft through it with soft hammer. The short hub side of gear goes to the outside, rear (Fig. 33).

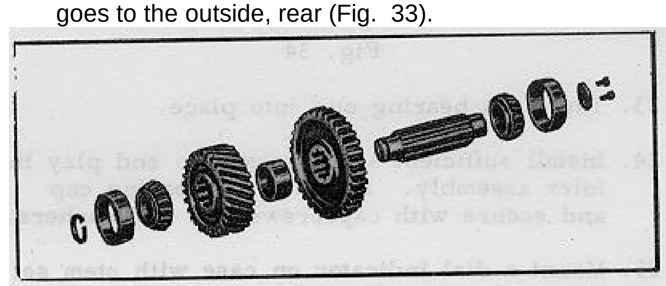

Fig. 32

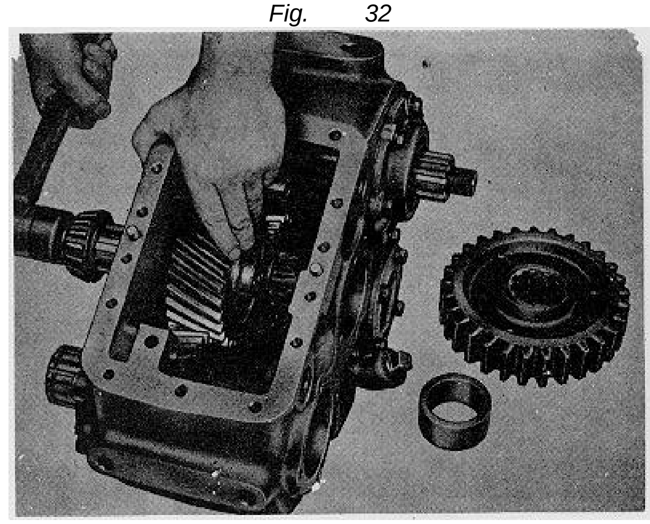

Fig. 33

20. Install gear spacer on shaft and then install Lo gear with long hub toward outside (front) of case.

21. With shaft in 'position, install rear bearing cup in case. Use a new gasket and install rear bearing cap, lockwashers and capscrews Tighten capscrews to specified torque.

22. Drive front bearing onto idler shaft. Hold shaft rigid to avoid damaging rear bearing and cup (Fig. 34). Install bearing retainer plate and capscrews. Lock wire.

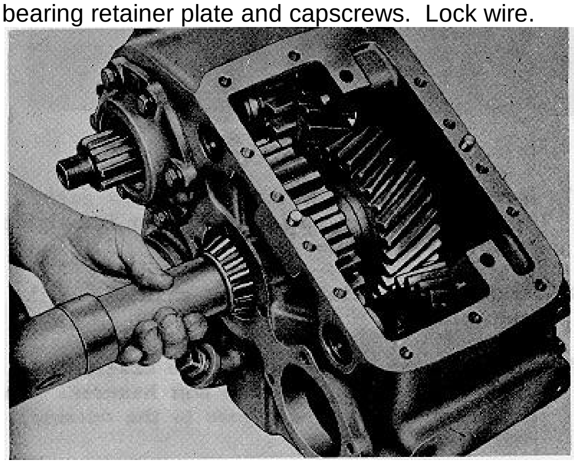

Fig. 34.

23. Tap front bearing cup into place.

24. Install sufficient shims to set up end play in idler assembly. Install front bearing cap and secure with capscrews and lockwashers.

25. Mount a dial indicator on case with stem set against inside face of Lo gear. Check the amount of end play by working assembly back and forth with two prybars as shown (Fig. 35). Remove sufficient shims to arrive at a bearing adjustment of .076 mm .127 mm (.003" - .005") end play.

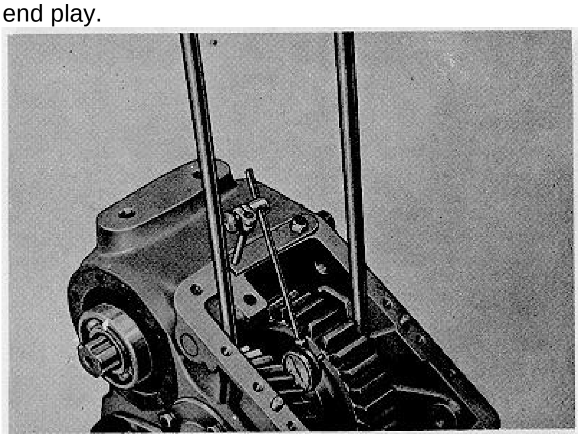

Fig. 35.

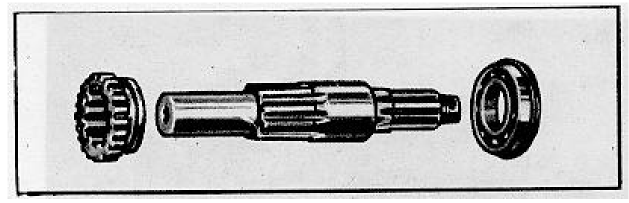

Fig. 36.

26. Install ball bearing on front output shaft with bearing snap ring toward outside.

27. Install sliding collar on shaft. Slide shaft into case (Fig. 37).

28. With shaft in position, install a new gasket, bearing cap and oil seal, lockwashers and capscrews. Tighten capscrews to specified torque.

29. Position a new gasket and then mount backing plate, deflector and stamped washer. Insert capscrews and star washers and tighten to specified torque (Fig. 38).

30. Position brake lever on backing plate.

31. Position brake shoes on backing plate with actuating pawl in web slot (Fig. 39).

32. Hook up brake shoe return springs.

33. Slide brake hub over splines of front output gear. Install retaining ring (Fig. 40).

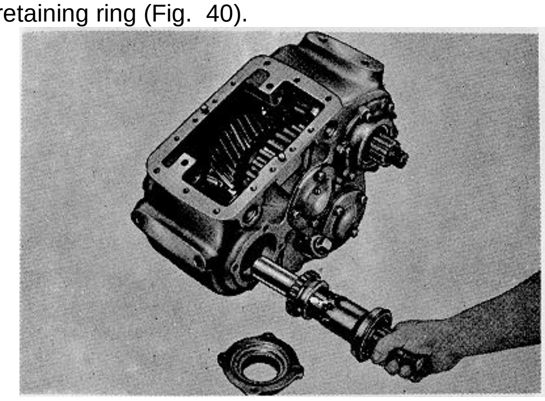

Fig. 37.

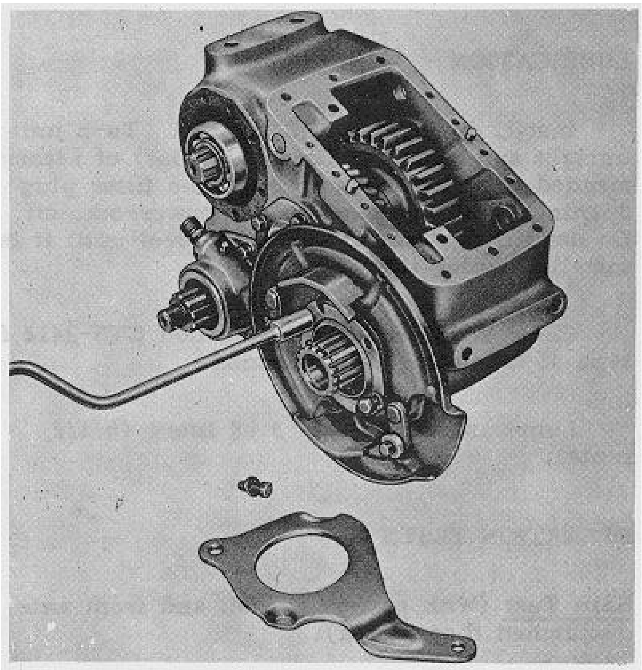

Fig. 38.

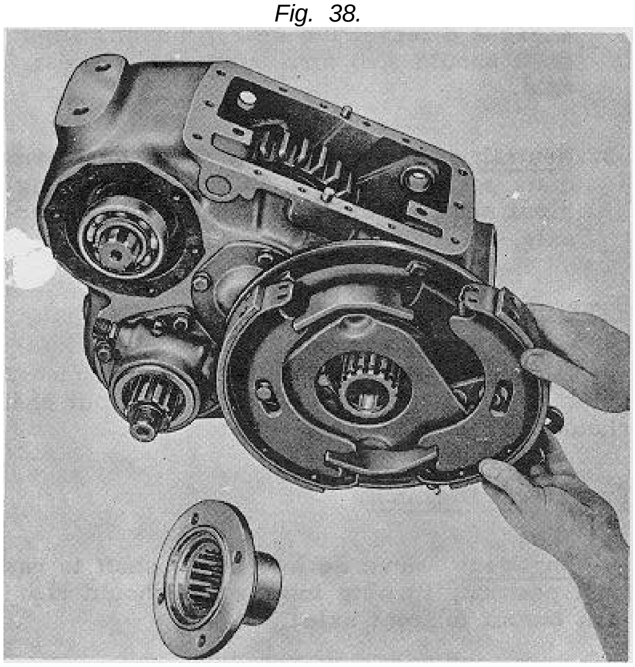

Fig. 39.

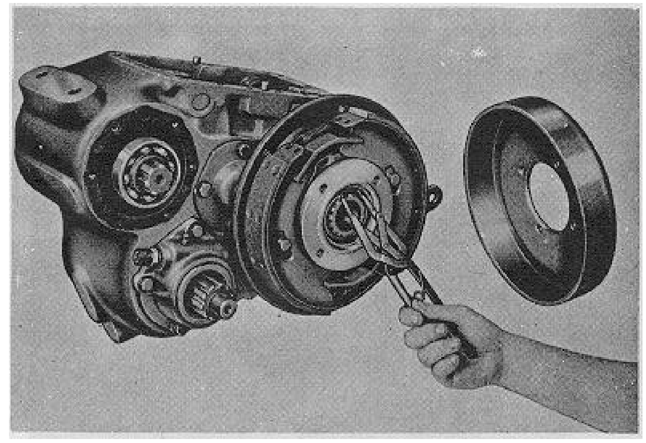

Fig. 40.

34. Install brake drum and lockwashers and capscrews. Tighten capscrews to specified torque and insert lock wire.

35. Install expansion plugs. The smaller goes in the bore of front output gear and the larger in brake hub.

36. Install new shift shaft oil seals in case.

37. Position declutch fork in collar.

38. Grease declutch shift shaft and slide it into case and through fork (Fig. 41).

39. With shift shaft in position, insert set screw. Tighten screw and lock wire to fork.

40. Position range shift fork in sliding gear.

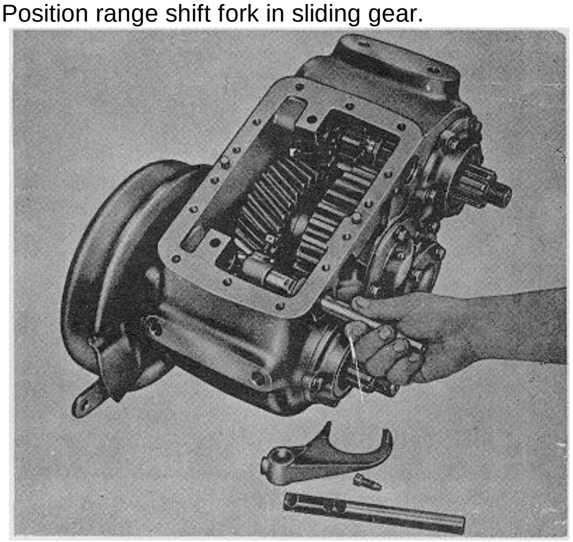

Fig. 41.

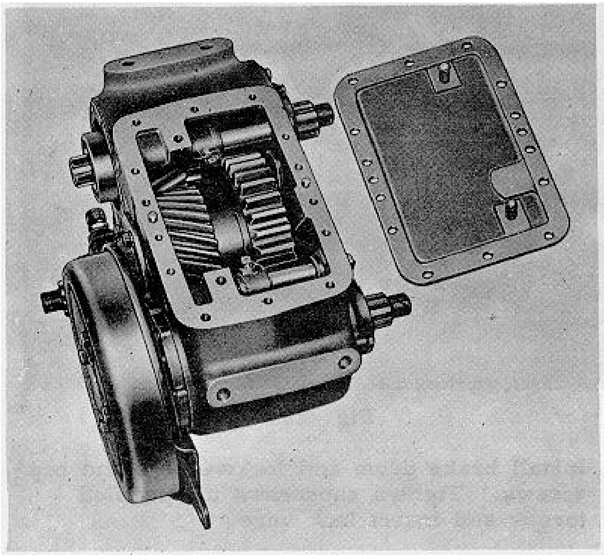

Fig. 42.

41. Slide range shift shaft through fork. Install set screw, tighten and lock wire to shift fork (Fig. 42).

42. Install expansion plugs at rear of case and flatten to expand.

43. Place detent balls and springs in position in case.

44. Install cover with a new gasket and tighten capscrews to specified torque.

45. Install power-take-off assembly over a new gasket (Fig. 43). Secure with capscrews and lockwashers.

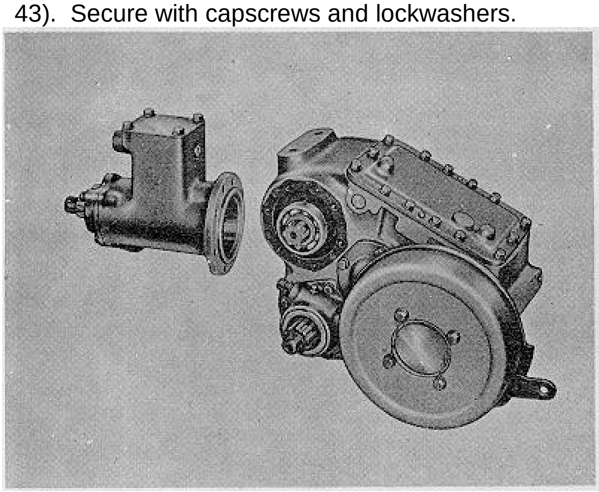

Fig. 43.

46. Install yokes or flanges and nuts and tighten to specified torque.

LUBRICATION

Install drain plug and tighten. Turn unit upright and pour .47 liter (1/2 pint) of recommended gear lubricant through the filter plug opening. Add some oil to the power-take-off. Do not fill the unit to specified level until it is installed under the vehicle.

Refer to LUBRICATION, Section CTS-2412 for type of lubricants recommended.

Lubricant capacity is 3.08 liters (6-1/2 pints).

OPERATION TEST'S

Shift Test (With power-take-off and front axle declutched disengaged).

1. High Range: Move range shift shaft to the rearmost position (so the sliding gear engages direct drive gear); turning input shaft should also turn output to the rear axle.

2. Low Range: Move range shift shaft to forwardmost position (so the sliding gear disengages direct drive gear); turning input shaft should also turn output to the rear axle.

3. Neutral: Move range shift shaft to intermediate position between Hi and Lo; turning input shaft should not turn output to rear axle.

Power-Take-Off

Engaged: Move shift shaft to forwardmost position to engage the PTO: turning input shaft should also turn the PTO shaft.

Front Axle Declutch:

Engaged: Move declutch shift shaft to rearmost position; turning input shaft should also turn output to front axle.

TORQUE CHART

CAPSCREWS		
Location on Unit	Torque, N.m (Lb Ft)	
	Minimum	Maximum
Top Cover	52 (38)	66 (49)
Bearing Caps (All)	52 (38)	66 (49)
Brake Drum	81 (60)	104 (77)
Brake Mounting	81 (60)	104 (77)
PTO to Case	52 (38)	66 (49)
PTO Bearing Cap-to-Housing	52 (38)	66 (49)
PTO Top Cover	52 (38)	(49)
YOKE OR FLANGE NUTS		
Input Shaft	407 (300)	543 (400)
Front Output Shaft	407 (300)	543 (400)
Rear Output Shaft	407 (300)	543 (400)
PTO Shaft	407 (300)	543 (400)

SPECIFICATIONS

IH MODEL	TC-155, TC-156
IH CODE	13155, 13156
TYPE	Constant Mesh
INPUT SHAFT:	
Bearings	Ball
Shaft End Play	.381 mm (.015") Max.
Shaft Adjustment Method	Shims
Shims Available	.076 mm (.003") .127 mm (.005") .254 mm (.010")
Drive Gear Thrust Washer Thickness	4.55 mm - 4.59 mm (.179" - .181")
Rear Bearing Thrust Washer Thickness	4.09 mm - 4.22 mm (.161" - .166")
IDLER SHAFT:	
Bearings	Tapered Roller
Bearing Adjustment	Zero End Play - No Preload
Bearing Adjustment Method	Shims
Shims Available	.076 mm (.003") .127 mm (.005") .254 mm (.010")
SHIFT BAR POPPET BALL SPRING:	
Free Length	37.70 mm (1-31/64")
Newtons (Pounds Pressure) at 25.4 mm (1")	227 - 267 N (50 - 60 Lbs)
LUBRICANT CAPACITY	3.08 Liters (6-1/2 Pints)
UNIT SERIAL NUMBER LOCATION	Top of Case

WHEELS, RIMS, TIRES

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CHAPTER II (BRAKE DRUMS)

CHAPTER III (RIMS AND TIRES)

PRINTED IN UNITED STATES OF AMERICA

CHAPTER III (Continued)

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CHAPTER III (Continued)

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CHAPTER IV

CHAPTER I

WHEELS

GENERAL

The information presented herein covers factory installed wheels and hubs for medium and heavy duty vehicles. Many types of wheels are available and they vary in size, types (disc or cast) and materials (steel or aluminum). Fundamentally, they are the same in that all wheels (or hubs for disc wheels) are mounted to the axles on tapered roller bearings.

SAFETY PRECAUTIONS

Always deflate tires completely before removing locks or side rings.
Always inspect and clean all parts before assembly.
Always inflate tires in safety cage.
Always use a "clip-on" air chuck with remote valve to inflate tires.

Never mix parts of different types or size.
Never use cracked, bent or badly rusted parts.
Never reinflate flat tire on vehicle--use the spare.
Never add air until certain each side or lock ring is fully seated.

WHEEL BEARING ADJUSTMENT

Satisfactory wheel operation and long bearing life depends on correct wheel bearing installation, lubrication and adjustment. The following will help you perform these required services for wheels and hubs.

FRONT WHEEL BEARINGS

Wheels or hubs, bearing cups, nuts, locks, hub caps, shafts and spindles are to be free from any foreign matter. Bearing cones must be properly packed with specified lubricant if wheels are grease packed (see LUBRICATION, Section

If wheel bearings are oil lubricated dip bearing cones in lubricant to provide proper starting lubrication. Outer surface of bearing cone and matching surface of cup may be coated with lubricant to promote cone-to-cup adhesion and facilitate assembly.

After wheel (or hub) and bearings are assembled in place on the spindle, tighten the wheel bearing adjusting nut to 69 N•m (50 ft lbs) while rotating the wheel. Then back off the nut 1/4 turn. If the lock or cotter key can be installed at this position, do so; if not, tighten to the nearest locking position and insert new key or lock. Bent type lockwasher is to have one tab bent over the adjusting nut. For axles that have double nut type lock, tighten jam nut to 136-203 N•m (100 -150 ft lbs) and bend one tab of the lockwasher over the jam nut (Fig. 1). These procedures are intended to result in zero to .25mm (.010") end play with no preload.

Fig. 1

NOTE: The cotter key should be inserted with the long tang toward the end of the spindle. Bend long tang of cotter key over end of spindle. Clip remaining tang leaving just enough stock to bend down against side of nut. A correctly installed cotter key should have the appearance as shown in Figure 2.

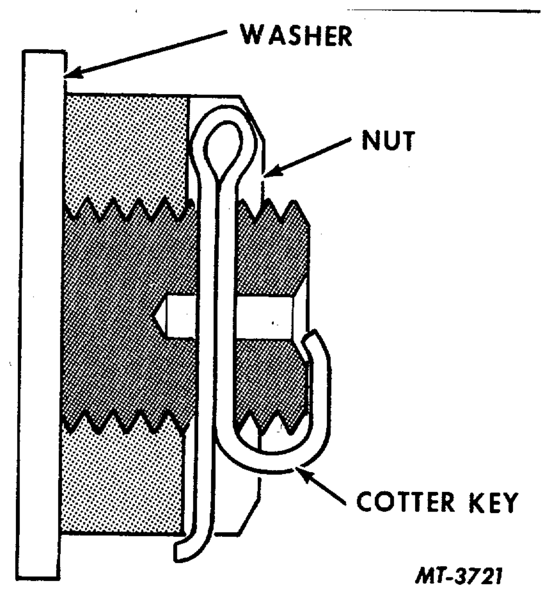

Fig. 2

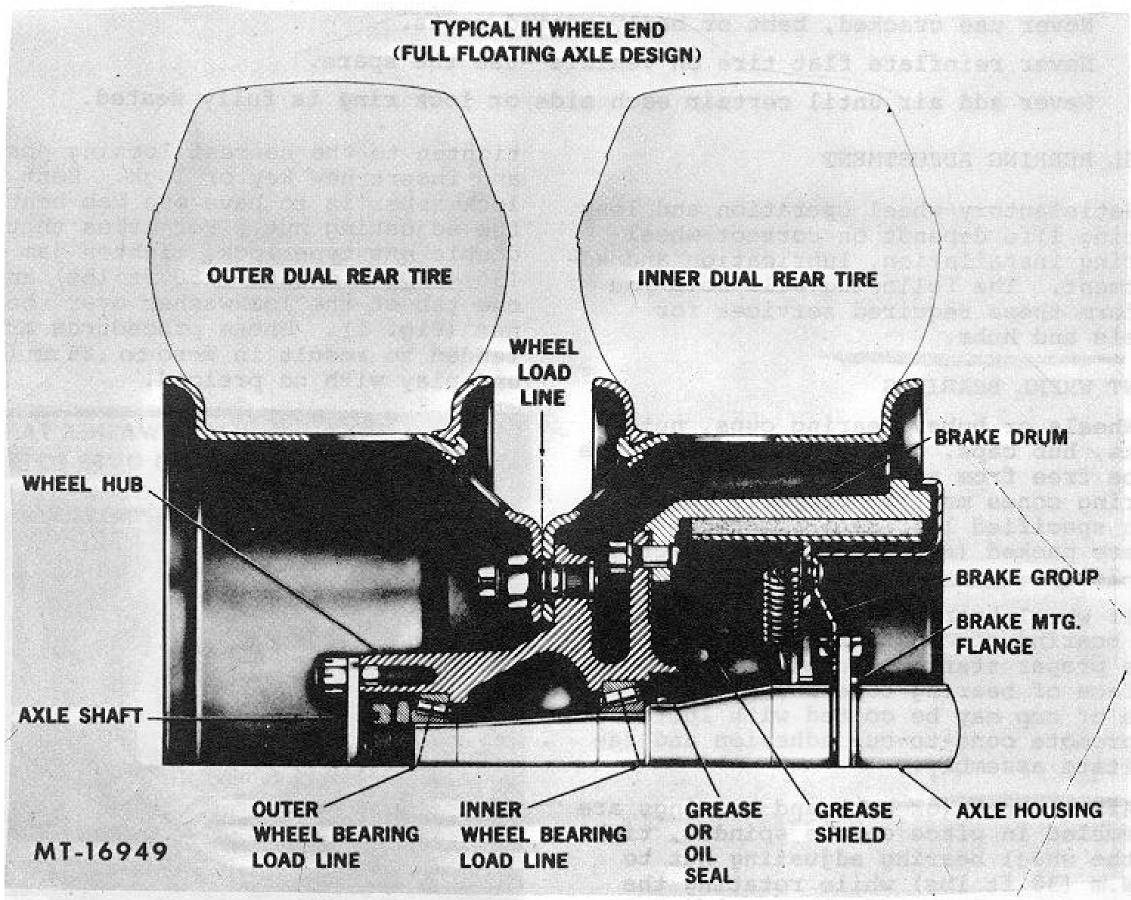

Fig. 3. Heavy Duty

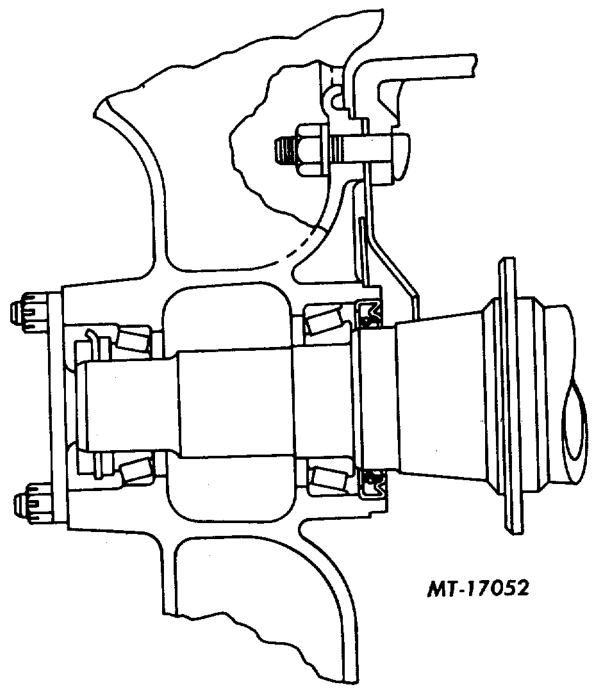

Fig. 4. Medium Duty

REAR WHEEL BEARINGS

Full Floating axle wheel bearings (Fig. 3 and Fig. 4) are adjusted by an adjusting (inner) nut on end of axle. Install adjusting nut and rotate wheel while tightening to be sure bearings are properly seated.

> NOTE: 68.0 N•m (50 ft lbs) torque on adjusting nut is considered sufficient to seat bearings.

Back off adjusting nut 1/4 turn and install lockwasher and jam nut. Tighten jam nut to 203 N•m (150 ft lbs) torque and bend over lockwasher tang to secure nut. Assemblies which use doweled adjusting nut and pierced wheel bearing nut lock require 271-407 N•m (200-300 ft lbs) torque on outer lock nut.

OIL SEALS (OIL LUBRICATED WHEEL BEARINGS)

Various precautions are necessary when oil seals are installed in wheels and also when wheels with oil seals are installed on axles. To insure satisfactory performance from oil seals, the following information has been prepared to guide and assist in proper installation.

Due to the various types of front and rear axle hub seal installations, check axle ring and hub seal position at time of disassembly to assure proper reassembly of new seal and axle ring (wiper).

OIL SEALS WITH AXLE RING (WIPER)

<u>Axle Ring (Wiper) Installation</u>

1. Thoroughly clean all parts: axle tube or spindle, bearings, nuts and inside of wheel hub.

2. Remove burrs from axle tube or spindle shoulder. Shoulder must be smooth.

3. Apply a thin coat of Permatex No. 2 to inside perimeter of axle ring.

4. Place axle ring on axle tube or spindle using an installing tool (Fig. 5).

> NOTE: A suitable installing tool can be made locally by obtaining a piece of standard 8.9 cm (3-1/2") inside diameter tubing approximately 25.4 cm (10") long.

Weld a used close fitting bearing cone or large washer to one end and similarly close opposite end with a plate. This will enable tool to pilot squarely onto axle tube and permit driving force to be centered over the complete ring. The same type of tool can be used for both front and rear axles.

The care with which the axle ring is installed cannot be over-emphasized. Damage to this ring will result in shortened seal life.

5. Tap on end of axle tool driving axle ring firmly on shoulder until axle tool contacts shoulder. Remove excess Permatex.

6. Check position of axle ring to make sure edge of ring is parallel with shoulder.

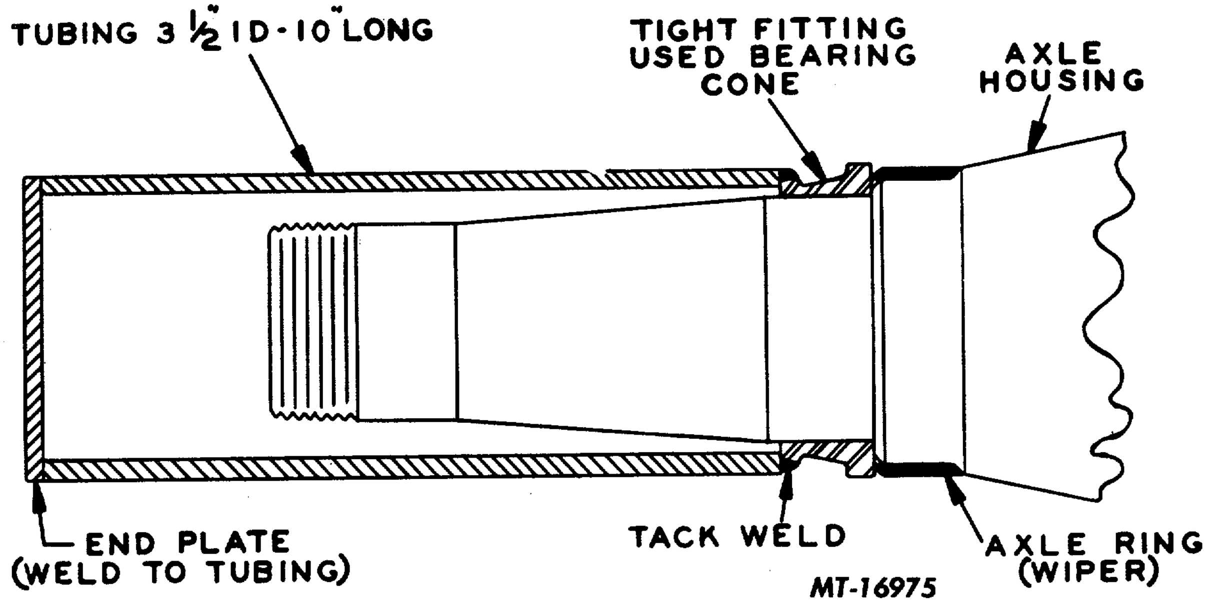

Fig. 5

OIL SEAL INSTALLATION
(OIL SEAL WITH AXLE RING)

1. Remove burrs from inside back edge of hub. Hub must be smooth and free from burrs that will scratch the hub seal.

2. Apply a thin coat of Permatex No. 2 around the outside perimeter of hub seal. Permatex coating must be very light yet cover press fit area. Remember that Permatex is abrasive and should never be allowed to contact lip of leather seal nor contaminate oil.

3. Lay wheel flat with brake drum up. Place inner wheel bearing into bearing cup and place hub seal into starting position on hub.

4. Install hub seal using SE-1904 Installer Set (Fig. 6). Select the size disc which will apply force to outer edge of hub seal and prevent seal from becoming distorted or damaged.

5. Drive hub seal into hub until it bottoms in hub bore. Do not continue to drive after seal is once seated as this will distort or damage the seal. After removal of seal installer tool, clean off excess Permatex (for proper installation, note Fig. 7).

UNITIZED OIL SEAL
(AXLE RING NOT REQUIRED)

Unitized oil seals do not require axle rings (wipers) and minimize wear on the axle spindle as follows. The outer shell of the seal being pressure fit in the wheel hub rotates with the wheel around the sealing element which is pressure fit on the axle spindle. With the unitized seal when replacement is made, the worn surface created by the sealing lip is also replaced.

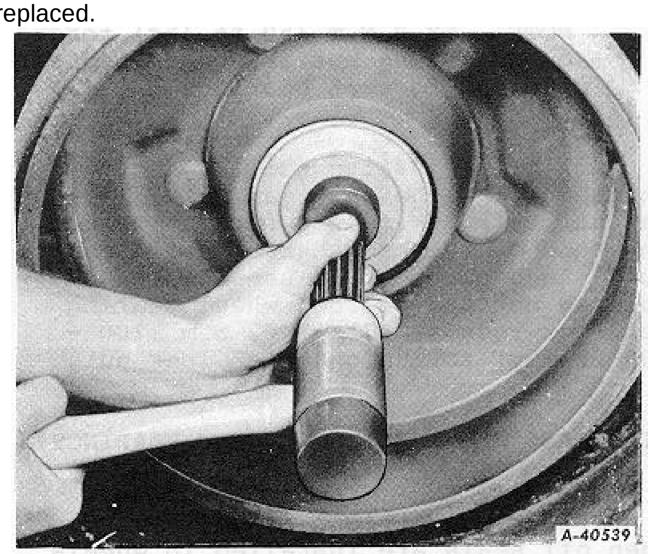

Fig. 6

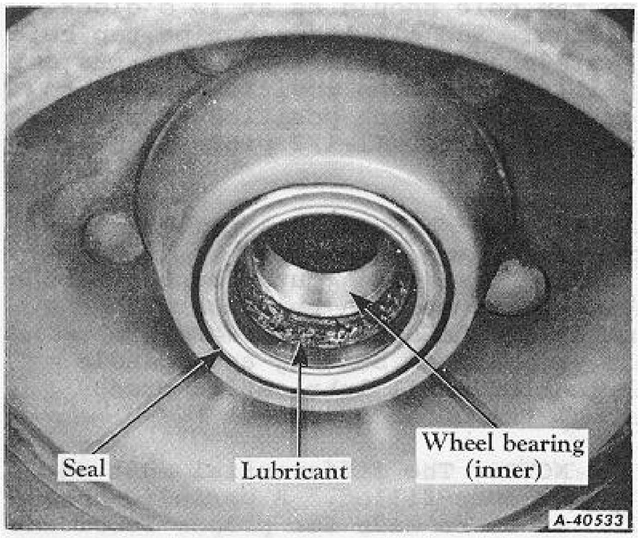

Fig. 7

Unitized Seal Installation

1. If wheel is being changed to a unitized seal from another type of seal, remove wear sleeve backing plates or axle rings as they are no longer required. Note the order of parts at disassembly to assure proper reassembly.

2. Thoroughly clean all parts and remove all burrs from spindle and hub bore. Inspect and replace all parts as warranted.

3. To install unitized seal in wheel, seat outer face of seal in the recess of tool adapter SE-2524 (Fig. 8). Insert centering plug of tool in bore of inner bearing cone (Fig. 9). Using the centering plug prevents cocking of the seal in wheel bore. Bore-tite coating on seal fills in minor imperfections in the wheel bore.

Fig. 8

Fig. 9

4. Hold tool handle firmly and strike until sound of impact changes when seal is seated (Fig. 10).

   NOTE: Seal must be reseated any time wheel is removed.

A good check of proper seal installation is to move the synthetic sealing member with your fingers after installation in wheel hub. There should be a slight in and out movement possible.

Fig. 10

MOUNTING WHEEL ON SPINDLE INSTRUCTIONS
(With Oil Lubricated Bearings)

1. To insure good starting lubrication fill wheel cavity between the bearings with lubricant.

   Front Axle: Fill wheel cavity with engine oil or rear axle lubricant (see LUBRICATION, Section CTS-2412).

   Rear Axle: Fill with same gear lubricant as used in the axle differential.

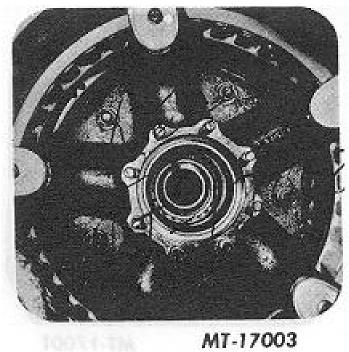

Fig. 11

2. Using a wheel dolly place wheel on spindle; care must be taken not to damage the seal, especially on the leading edge of the spindle or axle (Fig. 11).

INITIAL LUBRICATION OF WHEEL BEARINGS

<u>Transparent Hub Cap (Front Axle)</u>

Add oil through filler plug hole in hub cap allowing time for oil to seep through the bearings and seek a level on initial fill. When properly filled oil should be on or 9.5 mm (3/8") above the oil level mark on the hub cap window. Use engine oil or gear oil for front wheels (see LUBRICATION, Section CTS2412).

<u>Hub Cap Without Window (Front Axle)</u>

Add .71 liter (1-1/2 pints) of matching differential lubricant or enough lubricant to touch the bottom surface of the wheel spindle outside diameter of each front wheel. For initial fill, pipe tap hole should be at.12 o'clock position.

Add oil through pipe tap hole in axle shafts. Fill until oil runs out of filler hole when positioned at 4 to 5 or 7 to 8 o'clock positions [approximately .71 liter (1-1/2 pints)].

TRACTOR DRIVE WHEELS (Rear Axle)
Dip bearing cones in lubricant.

Before installing outer cone fill the wheel cavity between bearings with the same oil to be used in differential. This will assure bearing and spindle lubrication until lubrication creeps through the outer bearing.

> NOTE: The differential must not be over-filled. A periodic check is to be made for proper lubricant level.

On tractor drive wheels, apply Loctite gasket eliminator (sealant) material No. 504 to back of axle flange and install axle (Fig. 12).

Fig. 12

CHAPTER II

BRAKE DRUMS

INSPECTION

The friction surface of brake drums must be smooth, true and concentric whether for air or hydraulic brakes. Make certain with a visual check that drums are not barrel shaped, bellmouthed, scored or eccentric. A barrel shaped drum (Fig. 1) results from overheating. If this barrel shaped condition is not corrected, the braking surface is reduced and uneven lining wear results.

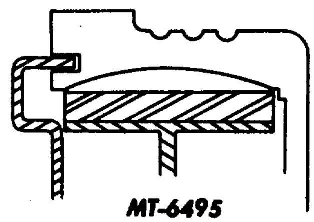

Fig. 1

Extreme pressure which over a period of time will create a bellmouthed drum is shown in Fig. 2. 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.

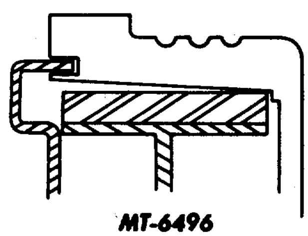

Fig. 2

Scored drums are the result of worn linings to the point where the drum-to-shoe contact is made or an accumulation of small steel particles imbed themselves in the brake lining (Fig. 3). 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.

Brake drum scoring never improves but continually gets worse until both lining and brake drum are useless. Attempting to reline brakes without turning scored

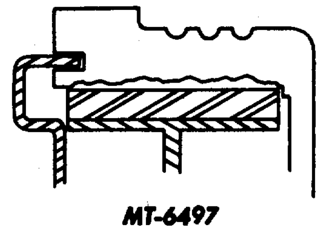

Fig. 3

brake drum surface will quickly destroy new lining and make effective braking impossible.

Brake lining in an eccentric or out of-round drum cannot make full contact with the drum resulting in rapid or uneven lining wear and could even cause brakes to seize or chatter. Maximum allowable out-of-round or eccentricity should be .10 mm (.004").

If inspection shows that any of the preceding conditions exist, brake drum should be either turned or replaced. To assure a balanced braking system, always install turned-or new brake drums in pairs on each axle.

Any time a new brake drum is to be installed on a vehicle, the runout should be checked as follows. Place the new brake drum with hub and wheel assembled in lathe making certain drum is centered. Mount Dial Indicator SE-1848 on lathe and check runout about 12.7 mm (.5") in from end of drum as shown in Fig. 4. Runout must not exceed .38 mm (.015").

> NOTE: Before assembling drum, hub and wheel, all parts must be clean and free of foreign matter.

If runout exceeds .38 mm (.015") remove drum from hub, rotate drum 180° and reinstall on hub. Check runout again; if runout still exceeds .38mm (.015"), remove drum from hub and rotate drum 1/4 turn. Reinstall drum on hub and recheck runout.

REFINISHING BRAKE DRUM

On brake drums manufactured' after January 1, 1971, the maximum diameter to which drum can be worn is stamped or cast into drum. Drum should be discarded if worn beyond this limit. Minor scores on brake drum can be removed with fine emery cloth or steel wool, but always clean

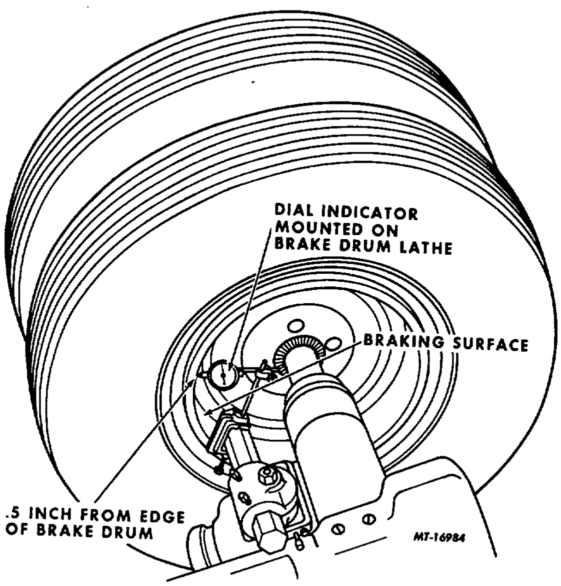

Fig. 4

emery or steel wool particles from drum after this operation. More heavily damaged or out-of-round drums should be ground or turned on brake drum lathe.

If depth of scoring, bellmouth or barrel shaping exceeds .13 mm (.005"), measured with micrometer across part or all of brake surface, drum should be refinished. Reboring limits (see drum) must not be exceeded and no heat checks, cracks or bluing is evident.

Use a micrometer also to check for an out-of-round drum. Make check by measuring drum brake surface diameter at various points, 45° apart around circumference. Eccentricity (out-of-round) should not exceed .38 mm (.015") on diameter.

For older brake drums which do not show a maximum diameter the drum must be discarded when diameter is 3.05mm (.120") over original diameter.

Remember that each time brake drums are turned, less metal remains to absorb the heat developed by braking action. Brake drums containing less metal will operate at a higher temperature. As a result, brake fade, slow recovery and erratic wear will be more noticeable. Also, extremely high temperatures shorten lining life and cause heat checks and cracks (Fig. 5) form on inner surface of drums. These conditions will become progressively worse until finally drums fail.

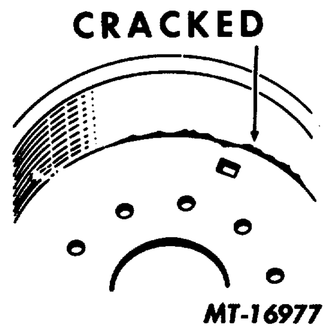

Fig. 5

To recondition a brake drum in a lathe (Fig. 6), the drum must be mounted so that it is centered. Use proper size cone to provide accurate centering. Turn drum, taking only light cuts and remove just enough material to clean up drum. Then grind the finished surface if grinder is available or use emery cloth on a straight piece of wood and polish the drum friction surface.

> NOTE: Brake drums that are otherwise in good condition can be turned in a lathe. However, it must be remembered that recommended rebore limit for brake drums over 35.6 cm (14") in diameter must not be increased more than 2.03 mm (.080") diameter (total cut) and discarded at 3.05 mm (.120") over normal diameter.

Brake drums should be cleaned thoroughly with a steam cleaner or hot water. Do not use a solvent which leaves an oily residue. If inspection shows the drums may be used without remachining, rub friction surface with fine emery cloth or sandpaper to remove any foreign deposits. If drum has been reconditioned, clean friction surface with fine emery cloth or sandpaper and wash. Next examine very carefully to see that no metal chips remain in drum.

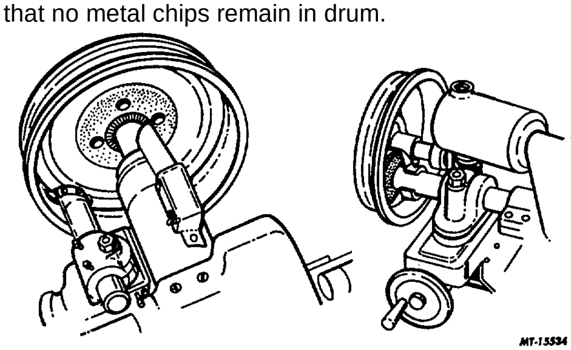

Fig. 6

CHAPTER III

RIMS AND TIRES

GENERAL

Since there are many different kinds of rims and tires for trucks, the methods of servicing them also vary. Most types, however, have been in use for many years, and for that reason the instructions covered here will pertain chiefly to the newest or tubeless types. Some of the most common types of rim and tire combinations are given in the following illustrations (Figs. 1 through 4).

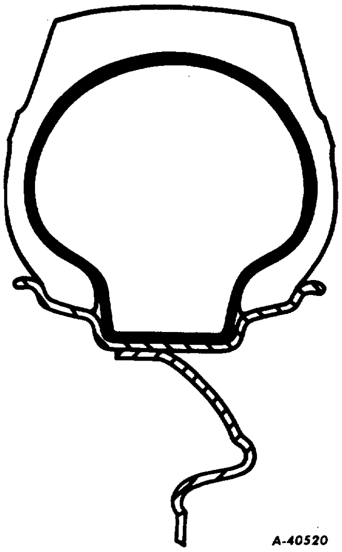

Fig. 1. Drop Center Type Disc Wheel (with Tube)

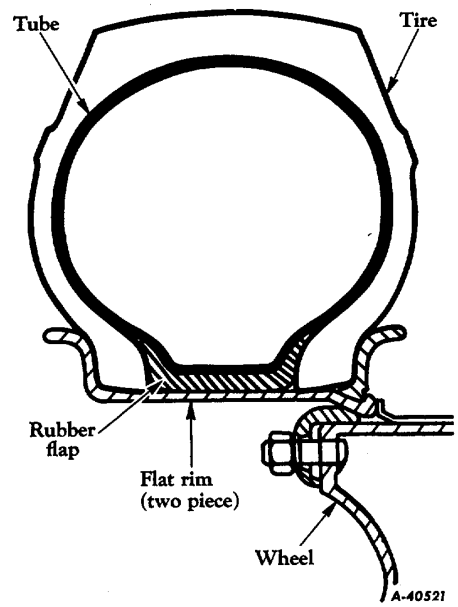

Fig. 3. Dual Cast Wheel and Two Piece Rim (with Tube)

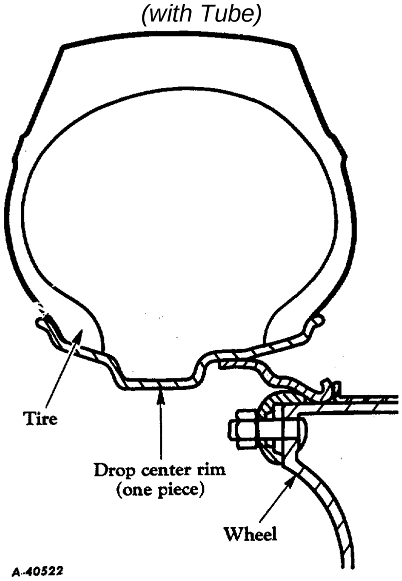

Fig. 2. Drop Center Type Disc Wheel (Tubeless)

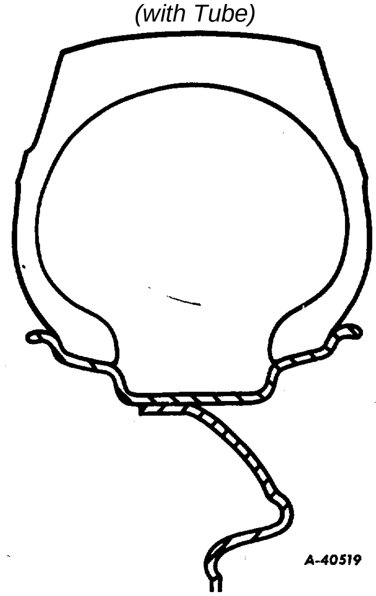

Fig. 4. Dual Cast Wheel and One Piece Rim (Tubeless)

Multiple Piece Rims

On multiple piece rims if it is determined during periodic inspection or during tire changes, that a part is defective it must be replaced.

Caution must be observed when selecting the proper replacement part, an incorrect fit is dangerous. (See Incorrect Assembly Fig. 5). The side ring, locking ring and base must all fit correctly as illustrated in Figure 5 under Correct Assembly.

MULTIPLE PIECE WHEEL ASSEMBLIES

CORRECT ASSEMBLY

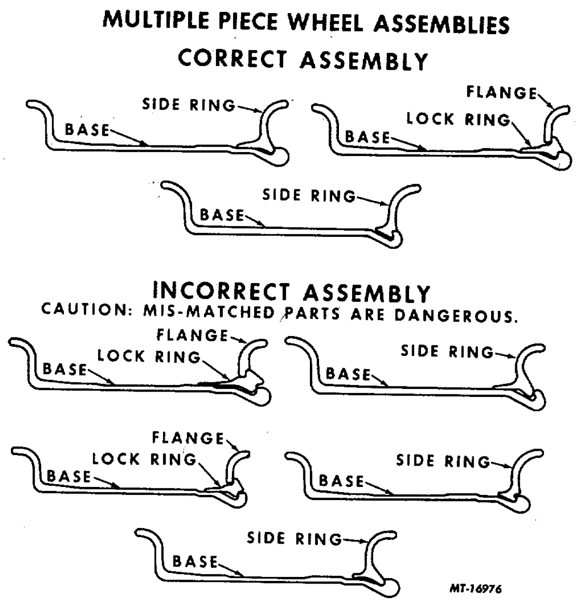

Fig. 5

ALUMINUM WHEELS

Care and Maintenance

Aluminum wheels should be periodically inspected both on the vehicle and during tire changes for cracks, loose wheel studs, worn mounting holes or being bent.

When checking cap nuts on dual disc wheels, back off outer nut before attempting to tighten inner nut.

Whenever a tire is removed, clean off all grease and road dirt. Use a wire brush or steel wool to remove the rubber from the bead seat.

Projections on the side wall of the gutter may cause uneven seating of the side ring and lead to chipping of the gutter. Remove these and other projections in the mounting area to assure the best possible fits.

Nicks and gouges in the vicinity of the fixed flange may lead to rim fracture.

NOTE: Do not heat or weld wheels in an attempt to straighten or repair severe road damage. The special alloy used in these wheels is heat-treated, and uncontrolled heating from welding torch affects the properties of the material.

To avoid possible corrosive affects to aluminum wheels, use only a slight amount of water and neutral soap (similar to Ivory Snow, Dreft, etc. no detergents) when mounting tires. Do not use commercial rubber lubricants.

Wheel Installation

When installing aluminum wheels, lubricate stud threads using a petroleum base grease containing colloidal graphite. Be certain end of wheel wrench is smooth as it will tear grooves in the wheel around the stud nuts it if is rough.

NOTE: Do not allow dirt to enter the mounting area during installation. See "TORQUE CHART" for correct torque values.

Wheel Studs and Mounting Nuts

Maintaining wheel stud and mounting nut tightness does much to insure safe and satisfactory wheel operation. Loose wheel mounting can cause vibration, shimmy, tire wear, stud breakage, worn studs, mounting nuts (Fig. 6) and worn or elongated stud holes (Fig. 7). Parts with these characteristics must be replaced. Always keep wheel stud nuts tightened to specified torque.

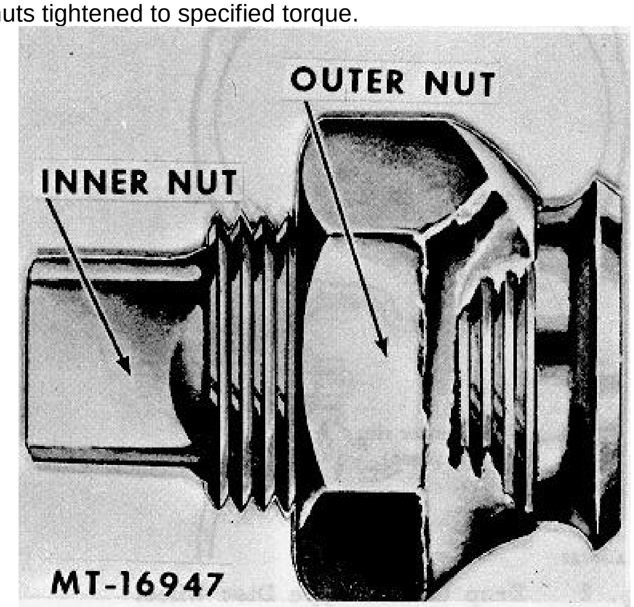

Fig. 6

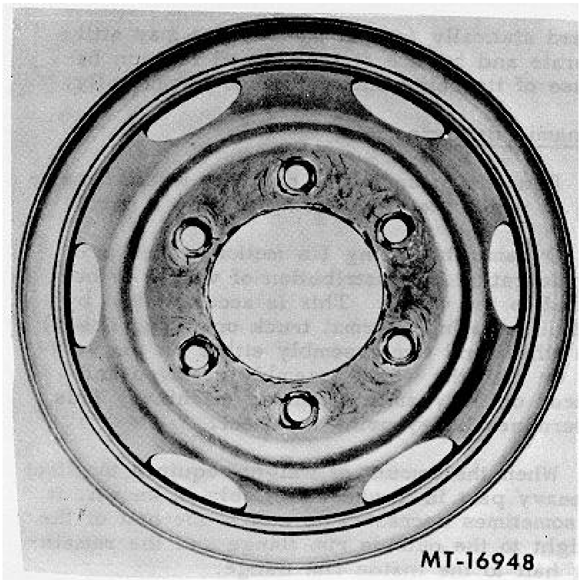

Fig. 7

NOTE: Rust streaks (Fig. 8) from stud holes is a good indication that mounting nuts are not tightened to the specified torque.

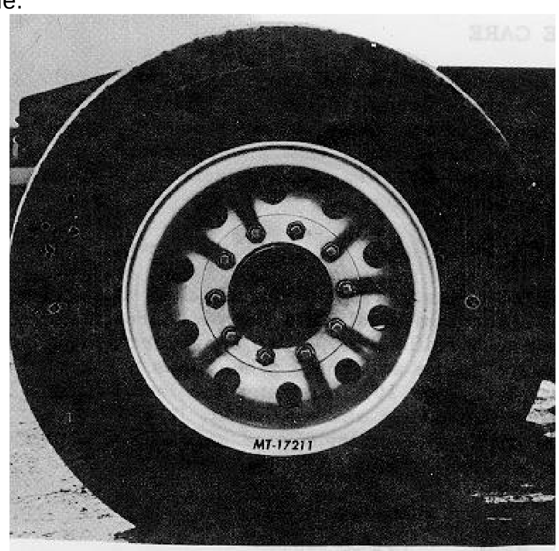

Fig. 8

DISC WHEELS

On disc wheels, which have rims integral with the wheel itself, the important thing to note is that the wheel stud nuts must be kept tight. This means they should be inspected and tightened at regular intervals. When checking the mounting studs and nuts on dual disc wheels, (Fig. 9) the outer nut should be backed off before attempting to tighten the inner nut. Try all cap nuts after the first trip or any wheel change. Properly installed they should remain tight indefinitely. On cast wheels which have rims that are demountable with the tire, the rim clamp nuts should also be kept tight. Rim and tire to wheel alignment should be checked frequently to make sure the tire is running true. Left-hand thread nuts can be identified by the small groove machined around the flats. Left hand studs can be identified by the letter "L" stamped on the head. Use left-hand nuts on the left side of the truck.

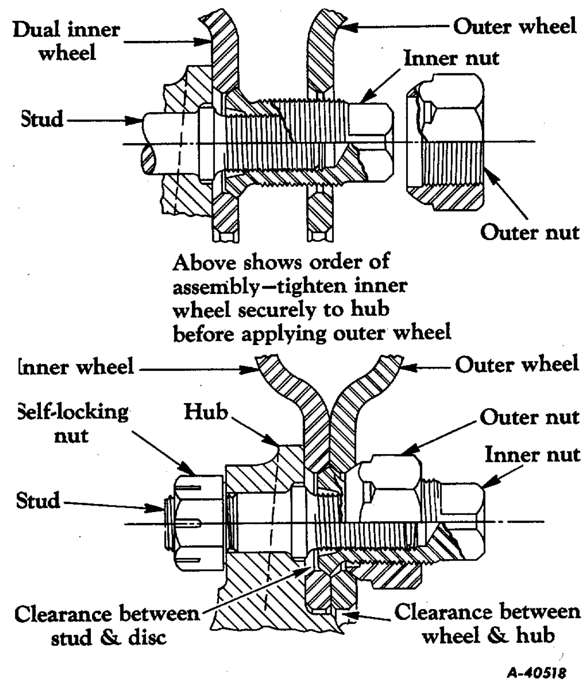

Fig. 9

NOTE: Before mounting wheel assemblies on vehicle make sure all parts are clean and free from foreign matter. Excess paint on wheel stud hole perimeters can permit wheel mounting nuts to loosen with use.

RIM TIGHTENING AND ALIGNMENT

When installing demountable rims, be certain stud threads are clean to permit correct torquing of nuts. NOTE: Do not use any type of lubrication on threads except when installing aluminum wheels.

With rims in position (valve stem 180 degrees apart) successively tighten opposite nuts to assure drawing wheel (or wheels in evenly. This procedure will also minimize wheel misalignment. See "TORQUE CHART" for correct torque values.

After rim has been properly torqued, it should be checked for alignment. This can be accomplished by rotating wheel with a piece of chalk attached to a steady, firm surface and placed to just barely clear outside surface of tire bead seat. This procedure will point out the "high spot". Keep in mind, however, that a "high spot" does not necessarily mean that lug nuts have been unevenly tightened. This condition or misalignment can also result from a bent wheel.

WHEEL AND TIRE BALANCING

Front wheel and tire assemblies must be balanced to prevent wheel vibrating and bounce. While the correct front wheel alignment is necessary for easy steering and maximum tire life, the cause of unstable steering can be frequently traced to improper balance of front wheels. When this condition exists, the wheel assembly should be properly balanced.

A vulcanized or retreaded tire, or a tire that has a boot in it, may cause an unbalanced condition that cannot be corrected by balancing. In such cases the tire should be replaced before attempting to balance the assembly.

Static Balancing

A wheel out of balance statically has a tendency to bounce up and down resulting in rapid tire wear in round or oblong spots.

Static balancing is performed while wheel is stationary by attaching weights to rim flange to offset an opposite heavy point.

Static balancing may be sufficient in some instances where vehicle is operated only at slow speeds, however, dynamic balancing (in motion) balances the wheel and tire assembly statically as well as dynamically, thereby eliminating vibrations and wheel bounce at both low and high speeds. NOTE: A wheel may be perfectly balanced statically (not in motion) but may still vibrate and bounce at high speed rotation because of its being out of balance dynamically.

Dynamic Balancing

Dynamic balancing is complete wheel balancing of which static balancing is only a part.

Dynamic balancing (in motion) takes into consideration the distribution of weight to be added to the wheel. This is accomplished by rapidly rotating (normal truck operating speed) the wheel and tire assembly either on the vehicle or with the wheel assembly removed and placed on a dynamic balancing machine. This determines heavy point on wheel.

When the amount of weight required to offset a heavy part in a wheel assembly is known, it is sometimes necessary to attach one-half of the weight to the outside rim flange and the remaining half to the inside rim flange.

With the weight properly distributed on the wheel assembly, the wheel should be in balance both statically and dynamically and should rotate free of vibration and bounce at normal truck operating speeds.

TIRE CARE

Proper tire inflation, tire loads, and road speeds are important determining factors governing tire mileage, and also affect steering ease and maneuverability. How much these three factors affect tire wear is illustrated in the paragraphs which follow.

INFLATION

Tire pressures should be checked at regular and frequent intervals and the pressures maintained to specifications. Use an accurate tire pressure gauge and check when tires are cool. The chart (Fig.. 10) illustrates the loss in tire mileage caused by underinflation. It will be noted that a tire underinflated only 20% will produce only 70% normal mileage.

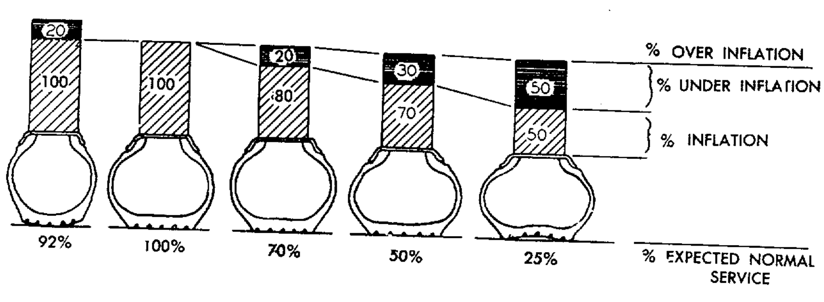

Fig. 10. Inflation vs. Mileage

Overinflation is also costly because a tire which is 20% overinflated will produce only 92% normal tire mileage.

"Bleeding" of air from hot tires should never be practiced. The pressure will be reduced but an increase in temperature will result as soon as driving continues.

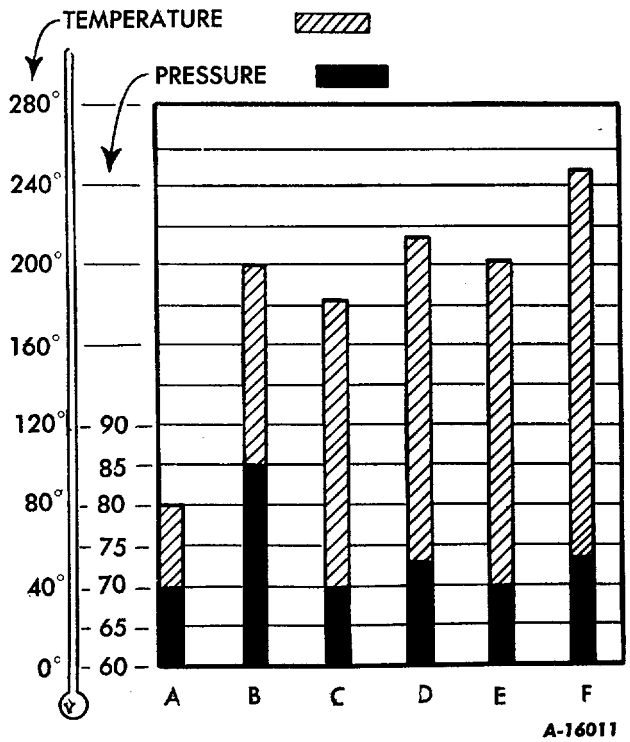

Fig. 11. Chart Showing Effects of Bleeding

The chart (Fig. 11) illustrates a condition where a tire was started cool with a pressure of 70 pounds and at a temperature-of 26.7 degrees C (80 degrees F).

A - Initial conditions.

B - After 225 km (140 miles) of driving the pressure had increased to 85 pounds and temperature 93.3 degrees C (200 degrees F).

C - The pressure was then "bled" to 70 pounds and an additional drive made of 225 km (140 miles). Note the temperature.

D - The pressure had increased to 73 pounds while the temperature increased to approximately 104.4 degrees C (220 degrees F).

E - Again "bleeding" was resorted to. Note the temperature.

F - After 322 km (200 miles), the tire failed from a temperature of over 121.1 degrees C (250 degrees F).

LOADS

Loading tires beyond their rated capacity is expensive because tire mileages are rapidly decreased with overloads. The following chart (Fig. 12) illustrates how an overload of only 20% will result in tire mileage being only 70% of normal.

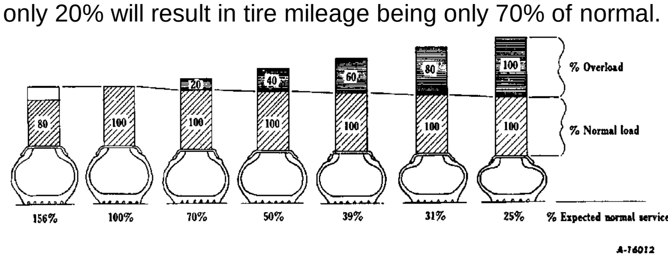

Fig. 12. Overload vs. Mileage

SPEEDS

Excessive speed is definitely one of the most important factors in loss of tire mileage. The chart (Fig. 13) illustrates how an increase in speed from 40 to 50 mph results in 18% loss in mileage. An increase of speed from 40 to 60 mph results in a 33% mileage loss.

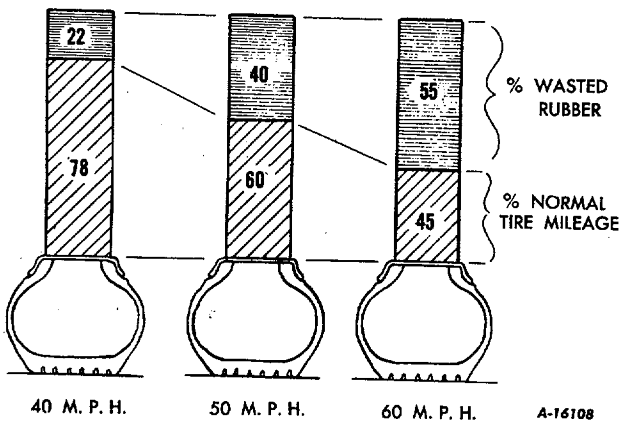

Fig. 13. Speed vs. Mileage

TIRE MATCHING (Dual Tires)

Use care in matching dual tires. Tires which differ more than 1/4" in diameter or 3/4" in circumference should not be mounted on the same dual wheel. Should it become necessary to mount two tires of unequal size on the same dual wheel, place the larger or less worn tire on the outside.

TIRE MATCHING (Tandem Drive Axles)

When mounting tires on tendem drive axles, follow the same instructions as specified for dual tires. However, never install the four largest tires on one driving axle and the four smallest on the other. This method of tire mounting will cause high lubricant temperatures which may lead to premature axle failures.

TIRE REPAIR

Methods for repairing tires will vary slightly with each manufacturer and it is recommended that the tire manufacturers' procedures be followed if possible. However, the procedure outlined here applies in general to most tires whether they are light duty or heavy duty. Patching will usually be satisfactory for all injuries up to 3/16" diameter. Larger injuries should be handled by spot or section repair methods. <u>The first four steps given here apply to both the hot and cold patch methods</u>.

NOTE: Some tire repair methods for simple punctures do not require the dismounting of tire from rim. These methods should be regarded as temporary fixes since there is a good chance of ply separation and ultimate tire failure can result when puncture plug is installed from the outside.

1. Remove tire and wheel assembly and inflate the tire to the recommended pressure. Locate the leak and mark with a crayon. It may be necessary to immerse the tire in water or apply a coat of soapsuds to the tire to locate the leak. Demount the tire. Probe the injury with an awl (Fig. 14) to remove the puncturing object and foreign material.

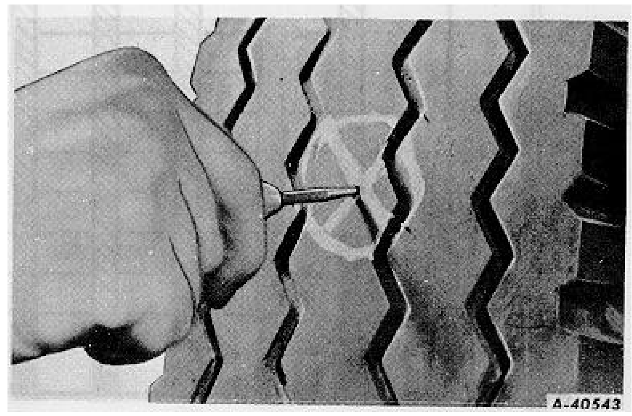

Fig. 14

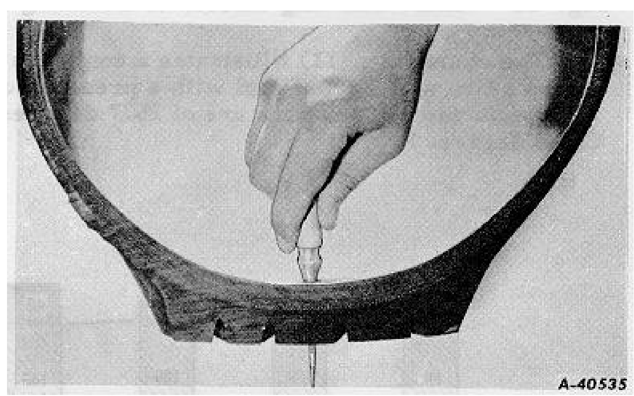

Fig. 15

2. Thoroughly clean the inside of the tire around the injury with rubber solvent and allow to dry. As a safety precaution, solvent vapors should be blown out of the tire with compressed air. Solvent is not needed

to clean an injury if a power buffer equipped with a fine wire 1brush is used. Care must be taken not. to buff through the innerliner. Clean the awl needle and dip in self-vulcanizing fluid and from the inside of the tire, force the needle through the puncture until the point extends beyond the tread (Fig. 15).

3. Remove the detachable handle from the needle. Cut a 3.175 mm (1/8") strip of filler rubber and place it into the hole of the needle with the end of the rubber strip extending beyond the needle. Pull needle through the tire with a pliers (Fig. 16). Filler rubber will remain in puncture. Using an awl, pack excess rubber flush with inside of tire.

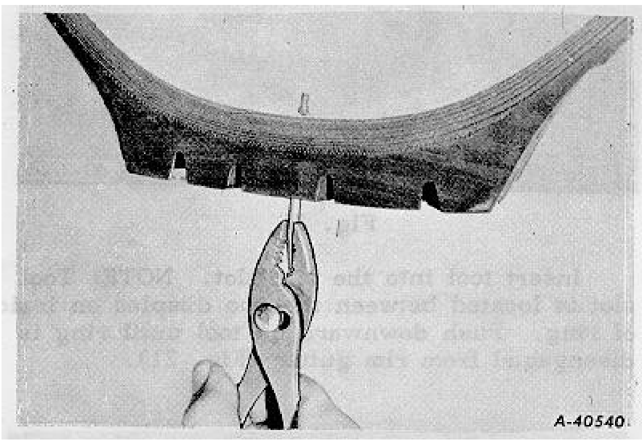

Fig. 16

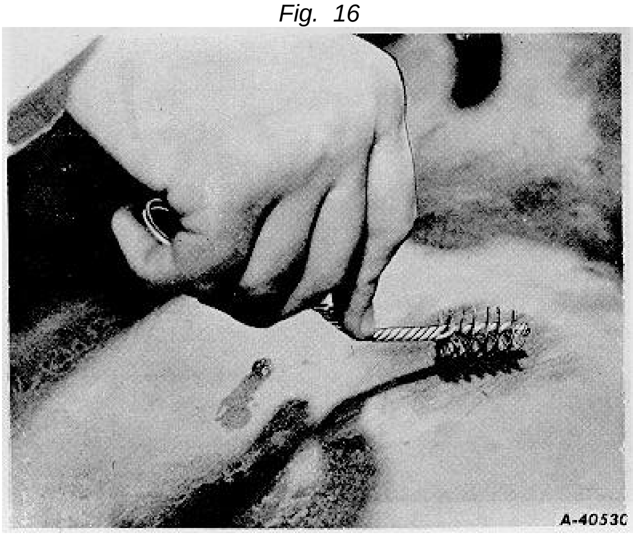

Fig. 17

4. With a wire brush (Fig. 17) or a power buffer, thoroughly roughen an area about the injury slightly larger than patch and within previously cleaned surface area. Remove all traces of lubricant, foreign material, etc. Do not use more solvent after buffing.

<u>The next three steps apply only to the hot patch method</u>.

5. Remove backing from patch and carefully center it over injury. Place a clamp over patch and tighten clamp only finger tight (Fig. 18).

6. Ignite patch and allow it to cool for at least 15 minutes or until cool to the touch. Carefully remove metal pan and ashes remaining in tire.

7. Remount tire. Inflate to recommended operating pressure. Then check to make sure injury is sealed.

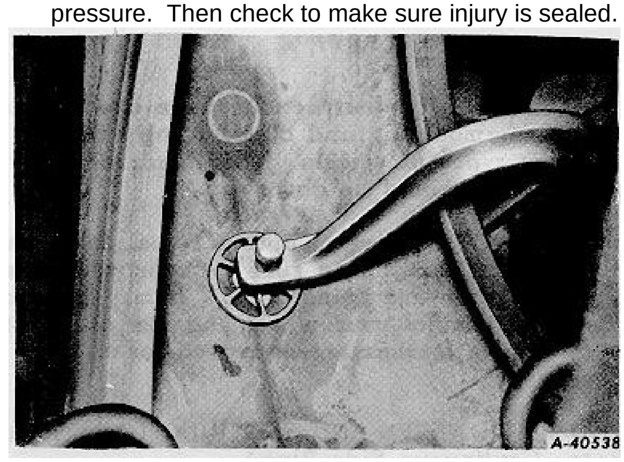

Fig. 18

<u>The next three steps apply only to the cold patch method</u>.

8. Apply self-vulcanizing cement over buffed area and allow it to dry for a minimum of five minutes. This time factor is important.

9. Remove backing from patch base and place patch over injury. Press down firmly, especially at the edges, for good adhesion (and easy removal of paper cover) (Fig. 19).

10. Remount tire. Inflate to the recommended --operating pressure. Then check to make sure injury is sealed.

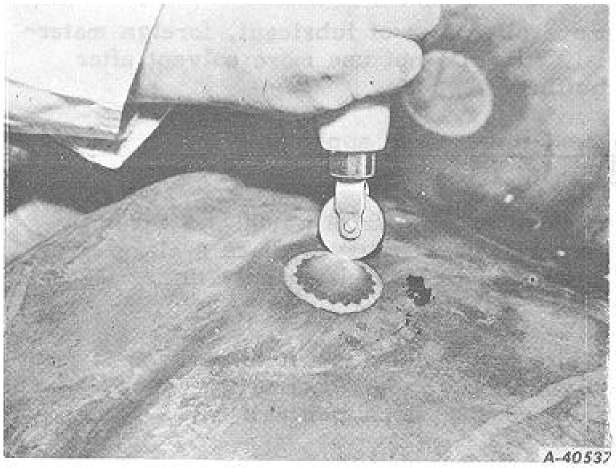

Fig. 19

MOUNTING AND DISMOUNTING TIRES

General

The following instructions were prepared as an aid for mounting and dismounting tires on different types of wheels. All standard safety precautions should be observed.

CAUTION: Before mounting radial tires make certain that heavy duty rims or approved rims for these tires are being used. It may be necessary to contact your wheel and rim distributor to determine if rims are approved for radial tires.

TWO-PIECE WHEEL AND SIDE RING (Continuous Base, Continuous Side-Ring)

The following instructions are given as an aid in servicing the two-piece wheel and side ring.

<u>Dismounting Tire</u>

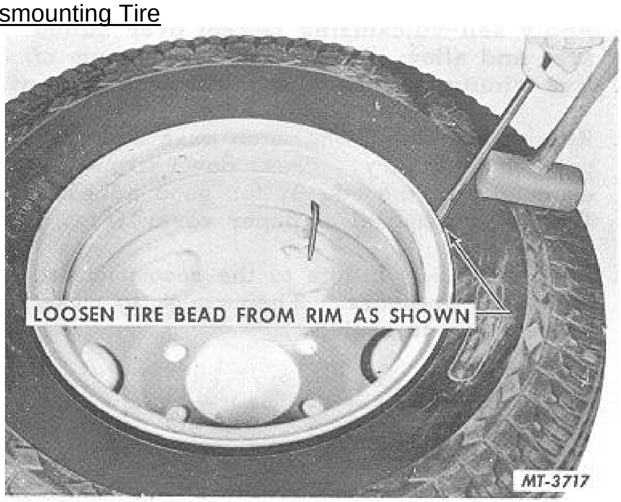

Fig. 20

Completely deflate tire by removing valve core. Loosen tire bead from ring by driving the curved end of tool between ring and bead (Fig. 20).

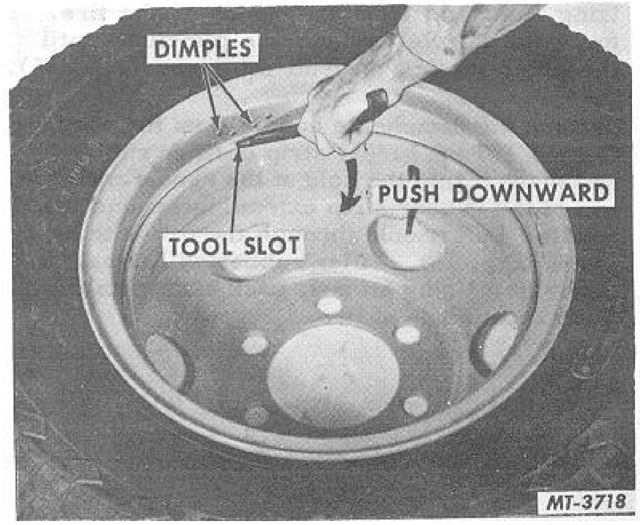

Fig. 21

Insert tool into the tool slot. NOTE: Tool slot is located between the two dimples on inside of ring. Push downward on tool until ring is disengaged from rim gutter (Fig. 21).

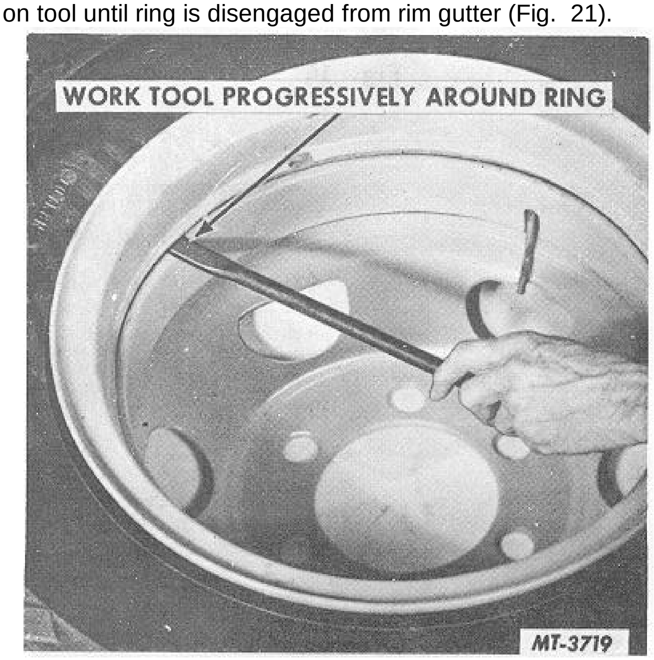

Fig. 22

Work progressively around ring until ring can be removed. Turn tire over and loosen opposite tire bead (Fig. 22).

Remove wheel from tire as shown in Fig. 23.

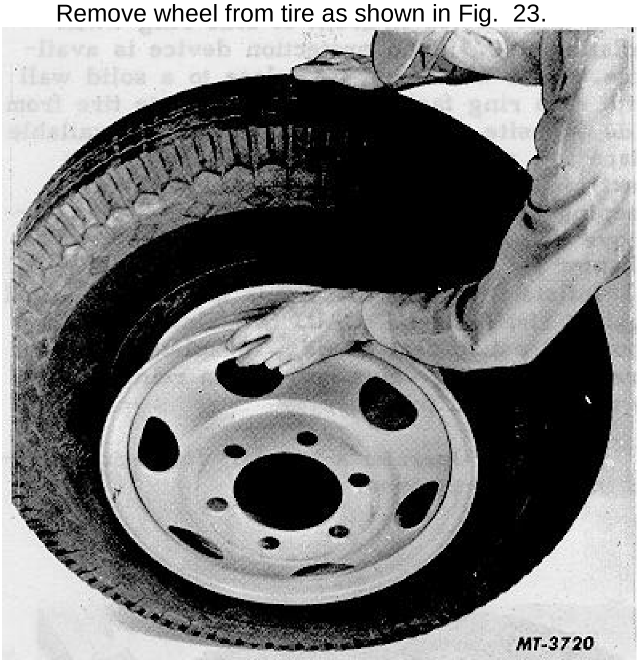

Fig. 23

Mounting Tire

Remove all dirt or foreign matter from wheel. Position tube in tire and inflate until tube is nearly rounded out. Lubricate tire beads, rim sides of tube, and tire flap sides. Position flap in tire. Lay disc portion of wheel on floor (Fig. 24).

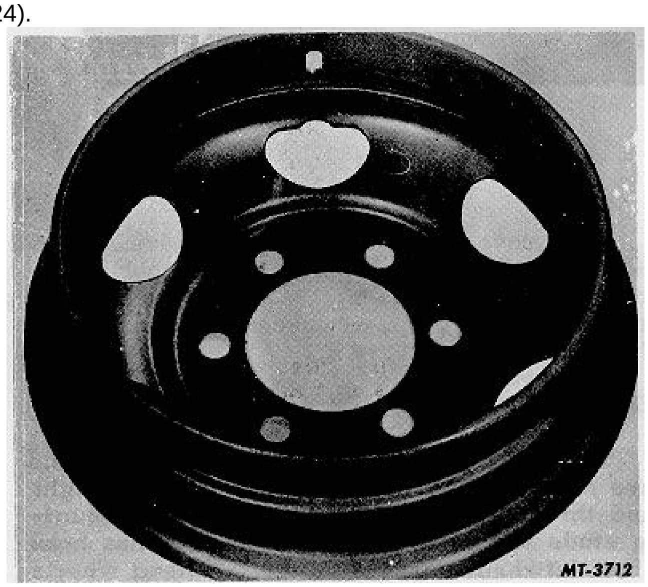

Fig. 24

NOTE: Do not use commercial rubber lubricants for mounting tires to aluminum wheels.

Install tire and lube assembly being sure valve stem is pointing in position shown in Fig. . 25

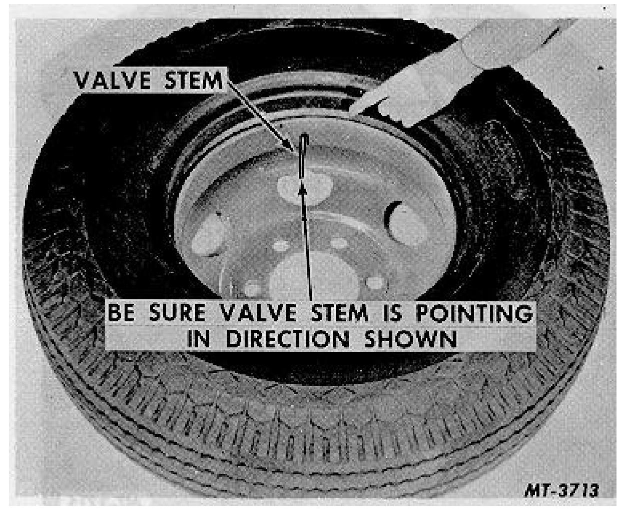

Fig. 25

Position side ring to wheel so that tool slot "A" is away from the valve stem (Fig. 26). This will prevent tool from contacting valve stem.

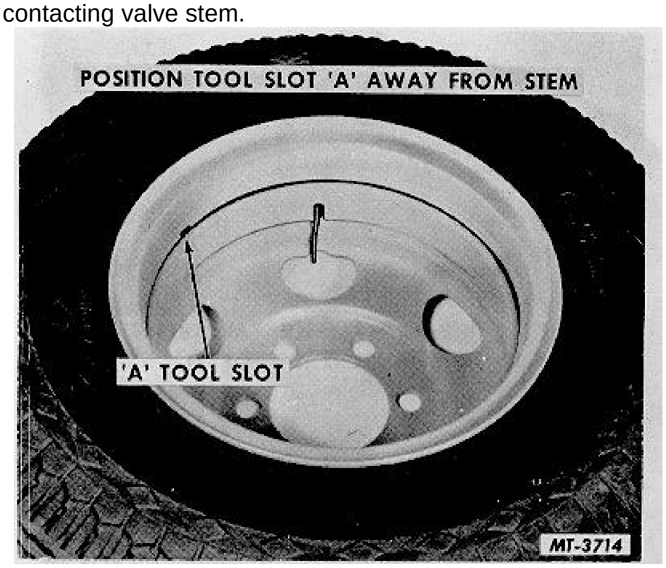

Fig. 26

Step on the ring to force tire down, until cut-away "AA" on ring slip over the edge and hook on rim. Then insert tool into tool slot and push outward (Fig. 26). Hold onto tool and hammer the ring between slot and nearest cut away. This action will hook ring and rim together.

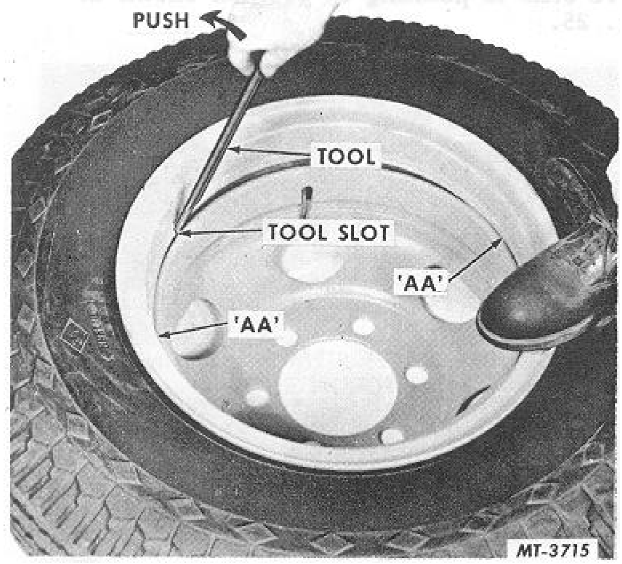

Fig. 27

Using a rubber hammer tap around wheel (side) ring to be certain it is properly seated (Fig. 28).

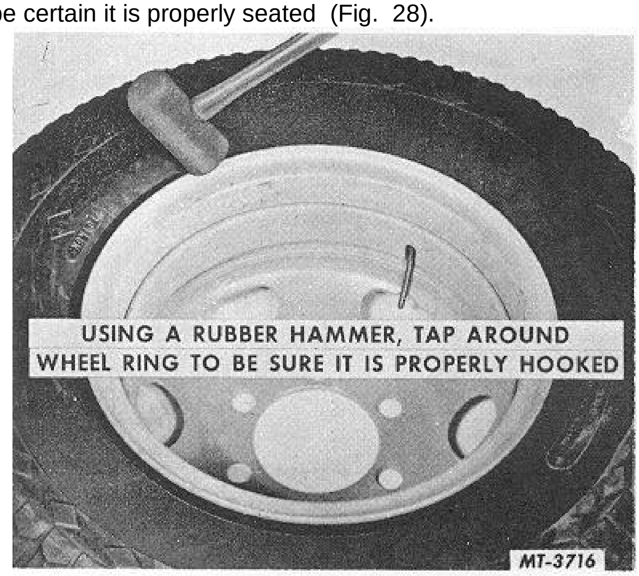

Fig. 28

When side ring is properly installed on rim, it is loose. If side ring cannot be moved, the ring is binding.

CAUTION!

TO PREVENT POSSIBLE BODILY INJURY caused by the wheel side ring being blown off with extreme violence during inflation, DO NOT stand unprotected in front of side ring when inflating tire. If no protection device is available, stand wheel and tire close to a solid wall with side ring facing the wall. Inflate tire from side opposite ring. If no solid wall is available place tire and wheel on floor with side ring next to floor (down) and inflate from above keeping body AWAY from directly in front of or above tire at all times. See Precautions, Chapter I.

Inflate tire until tire beads are firmly seated against rim flanges. CAUTION: Never inflate above 40 psi to seat beads. Completely deflate tire by removing valve core; then reinflate tire to recommended pressure.

Refer to "Operator's Manual" for recommended inflation pressures. /

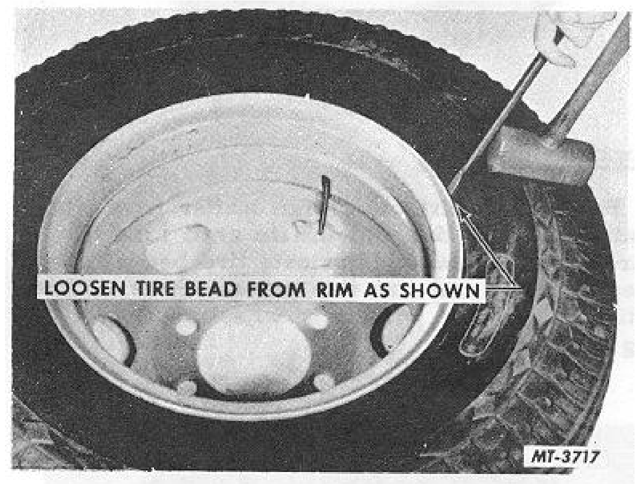

Fig. 29

To remove side ring from a new rim, spread the rim and side ring apart. Insert tool in the tool slot and pull tool to the left. After side ring starts to lift over lip, remove ring from rim (Fig. 29).

MOUNTING NUTS (Disc Wheels)

Where Standard automotive type disc wheels have been used in the past, both left and right hand threads will be found at the wheel mounting studs and nuts. Common practice has been to use left-hand threads at the left-hand wheels and right-hand threads at the right side of the vehicle. This was done to assure keeping wheel mounting nuts tight.

With the improvement in design of both wheel bolt holes and mounting bolts or nuts the left-hand threaded parts are no longer used and right-hand threaded parts are used at all wheels. To prevent loosening of wheel bolts or nuts, cup-shaped depressions are formed in wheel disc at the bolt holes so that when mating cup-shaped nut or bolt is tightened, elastic pressure against the nut or bolt together with thread friction prevents loosening in service. For this reason wheel mounting bolts, nuts and wheel bolt hole surface must not be lubricated.

It is good practice to tighten wheel nuts daily during the first 500 miles of service on new vehicles and anytime wheels have been removed. Regular inspection periods should be established to' assure keeping nuts tightened.

ONE PIECE DROP CENTER HEAVY DUTY TUBELESS TIRES (7.00-20 and Up)

The mounting or demounting of heavy duty tubeless truck tires is accomplished in much the same manner as light duty or passenger-car type tubeless tires. Consequently, same precautions for protecting the sealing edges of the tire beads and rims should be observed. Rims used are all of the one-piece drop-center type whether they are integral with wheel (disc type) or demountable (cast type). Because heavier tires are less flexible, it is suggested that the special tubeless truck tire tools, which are available, be obtained. Fig. 30

Fig. 30

Dismounting Instructions

1. Remove the valve core to completely deflate tire. With tire lying flat on the floor, loosen beads from rim seats by walking around on tire with heels at points close to rim. With wide side of rim down, lubricate top bead thoroughly. Insert spoon ends of both tire irons between rim and tire bead at points about 10" apart. While standing on tire, pull end of tire iron to the opposite side of rim so as to pry tire bead up and out of rim (Fig. 30).

2. Hold tool in position with one foot and pull second tool toward center of rim (Fig. 31). Progressively work bead off rim in this manner, taking additional bites as necessary.

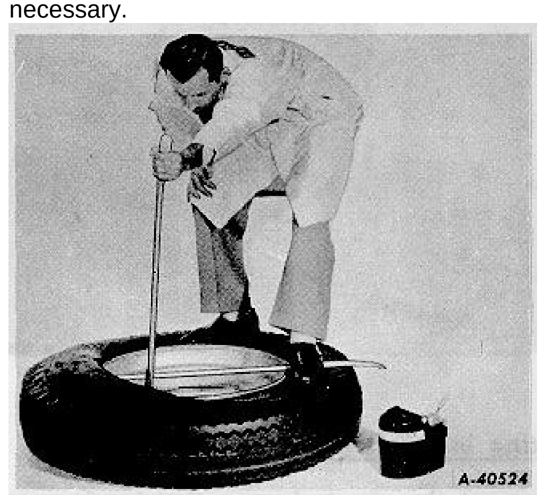

Fig. 31

3. Stand assembly in a vertical position and lubricate second bead. At top of assembly, insert straight end of tool between bead and back flange of rim at about 45 degree angle (Fig. 32).

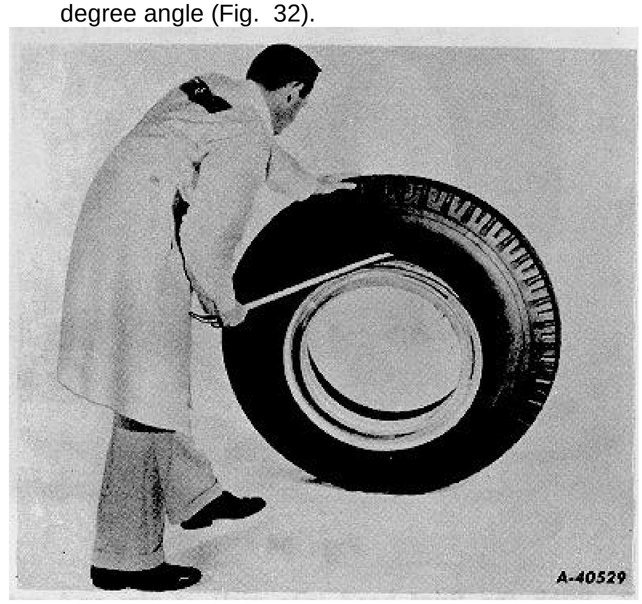

Fig. 32

4. Turn tool so it is perpendicular to rim and pry off second bead (Fig. 33).

Fig. 33

Mounting Instructions

1. Inspect the rim to insure that bead seats are clean and smooth. Then place rim on the floor with wide side down and lubricate first bead of tire and upper bead seat of rim (Fig. 34).

Fig. 34

2. Push the first bead into well of rim and onto rim as far as possible. Using straight end of tool (with stop resting on rim flange), take small bites to work remaining section of first bead onto rim (Fig. 35).

Fig. 35

3. Hold the second bead in the well by standing on tire. When necessary, push a section of the bead into rim well and anchor with a vise-grip pliers by pinching the plier onto the rim flange (snub side toward tire). Using spoon end of the tire iron with stop toward rim, work progressively around the bead, using small bites until bead slips over flange onto the rim base. If necessary, insert a second tire iron and lubricate the last 15.3 cm (6") of bead before completing mounting (Fig. 36).

Fig. 36

4. Check valve to be certain that hex nut at the base is tight; also check valve core to make sure that no air loss can occur. Stand tire in a vertical position and inflate to recommended air pressure.

TWO-PIECE FLAT BASE (Continuous Base, Split Side-Ring)

<u>Dismounting:</u>

1. Deflate tire or both tires if working on duals completely by removing the valve core, before removing tire and rim assembly from truck. Remove tire from truck and place on floor with the side-ring up. Pry bead loose from side-ring by inserting curved end of rim tool and hooked-end of rim tool between side-ring and side-wall of tire. Then apply downward pressure on rim tools. Continue to pry around tire until bead is completely free from side-ring (Fig. 37).

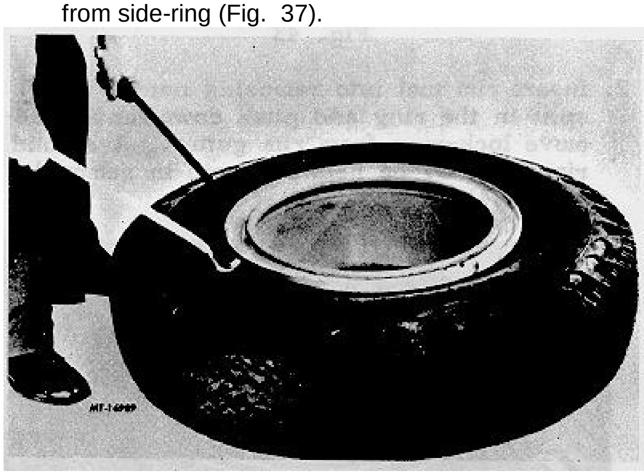

Fig. 37

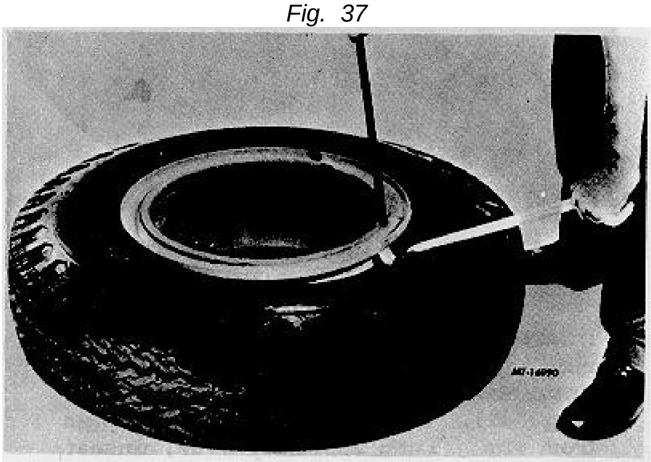

Fig. 38

2. Insert tapered end of tool into notch on sidering, pry ring upward and outward to remove side-ring from its groove in rim. Place hooked-end of tool between the ring and tire. Pry upward on ring and downward on tire to free ring from tire bead (Fig. 38).

3. Continue prying around tire until ring is free (Fig. 39). Turn tire and rim assembly over on floor. Unseat second bead from rim. Lift the rim from tire. Remove tube and flap, if used, from tire.

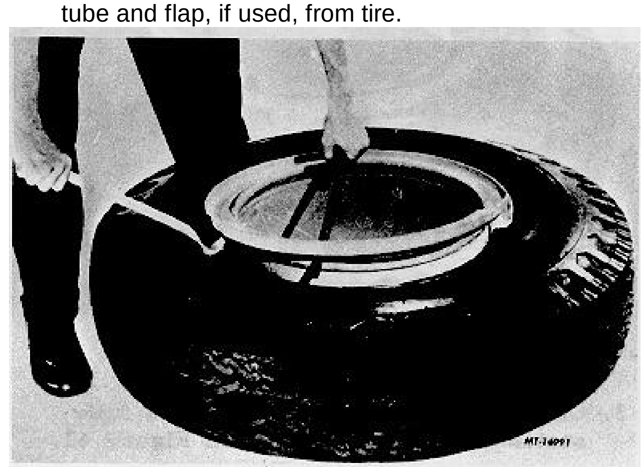

Fig. 39

<u>Mounting:</u>

1. Place tube and flap into tire and partially inflate to round out tube. Apply approved rubber lubrication to inside and outside surfaces of both beads and also to the portion of tube and flap that appears between beads. With valve slot up place rim flat on floor. Align valve with rim valve slot, place tire on rim and insert valve through valve slot. Place side-ring on rim base with ring split opposite the valve stem. Install leading end of ring into gutter of rim (Fig. 40).

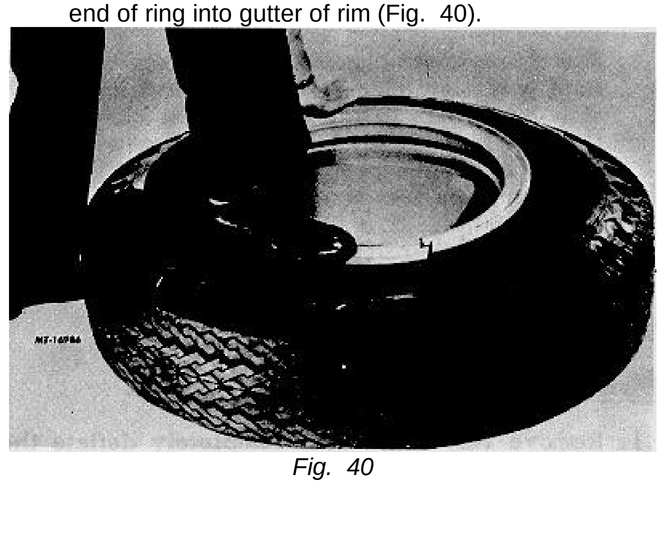

Fig. 40

2. Continue "Walking" side-ring into place (Fig. 41). ,

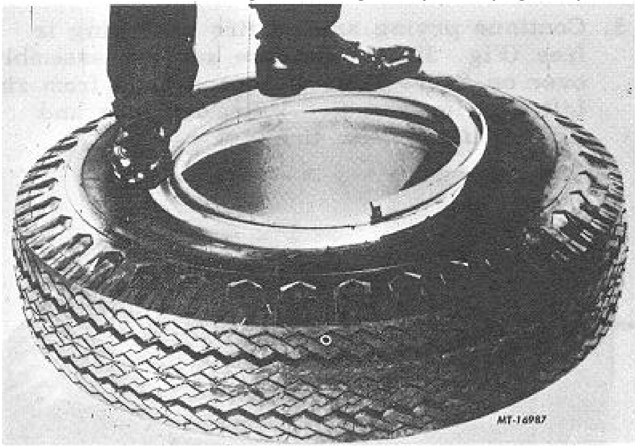

Fig. 41

3. Check to insure that side-ring is fully seated in gutter as shown in Figure 42.

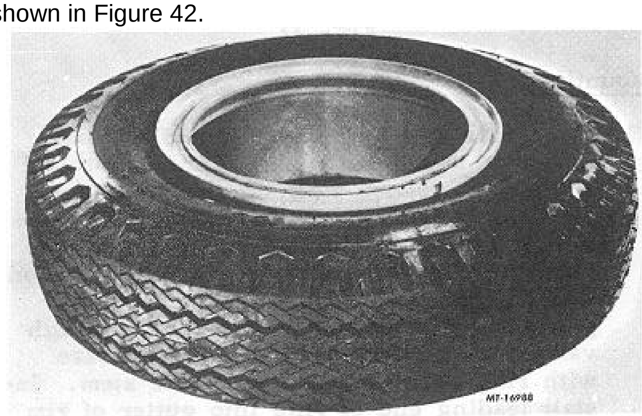

Fig. 42

4. Place tire assembly into safety cage and inflate to a maximum of 10 psi using an extension hose with gauge and clip-on chuck. Check side-ring by lightly tapping with mallet to insure proper engagement. Inspect to insure proper seating of beads. Completely deflate tire to prevent tube from buckling. Reinflate to recommended pressure.

THREE-PIECE FLAT BASE

Dismounting:

1. Remove valve core and completely deflate the tire or both tires if working on duals before removing the tire and rim assembly from the truck. Remove tire assembly from truck and place on floor with the side-ring up. Insert tapered end of rim tool into depression in lock ring, or between rings, and press down on side ring to free bead. Continue around tire until the bead is completely freed from the bead seat (Fig. 43).

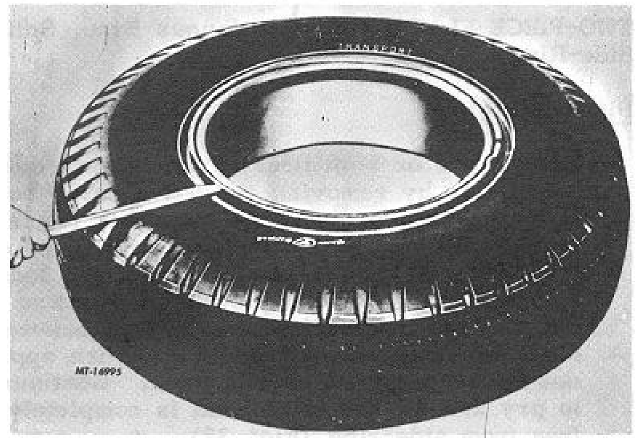

Fig. 43

2. Insert rim tool into removing notch, near split in the ring and push downward to remove lock-ring from rim gutter. A second rim tool may be helpful to aid in removal (Fig. 44).

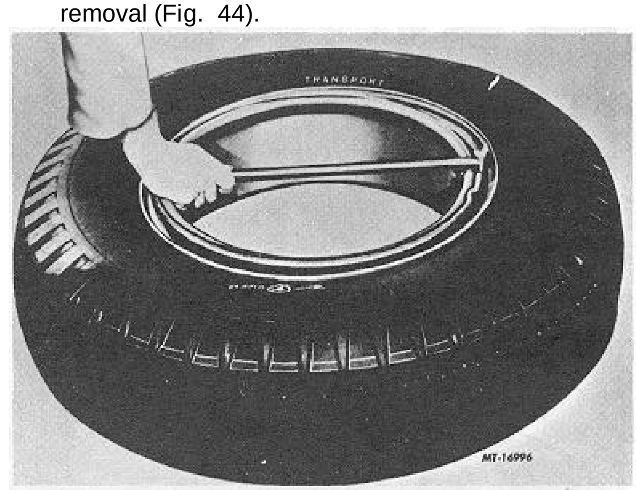

Fig. 44

3. Insert rim tool between lock-ring and sidering. Press down to pry ring up and continue around rim until lock-ring is free (Fig. 45). Remove lock and side-rings from rim. Turn assembly over, unseat second tire bead, stand tire up and remove rim base.

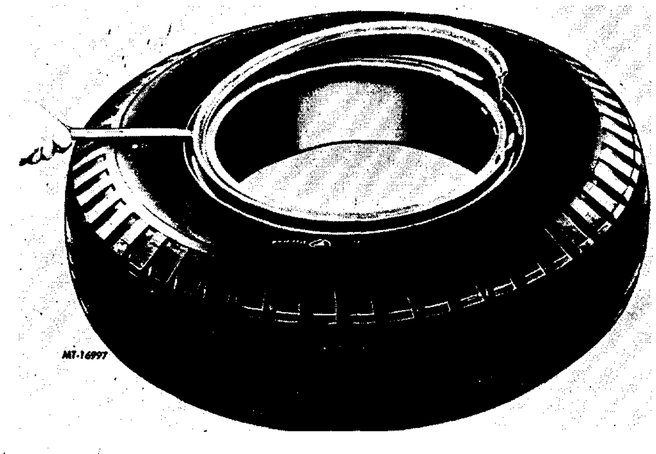

Fig. 45

Mounting'

1. Insert tube and flap into tire and partially inflate to round out tube. Apply approved rubber lubricant to inside and outside surfaces of both beads and also to the portion of tube and flap that appears between beads. Lay rim flat on floor with valve slot up. Align valve with rim valve, place tire on rim and insert valve through valve slot.

2. Place side-ring on bead of tire. Insert tapered end of lock-ring between side-ring and rim base (Fig. 46).

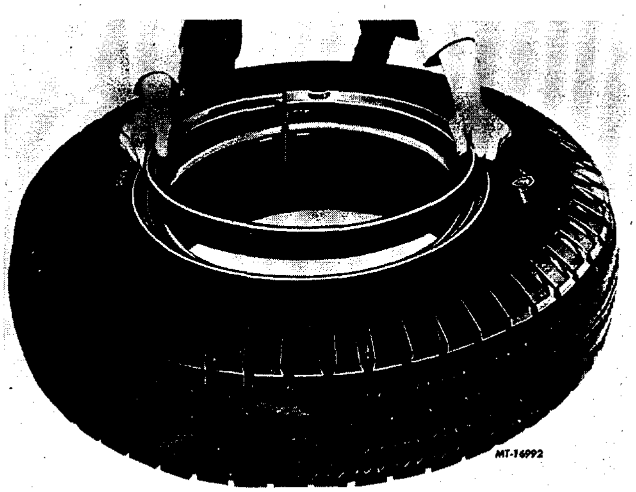

Fig. 46

3. Fasten lock-ring by holding at one end of split with foot and hammering end of ring into place with rim mallet ,(Fig. 47).

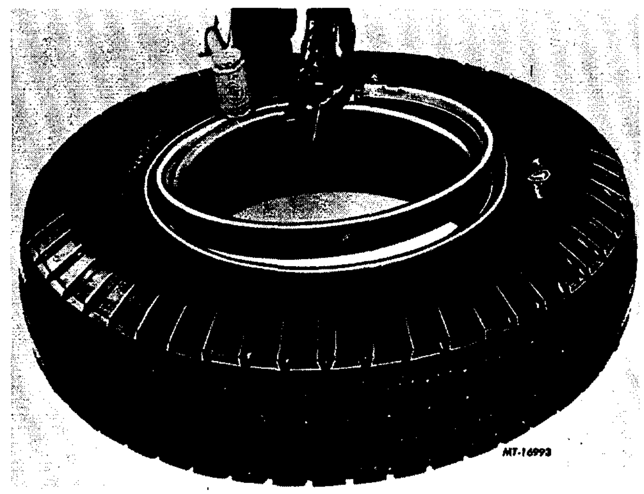

Fig. 47

4. Continue hammering around rim while holding ring with foot until entire ring is seated (Fig. 48).

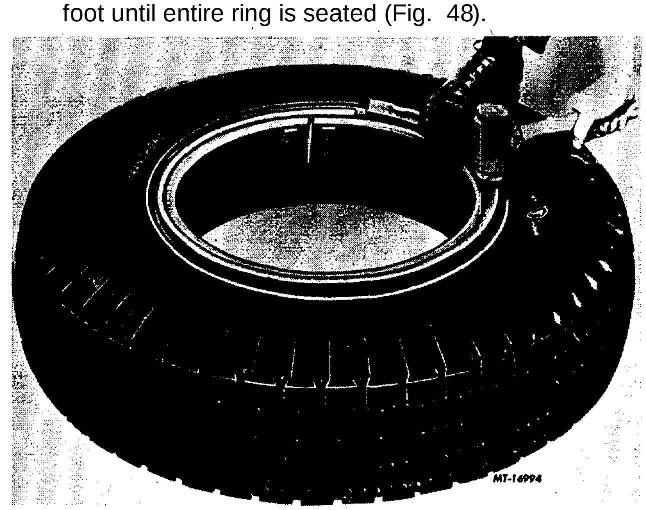

Fig. 48

5. Place tire assembly into safety cage and inflate to a maximum of 10 psi using extension hose with gauge and clip-on chuck. Inspect beads, side-ring and lock-ring for proper seating. Completely deflate tire to prevent tube from buckling. Reinflate to recommended pressure.

TIRE LOAD AND INFLATION CHART

(For Trucks, Buses and Trailers in Normal Highway Service)

Tire Size Designations: Tube Type	Tubeless		Tire Load Limits at Various Cold Inflation Pressures															
		*	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115
		**	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
7.50x20	8-22.5	D	2070	2220	2350	2490	2620	2750D	2870	2990	3100E	3210	3320	3430F	3540	3640G		
		S			2360	2530	2680	2840	2990	3140D	3270	3410	3530E	3660	3780	3910	4040	4150G
8.25x20	9-22.5	D	2460	2640	2800	2960	3120	3270	3410	3550E	3690	3820	3950F	4070	4200	4320G		
		S			2800	3010	3190	3370	3560	3730	3890	4050E	4210	4350	4500F	4640	4790	4920G
9.00x20	10-22.5	D		3120	3310	3510	3690	3870	4040E	4200	4360	4520F	4670	4820	4970G			
		S				3560	3770	4000	4210	4410	4610E	4790	4970	5150F	5320	5490	5670G	
10.00x20	11-22.5	D			3760	3970	4180	4380	4580	4760F	4950	5120	5300G	5470	5630	5800H		
		S					4290	4530	4770	4990	5220	5430F	5640	5840	6040G	6240	6430	6610H
10.00x22	11-24.5	D			4000	4230	4450	4660	4870	5070F	5260	5450	5640G	5820	6000	6170H		
		S					4560	4820	5070	5310	5550	5780F	6000	6210	6430G	6630	6840	7030H
11.00x20	12-24.5	D			4100	4330	4560	4780	4990	5190F	5390	5590	5780G	5960	6150	6320H		
		S					4670	4940	5200	5450	5690	5020F	6140	6370	6570G	6790	7010	7200H
11.00x22	12-24.5	D			4350	4600	4840	5080	5300	5520F	5730	5940	6140G	6330	6530	6720H		
		S					4960	5240	5520	5790	6040	6290F	6530	6770	7000G	7220	7440	7660H
11.00x24		D			4620	4890	5140	5390	5630	5860F	6090	6310	6520G	6730	6930	7130H		
		S					5270	5570	5860	6140	6420	6680F	6940	7190	7430G	7670	7900	8130H
12.00x20		D				4930	5190	5440	5680	5910	6140G	6360	6580	6790H	7000	7200J		
		S						5620	5920	6200	6480	6740	7000G	7250	7500	7740H	7980	8210J
12.00x24		D				5550	5840	6120	6390	6650	6910G	7160	7410	7640H	7870	8100J		
		S						6330	6660	6980	7280	7580	7880G	8160	8450	8710H	8970	9230J
	15-22.5	D		5000E	5320	5620	5910F	6200	6480	6740G	7000	7250	7500H					
		S				5680E	6040	6390	6720F	7040	7360	7660G	7950	8240	8520H			
	16.5-22.5	D		5800	6170	6520	6860	7190	7520	7820	8120H							
		S				6590	7010	7410	7790	8170	8540	8890	9230H					
	18-22.5	D		6430	6850	7230	7610G	7980	8330	8680H	9010	9340	9650J					
		S				7310	7780	8220	8650G	9070	9470	9860H	10240	10610	10970J			

For applicable load limits for other than normal highway service, for other size designations and for size designations with suffixes such as "ML" consult the tire manufacturer.

* Cold Inflation Pressure for Bias Tires.

** Cold Inflation Pressure for Radial Tires. Radial Tires have an "R" in the Size Designation; examples 10.00R20.

TIRE AND RIM COMBINATIONS

Tube Type

Tire Size	Rim Width
7.50x20	6.00,6.50
8.25x20	6.50,7.00
9.00x20	7.00,7.50
10.00x20	7.50,8.00
10.00x22	7.50,8.00
11.00x20	7.50,8.00
11.00x22	7.50,8.00
11.00x24	7.50,8.00

Tubeless

Tire Size	Rim Width
8-22.5	6.75
9-22.5	6.75
10-22.5	6.75,7.50
11-22.5	7.50,8.25
11-24.5	7.50,8.25
12-22.5	8.25
12-24.5	8.25
15-22.5	12.25
16.5-22.5	12.25
18-22.5	14.00

CAUTION: Always use approved tire and rim combinations for diameters and contours. After mounting dual tires, insure tires do not contact each other under a loaded condition.

CONVERSION OF PLY RATING TO LOAD RANGE DESIGNATION

Load Range	Replaces Ply Rating
A	2
B	4
C	6
D	8
E	10
F	12
G	14
H	16
J	18
L	20
M	22
N	24

CHAPTER IV

TORQUE CHART

DISC WHEELS

Size		Torque N•m	Torque Ft Lbs
11/16"	Flange Nut Mounting	475- 543	350-400
3/4"	Standard Square Cap Nut Mounting:		
	13/16" Across Flats	610- 678	450-500
	1-1/2" Across Flats	610-678	450-500
1-1/8"	Standard Hex Cap Nut Mounting:		
	1-1/2" Across Flats	610-678	450-500
	Heavy Duty Hex Cap Nut Mounting:		
	1-3/4" Across Flats	882- 949	650-700
15/16"	Heavy Duty Square Cap Nut Mounting:		
	1-5/16" Across Flats	1017-1221	750-900
1-5/16"	Heavy Duty Cap Nut Mounting:		
	1-3/4" Across Flats	1017-1221	750-900

CAST WHEELS

1/2"	Rim Clamp	109-122	80-d90
9/16"	Rim Clamp	217-237	160-175
5/8"	Rim Clamp	217-237	160-175
3/4"	Rim Clamp	237-271	175-200

DRY THREADS-NO LUBRICATION

Where excessive corrosion exists, a light coat of lubricant on first three threads of stud on bolt is permitted. Keep lubricant away from cap nut ball faces or ball seats of disc wheels and rim clamps of cast wheels.

FAILURE ANALYSIS

This failure analysis section has been prepared to assist servicemen in diagnosing the cause of failed tire and wheel components. The section contains various corrective measures for preventing the reoccurrence of the same type failure.

This publication has been compiled from actual case histories in an effort to record information that will be of assistance in analyzing tire, wheel, rim, or stud failures.

Proper wheel and tire maintenance is more than simple parts replacement. It also includes the application of mechanical skills and knowledge for reassembly, lubrication and periodic inspection.

INDEX

CHAPTER 1-WHEELS, RIMS

CHAPTER 2-TIRES AND TUBES

CHAPTER 1-WHEELS, RIMS

Road failures are generally caused by either overloading or oversight in the maintenance program. To save hours of downtime a simple visual check of the following components should periodically be made.

Cracked Rims

Cracked rims or flanges are a result of metal fatigue or overloading, thus periodic inspections should be made to assure safe operations, Fig. 1.

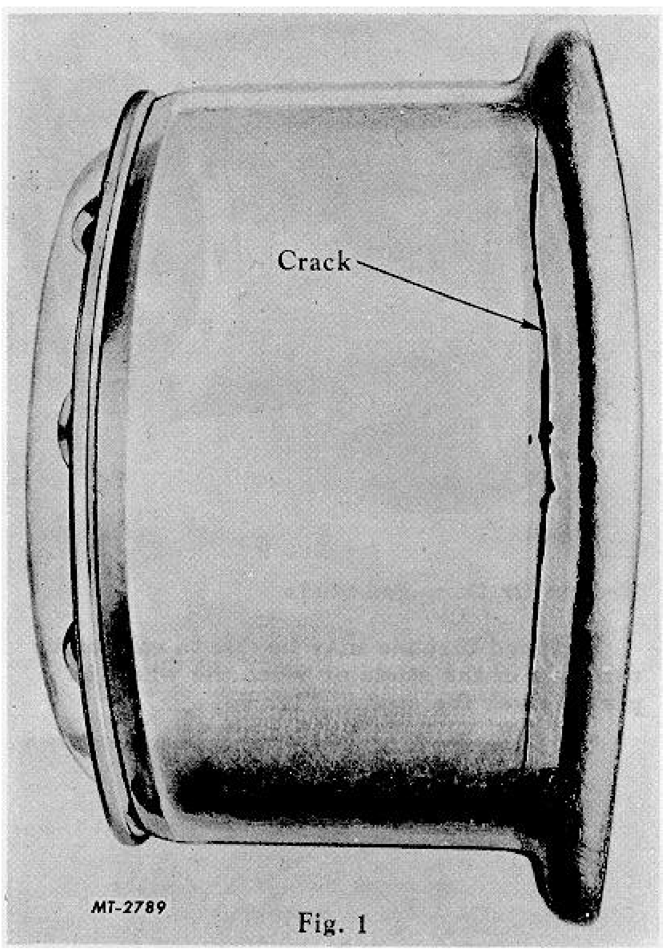

Fig. 1

Rim Corrosion

Corrosion is occasionally found on both tubed and tubeless type rims, Fig. 2. If the corrosion is minor a wire brushing or buffing' will clean satisfactorily. The tire mounting surfaces of the rim can then be painted with a good quality frame enamel or coated with a non-water suspended lubricant. If corrosion is excessive, fatigue cracks may have developed in the rim base or the ring may not be seating in the gutter. The wheel in this case should be replaced.

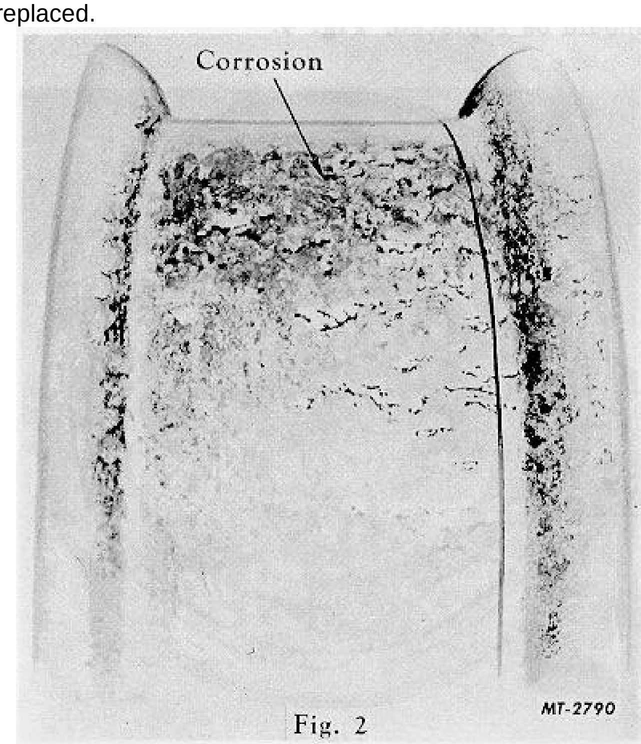

Fig. 2

Damaged Or Cracked Rings

Broken or cracked rings are generally caused by rough use of tire tools or improper initial seating in the rim gutter. Bent or sprung rings are caused by rough or improper removal, and cannot be properly reformed to seat accurately in the rim gutter. They should be replaced, Fig. 3. When removing the rings they should be worked off in small steps, starting at one point and gradually working in one direction around the entire circumference.

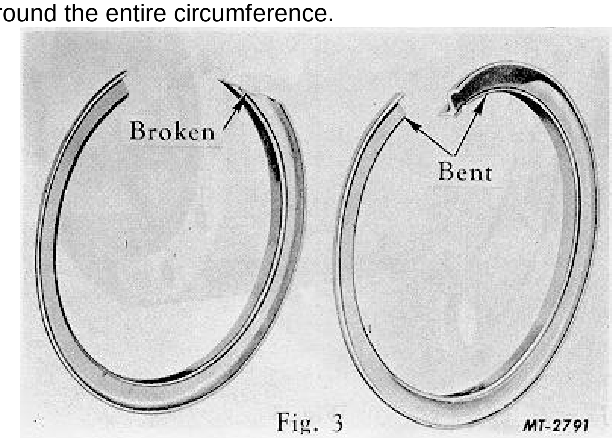

Fig. 3

Worn Wheel Stud Holes

This condition will usually be accompanied by evidence of a bright worn surface on the wheel face, indicating that loose wheels are working against each other. The wheels should be replaced, Fig. 4.

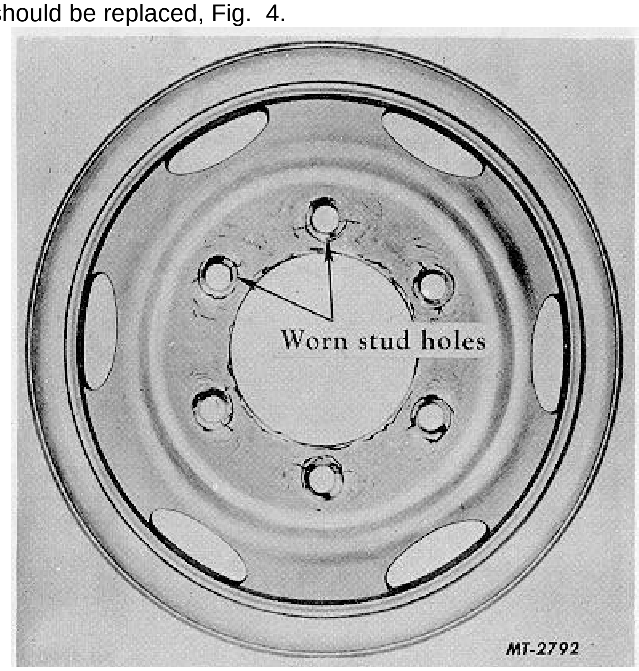

Fig. 4

Worn Hub Face

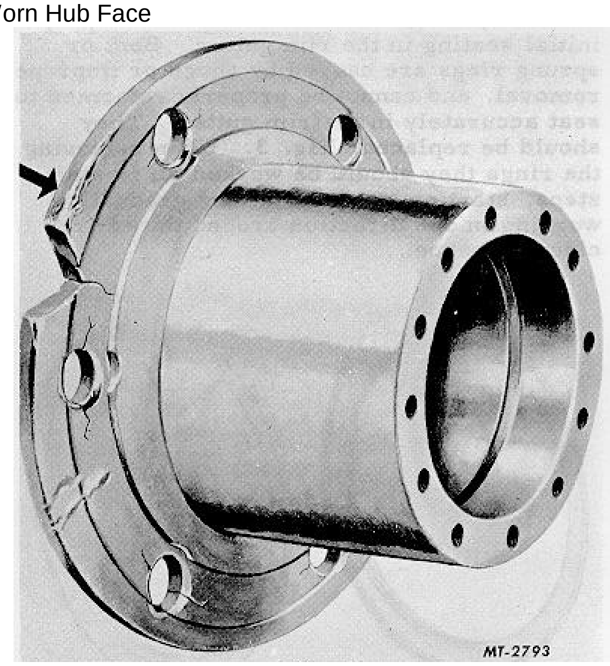

Fig. 5

A worn hub face is always caused by running wheel assemblies in a loose condition. If the wear is not too excessive the hub face can be machined to a flat surface with the studs removed, otherwise a new hub should be installed, Fig. 5.

Broken Or Cracked Hub

If the hub barrel or flange is broken or cracked the unit must be replaced, Fig. 6.

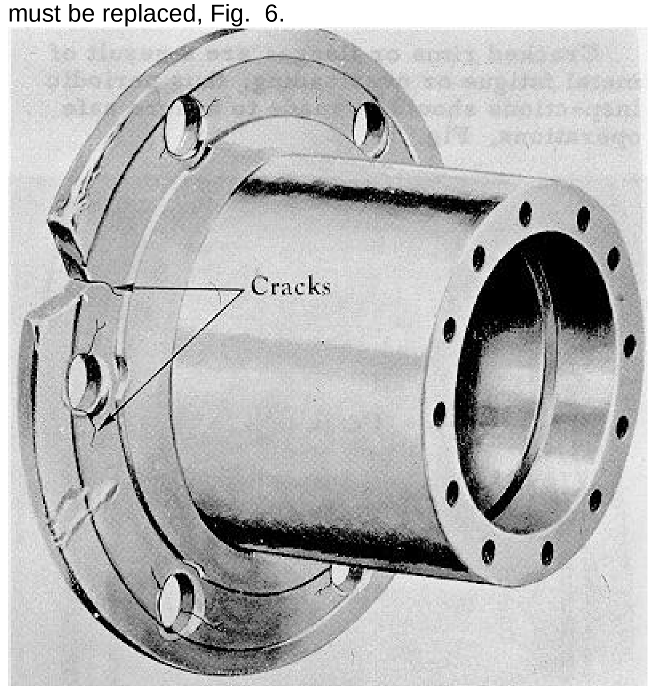

Fig. 6

Broken Or Damaged Studs

Stripped threads may be due to excessive torquing of the studs or when the wheel is placed over the studs, Fig. 7.

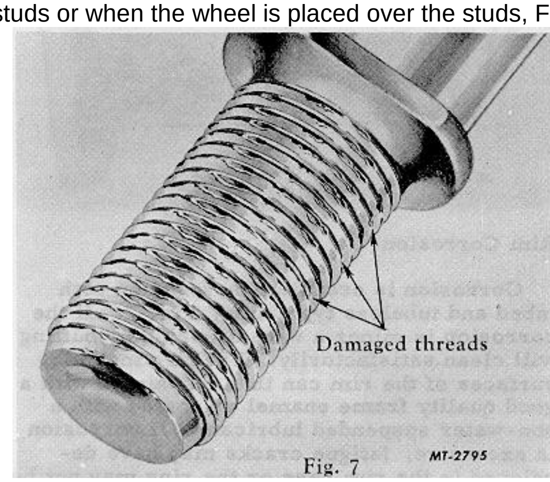

Fig. 7

Stud Corrosion

While this problem is not too common, it can occur and make it difficult to obtain accurate' torque checks. When corroded studs are encountered thorough wire brushing is necessary. If corrosion is excessive, stud replacement is recommended. If corrosion is persistent and a definite problem is encountered with the cap nut freezing, the lubrication of the first three threads of the stud with a graphite base lubricant will solve this problem. Care must be taken to assure that no lubricant gets in the ball seats of the stud holes or in the ball faces of the cap nuts. Clean, dry cap nut faces and nut seats at the wheels is necessary to maintain tight nuts to specified torque. DO NOT OIL nut or stud threads except as stated above.

Worn Stud Grooves

This is a result of improper initial assembly of the stud, or from insufficiently tightened cap nuts. Either of these conditions allow the shoulder of the stud to work in the groove and eventually wear the groove until the stud will not hold, Fig. 8.

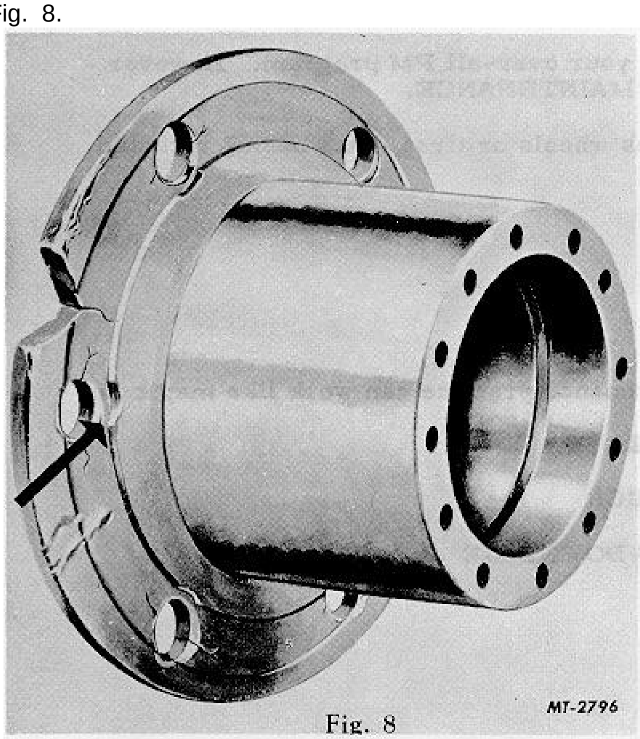

Fig. 8

Use Of Correct Studs

When it is necessary to replace studs in a hub, it is very important that the correct stud is used. Fig. 9 and 10 illustrate the correct stud application.

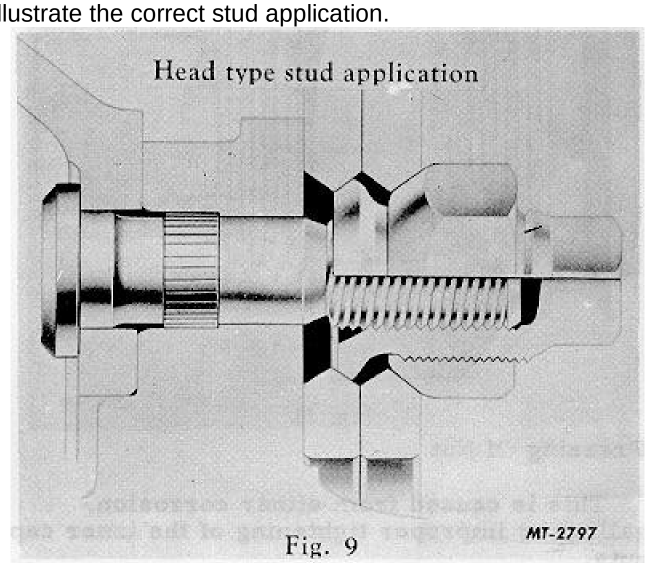

Fig. 9

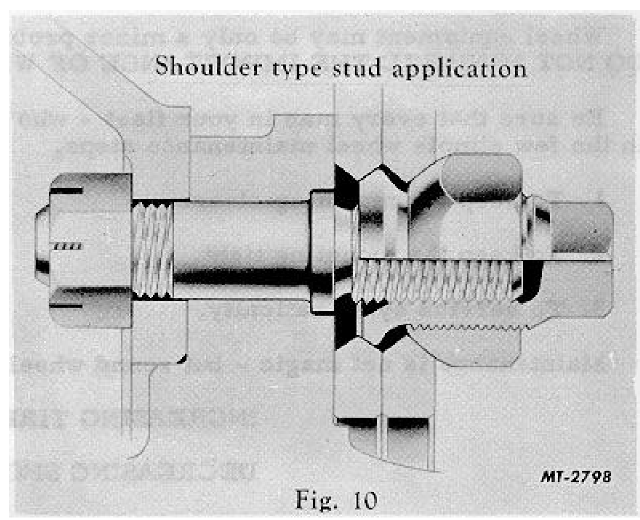

Fig. 10

CAP NUTS

Worn Ball Faces

This is a result of operating on a loose wheel assembly, Fig. 11.

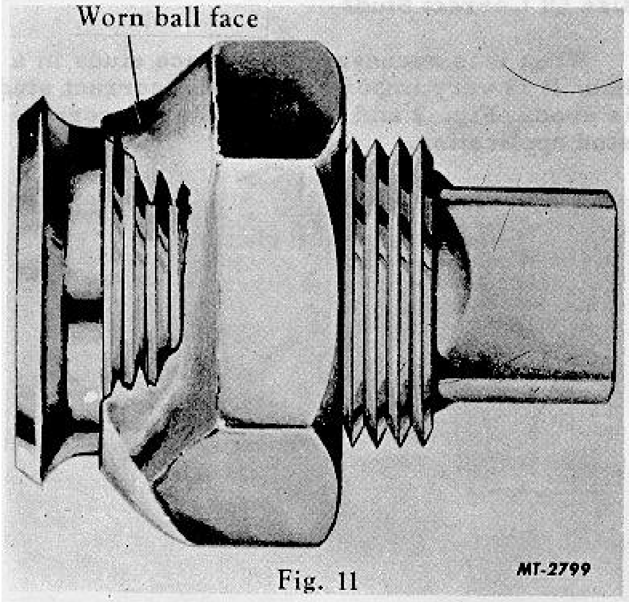

Fig. 11

Fig. 11

Freezing Of Nut

This is caused from either corrosion, galling or improper tightening of the inner cap nuts.

TO THE FLEET OPERATOR

Wheel equipment may be only a minor problem in your over-all PM program. However - DO NOT MINIMIZE THE IMPORTANCE OF WHEEL MAINTENANCE.

Be sure that every man in your fleet-who handles wheels or tires-has been instructed in the few simple wheel maintenance steps.

1. To keep the mounting clean.

2. To keep the mounting tight.

3. To service systematically.

Maintenance is not magic-but sound wheel maintenance practice can work like magic in:

INCREASING TIRE MILEAGE

DECREASING SHOP LABOR

REDUCING OPERATING DOWNTIME

CHAPTER 2 - TIRES AND TUBES

GENERAL

Proper maintenance and careful driving will result in maximum tire life. When a tire is properly inflated it will provide maximum traction, resist damage from road shock, tires will run cooler and "squirm" less than at a lower pressure. A tire properly inflated can be injured when a chuck hole, curb or other object is struck with sufficient force. When driving on a rough surface road slow down. Tread wear can be shortened by driving habits such as, sudden stops, excessive use of brakes, driving at excessive speeds, and riding on edge of pavement.

Air pressure is what enables tires to support a load and proper inflation is essential for maximum tire life. Refer to the vehicles operator manual or tire manufacturer's inflation chart for proper air pressure. Remember that the recommended pressures are cool tire pressure. Check air pressure before driving or after tires have a chance to cool.

"Bleeding" air from hot tires should never be practiced. The pressure will be reduced, but an increase in temperature and pressure will result as soon as driving continues.

TREAD WEAR PATTERNS

Underinflation:

The abnormal wear of the treads as shown in Fig. 12 is due to underinflation. Increase air pressure to the recommended level. Never exceed maximum tire pressure.

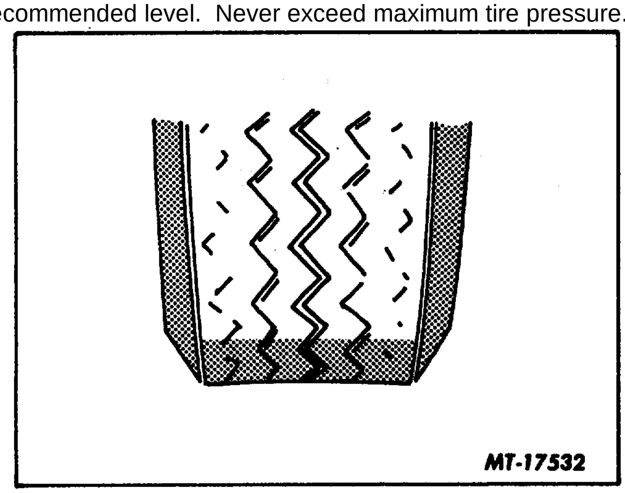

Fig. 12 Underinflation Causes Excessive Side Tread Wear

Overinflation:

Excessive wear in the center of the tread is due to overinflation, Fig. 13. Never "bleed" air from hot tires. The pressure will be reduced but an increase in temperature will result as soon as driving continues.

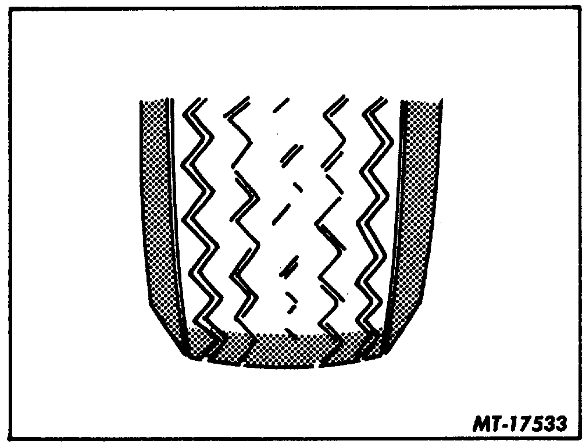

Fig. 13 Overinflation, Excessive Wear in Center of Tread

Fast Cornering:

Fast cornering causes tires to wear more on the shoulders of the tread as shown in Fig. 14. Slow down before negotiating curves or corners.

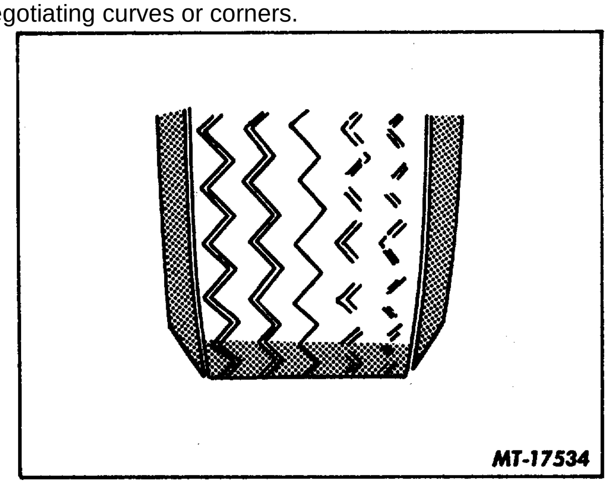

Fig. 14 Fast Cornering Results in Excessive Wear on Shoulders of Tread

Camber:

Excessive even tread wear on one or the other side of a tire indicates too much wheel camber, Fig. 15. Unequal camber can cause one tire to wear uneven and pull vehicle to one side. Readjust camber to specifications of vehicle, see proper service manual.

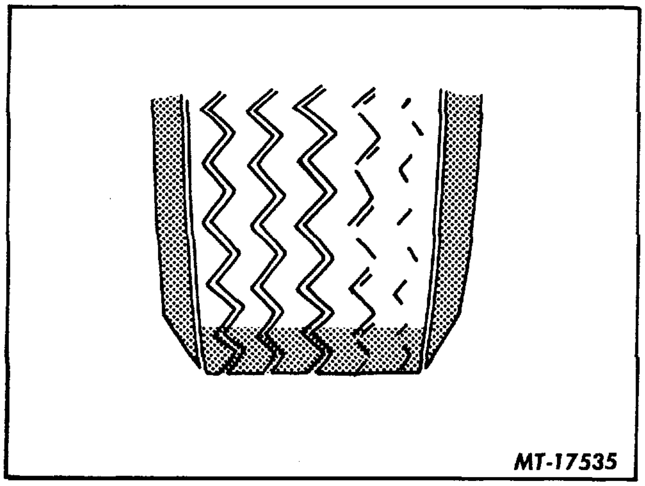

Fig. 15 Excessive Even Tread Wear on One Side Caused by Too Much Camber

Mechanical Problems:

Mechanical problems or underinflation can cause irregular tread wear as shown in Fig. 16. A single spot or a series of cuppings around the circumference of a tire is usually caused by a combination of worn wheel bearings, worn shock absorbers, loose tie rods, out of balance wheel and tire assemblies, or brakes that grab. Inspect and service parts as required.

Caster is the backward tilt of the axle or inclination of the king pin at the top. Too little caster causes wheel wander or weave resulting in irregular tread wear. Too much caster may cause wheel "shimmy". Unequal caster will cause wheel pull to one side, resulting in excessive irregular tread wear.

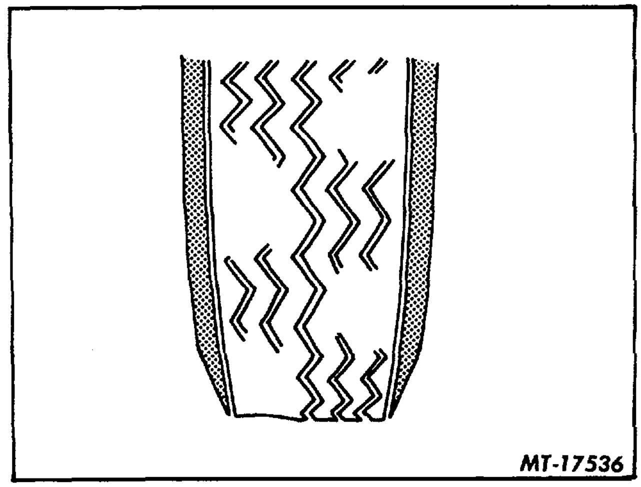

Fig. 16 Irregular Tread Wear May be a Sign of Mechanical Problems

Misalignment:

Misalignment causes a tire to be dragged sideways over the road. Excessive toe-in produces a feathered edge on the inside of the tread design. Toe-out causes a feathered edge on the out-side of the tread design. Align to specifications of vehicle.

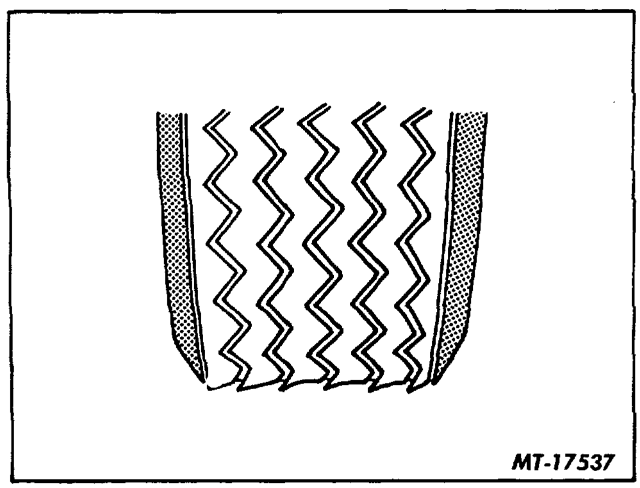

Fig. 17 Feathered Edge is Result of Misalignment

TIRE INJURIES

Ply or Tread Separation:

Ply or tread separation as shown in Fig. 18 can result from underinflation, overloading, or high speed.

Driving a tire that is flat or seriously underinflated can cause unrepairable cord breakage, ply, and even tread separation. The amount of damage is directly proportional to the amount of underinflation and distance driven in this condition.

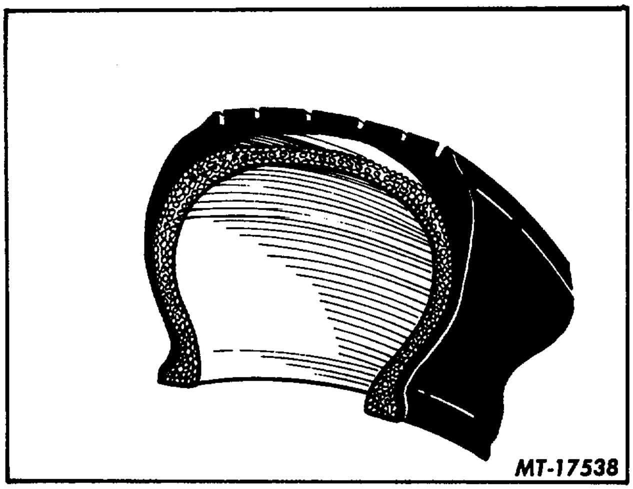

Fig. 18 Tread Separation Result of Underinflation, Overloading, or High Speed

Cord Breakage:

The proper deflection of tire sidewalls is inhibited by the increased tension caused by overinflation. Overinflation increases strain on the cords in the tread area and the tire loses its ability to absorb ordinary road shocks. Under this overinflated condition an impact can cause either an X-break or a diagonal break. Four pounds extra pressure for high speed driving is not considered overinflation, providing the maximum inflation of the tire is not exceeded. Reduce cool air pressure to recommended level. Never "bleed" air from a hot tire.

Even with properly inflated tires, cords can be broken when a tire is crushed between an object like a concrete curb and steel rim of the wheel. The position and breakage of cords is determined by the angle and force of impact.

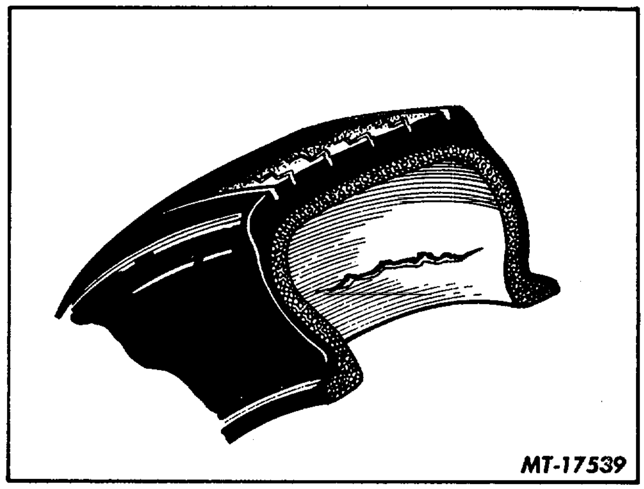

Fig. 19 Broken Cords Caused by Severe Blow

INNERTUBE INJURIES

Chafed Innertube:

Innertubes that are chafed by the tire can be prevented by proper mounting techniques. First inflate innertube to 10 psi, deflate and reinflate innertube to recommended pressure. This procedure will prevent chafing.

Damage to both the innertube and inside of tire can be caused by not cleaning foreign matter from tire, innertube, or wheel at time of assembly. Thoroughly clean tire, innertube, and wheel removing all foreign matter, dirt, rust, and labels from all surfaces.

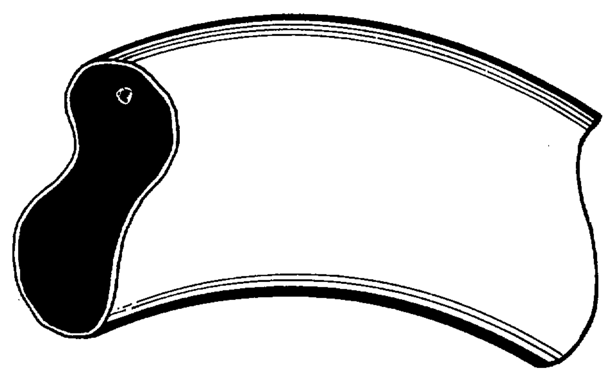

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Fig. 20 Damage Caused by Dirt In Tire

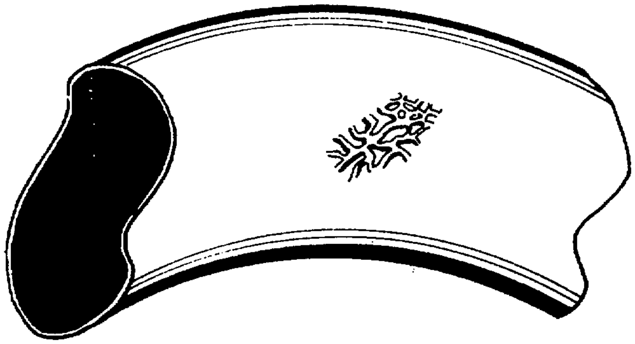

Fig. 21 Damage Caused by Not Removing Label

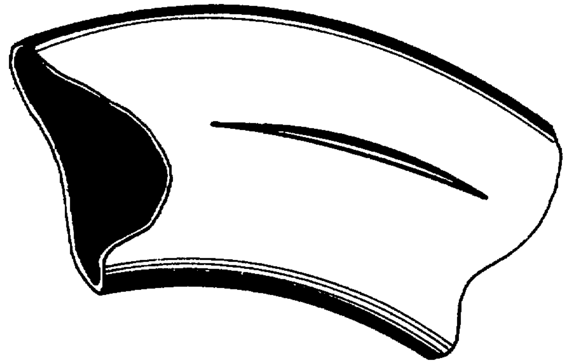

Fig. 22 Crease or Fold Result of Innertube Being Too Large for Tire Pinched Innertube:

Crease or Fold:

Be certain the innertube being used is the proper size for the tire. A crease or fold can result from innertube being too large for the tire, Fig 22.

Underinflation:

Driving on severely underinflated tires can result in a broken valve stem. To prevent damage inflate innertube to recommended cool air pressure.

Pinched Innertube

Proper mounting techniques increase the life of innertubes. Be careful not to pinch innertube with tire iron when mounting tire on rim.

Proper assembly, maintenance and good driving habits will result in maximum wheel, tire and innertube life.

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

SOMETHING WRONG WITH PUBLICATION

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BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

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PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

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 = 3.2808.8 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

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu in.
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Square measure

1 sq. centimeter = 100 sq. millimeters =.155 sq. in.
1 sq. decimeter = 100 sq. centimeters = 15.5 inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 feet
1 sq. dekameter (are) = 100 sq. meters = 1.076.4 sq. ft.
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 hectometers = .386 sq. miles

Liquid Measure

1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons
1 liter = 10 deciliters = 33.81 fl. ounces
1 centiliter = 10 milliliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3 38 fl. ounces
1 metric ton = 10 quintals = 1.1 short tons

Approximate Conversion Factors

To change	To	Multiply by
inches	centimeters	2.540
feet	meters	.305
yards	meters	.914
miles	kilometers	1.609
sq. inches	sq. centimeters	6.451
sq. feet	sq. meters	.093
sq. yards	sq. meters	.836
sq. miles	sq. kilometers	2.590
acres	sq. hectometers	.405
cubic feet	cubic meters	.028
cubic yards	cubic meters	.765
fluid ounces	milliliters	29.573
pints	liters	.472
quarts	liters	.946
gallons	liters	3.785
ounces	grams	28.349
pounds	kilograms	.454
short tons	metric tons	.907
pound inches	newton-meters	.11296

To change	To	Multiply by
ounce inches	newton-meters	.0070062
centimeters	inches	.394
meters	feet	3.280
meters	yards	1.094
kilometers	miles	.621
sq. centimeters	sq. inches	.155
sq. meters	sq. yards	10.764
sq. kilometers	sq. miles	1.196
sq. hectometers	acres	2.471
cubic meters	cubic feet	35.315
milliliters	fluid ounces	.034
liters	pints	2.113
liters	quarts	1.057
grams	ounces	.035
kilograms	pounds	2.205
metric tons	short tons	1.102
pound-feet	newton-meters	1.356

Temperature (Exact)

°F Fahrenheit temperature	5/9 (after subtracting 32)	Celsius Temperature °C

PIN: 061934-000